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**DIVISION 13: SPECIAL CONSTRUCTION**

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**DIVISION 21: FIRE SUPPRESSION**

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<td>321216</td>
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<td>Revised 03/09</td>
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SECTION 011400 - WORK RESTRICTIONS

PART 1 - GENERAL

1.1 SUMMARY
A. As an Electric and Water Utility, SRP has many critical facilities and systems. It is important that Contractors do not interfere with SRP operations. SRP is subject to many government regulations that require restrictions and accountability on access to buildings and rooms within the buildings. As a result, there are many restrictions on access and times of work not found on commercial construction sites.

1.2 REFERENCES
A. Specification Section 015000 Temporary Construction Facilities.

1.3 SUBMITTALS
A. Personnel Roster with full names and birth dates

PART 2 - EXECUTION

2.1 SITE SECURITY
A. SRP facilities may have a security post for access control at the property fence. If so, the security post will control access to the jobsite for the Contractor’s workforce and their personal vehicles.
B. The SRP PM will designate parking areas for personal vehicles shown on the Construction Site Plan required by Specification 015000 Temporary Construction Facilities.
C. Deliveries of materials or equipment shall be coordinated with SRP’s PM at least 24 hours in advance in order to notify SRP Security to grant clearance. Delivery personnel may be required to use specific routes inside SRP facilities in accordance with the Construction Site Plan required by Specification Section 015000 Temporary Construction Facilities.

2.2 PERSONNEL ACCESS & SECURITY REQUIREMENTS
As an electric utility, SRP has several regulatory requirements to limit people accessing SRP facilities.
A. A green (contractor) picture ID security access card may be granted to the Contractor’s PM and Superintendent for one year. The SRP PM will arrange for this.
B. All other members of the Contractor’s workforce (including subcontractors) requiring access to SRP property and the work area will require a temporary visitor badge (issued each day). Contractor must submit a list of full names (including middle name) and date of birth for every Contractor and Subcontractor employee who needs access. SRP Security will conduct a screening of these names and will identify those who will not be granted access and therefore are not allowed to be part of the Contractor’s workforce. SRP PM provide the visitor badges to the Contractor’s Superintendent. The Contractor’s Superintendent will create and enforce a procedure to issue the visitors badges to the workforce. These badges are an accountable item; the Contractor will be charged $20 for every badge not returned at the end of the project.
C. Restricted Areas. Even with green or temporary visitor badges, some areas will require an SRP or Security escort at all times.
D. Tailgating (using one badge and letting another person pass through without using the second badge) in badge reader restricted areas is strictly forbidden and shall result in removal of both persons from SRP property. Contractor personnel with a green (contractor) badge shall escort
contractor personnel with visitor badges at all times on SRP property including in badge reader restricted access areas.

2.3 STANDARD WORK HOURS
A. The standard work hours for construction shall be 5:00 am to 5:00pm. Many SRP facilities are 24 hour operations. So the SRP PM may adjust these hours based upon the standard work day at the building or facility where construction will occur.
B. Many projects are constructed in occupied buildings where construction will interfere with daily 8-5 operations. Therefore some projects will restrict construction work to start after 6pm and end prior to 6am. These are the “standard work hours” for that project as stated in the RFP.

2.4 AFTER HOURS WORK (WEEKDAYS or WEEKENDS)
A. After hours work is defined as work occurring outside the standard work hours established for a particular project. After hours work may be required for tie-ins, electrical outages, fire protection outages, or for overtime to allow the schedule to recover or advance.
B. All after hours work will require advance coordination with and approval by the SRP PM so that resources such as extra security may be coordinated and building occupants can be notified. Provide SRP with written notice one week in advance of desired work date.

2.5 EMERGENCY WORK
A. Emergency work (unscheduled work outside standard work hours) may be necessary to fix a problem caused during construction or in response to a problem encountered by the Contractor due to weather, Act of God (Force Majeure), or other causes. The SRP PM can authorize the Contractor to perform work not scheduled in order to recover from the Emergency.
B. Emergency contacts are the SRP PM, and SRP Security at 602-236-3911.

2.6 TOBACCO POLICY
A. Smoke-Free Areas
   1. Smoking is never permitted in an area where it compromises safety.
   2. Smoking is prohibited in the following areas:
      a. Anywhere inside an SRP building
      b. Directly in front of SRP Facilities main entrances
      c. Within 50 feet of any all access entrances and building air intakes.
B. Smoking Permitted Areas: Smoking is permitted outside in approved designated areas, where posted with SMOKING AREA signs.
C. Chewing Tobacco is permitted as long as it does not pose a safety or hygiene hazard or is a nuisance as defined by the SRP PM.

2.7 HAZARDOUS MATERIALS
A. SRP is responsible to provide the Contractor with documentation that all materials to be disturbed have been tested and cleared for removal “prior” to any work commencing.
B. The Contractor is to post the written documentation of the materials sampled with the results at the job site for the duration of the project.

C. The Contractor is responsible for communicating to all their Sub-Contractors of the materials sampled and the laboratory results as noted in the written documentation provided by SRP.

D. The Contractor and their Sub-Contractors are responsible for notifying the PM should they discover suspect materials or materials not documented as being previously sampled that will impact their work. All work is to cease immediately until SRP’s Facilities Asbestos Administrator ("FAA") has sampled the suspect material(s) and provided documentation that the material(s) are negative and written clearance has been provided to the Contractor. The additional clearance will need to be posted at the job site.

E. Contractor is NOT responsible for removal or abatement of asbestos, lead or any remediation of mold and other hazardous materials. In the event hazardous material(s) are found, all work must come to an immediate halt and the SRP PM notified immediately.

F. SRP will be responsible for providing contractors to abate hazardous material(s). SRP will also be responsible to provide air testing and documentation of clearances after removal.

G. Contractor and the Sub-Contractors are responsible for not using or installing any building material that contains asbestos or any other hazardous material.

END OF SECTION 011400
SECTION 012300 - ALTERNATES

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes administrative and procedural requirements for modifying the Work and Contract Sum with deductive or additive alternates.

1.2 DEFINITIONS

A. Alternate means certain work defined in the Bidding Requirements that may be added to or deducted from the base bid. An Alternate can encompass a change in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.

1. Alternates described in this Section are part of the Work only if specifically included in the Contract.

2. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate the Alternate into the Work. The credit for a deduction must include a corresponding reduction in the fee. No other adjustments are made to the Contract Sum.

1.3 PROCEDURES

A. Coordination: Modify or adjust affected adjacent work as necessary to completely integrate the Alternate into Project.

1. Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not indicated as part of alternate.

B. Notification: Immediately following award of the Contract, notify each subcontractor, supplier or party involved, in writing, of the status of each Alternate. Indicate if Alternates have been accepted, rejected, or deferred for later consideration. Include a complete description of negotiated modifications to Alternates.

C. Execute accepted Alternates under the same conditions as other work of the Contract.

D. List: A list of Alternates is included at the end of this Section. Specification Sections referenced in list contain requirements for materials necessary to achieve the work described under each Alternate.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 LIST OF ALTERNATES

A. Alternate No. <Insert number>: <Insert title of alternate>.

1. Base Bid: <Insert brief description of base bid requirement> [as indicated on Sheet <Insert title of sheet>] [and] [as specified in Division <Insert Division number> Section "<Insert Section Title>"].

2. Alternate: <Insert brief description of alternate requirement> [as indicated on Sheet <Insert title of sheet>] [and] [as specified in Division <Insert Division number> Section "<Insert Section Title>"].
SECTION 012500 - SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1  SUMMARY
Section includes administrative and procedural requirements for substitutions. This Section does not apply to equipment specifications that state “or equivalent”. Under that condition, the Contractor should submit an equivalent product using the submittal process defined in the equipment specification and in Section 013300 Submittal Procedures.

1.2  DEFINITIONS
A. Substitution: A change proposed by the Contractor to products, materials, equipment, or methods of construction that differ from those required by the Contract Documents and that maintain equal value.

B. Value Engineering: A systematic method to improve the "value" of goods and services by using an examination of function. Value, as defined, is the ratio of function to cost. Value can therefore be increased by either improving the function or reducing the cost. The goal of VE is to achieve the desired function at the lowest overall cost consistent with required performance.

C. Specified Product or Manufacturer: Required product or manufacturer. Because SRP constructs, owns, and maintains its facilities, SRP achieves significant cost savings by standardizing on types and manufacturers of equipment. SRP achieves our savings in training, stocking of parts, and shorter time to repair by standardizing on certain products or manufacturers.

1.3  SUBMITTALS
A. Value Engineering or Substitution Requests: Submit one electronic or three paper copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section numbers and titles and Drawing numbers and titles.

   1.  Documentation: Use CSI Form 13.1A if available. Provide the following, as applicable. The more information provided, the better chance of adoption:

      a. Statement explaining why specified product or fabrication or installation cannot be provided, or why Contractor wants to provide a substitution.
      b. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by other separate contractors that will be necessary to accommodate proposed substitution.
      c. Detailed comparison of significant characteristics of proposed substitution with those of the Work specified. Include annotated copy of applicable specification section. Significant characteristics may include attributes such as performance, weight, size, durability, visual effect, warranties, specific features, purchase price, and any environmental benefits. Indicate all deviations from the Work as specified.
      d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
      e. Samples, as required by the original equipment Specification.
      f. Certificates, material test reports, and qualification data, where applicable.
      g. Research reports evidencing compliance with building code in effect for Project.
h. Detailed comparison of Contractor's construction schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.

i. Cost information that includes purchase, replacement, consumables, and a total cost of Ownership comparison. If the Contract Sum will change, include a change proposal or OCCD.

j. Contractor's certification that proposed substitution complies with requirements in the Contract Documents except as indicated in substitution request, is compatible with related materials, and is appropriate for applications indicated.

k. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.

2. Transmission by Contractor: Transmit the request for substitution to the Architect or Engineer with a copy to the SRP PM.

3. Architect or Engineer's (A/E) Action: If necessary, A/E will request additional information or documentation for evaluation within five (5) workdays of receipt of a request for substitution. A/E will notify Contractor of acceptance or rejection of proposed substitution within ten (10) workdays of receipt of request, or receipt of additional information, whichever is later.

   a. Method/Forms of Acceptance: Architect's Supplemental Instructions for minor changes in the Work or OCCD (prepared by the Contractor) and signed by the Architect.

   b. Use product/fabrication/installation found in the Specifications if A/E does not issue a decision on use of a proposed substitution within time allocated.

1.4 QUALITY CONTROL BY THE CONTRACTOR

A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products, materials, and specifications.

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS

A. Substitutions for Cause: Submit requests for substitution immediately upon discovery of need for change.

   1. Conditions: A/E will consider Contractor's request for substitution when the following conditions are satisfied:

      a. Requested substitution is consistent with the Contract Documents and will produce indicated results.

      b. Requested substitution will not adversely affect Contractor's construction schedule.

      c. Requested substitution is approved in writing by SRP's PM.

      d. Requested substitution is compatible with other portions of the Work.

      e. Requested substitution has been coordinated with other portions of the Work.

      f. Requested substitution provides specified warranty.
g. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

B. Substitutions for Convenience: A/E will consider requests for substitution if received within sixty (60) days after commencement of the Work.

1. Conditions: A/E will consider Contractor's request for substitution when the following conditions are satisfied:

   a. Requested substitution offers SRP a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities SRP must assume. SRP's additional responsibilities may include compensation to A/E for redesign and evaluation services, increased cost of other construction by SRP, and similar considerations.

   b. Requested substitution does not require extensive revisions to the Contract Documents.

   c. Requested substitution is consistent with the Contract Documents and will produce indicated results.

   d. Requested substitution will not adversely affect Contractor's construction schedule.

   e. Requested substitution has received necessary approvals of authorities having jurisdiction.

   f. Requested substitution is compatible with other portions of the Work.

   g. Requested substitution has been coordinated with other portions of the Work.

   h. Requested substitution provides specified warranty.

   i. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

PART 3 - EXECUTION (Not Used)

END OF SECTION 012500
PART 1 - GENERAL

1.1 SUMMARY

A. Section includes requirements for handling and processing Contract modifications.

1.2 MINOR CHANGES IN THE WORK

A. Architect or SRP may issue supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time, on AIA Document G710, "Architect's Supplemental Instructions." These minor changes may include details to clarify the Work. Via e-mail or letter, the contractor must acknowledge receipt of instruction authorizing minor changes in the Work and incorporate these changes in the as-built drawings.

1.3 REQUEST FOR A CHANGE ORDER

A. Owner-Initiated Proposal Requests: The Architect or SRP will issue a description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. When necessary, the description will include supplemental or revised Drawings and Specifications.

1. Owner-Initiated Proposal Requests are not instructions to stop work in progress or to execute the proposed change, unless the document explicitly instructs the Contractor to do so.

2. Within ten (10) workdays after receipt of Proposal Request, the Contractor shall submit a proposal estimating the additional costs and time (if any) necessary to execute the change.

   a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
   b. Indicate applicable taxes, delivery charges, and equipment rental.
   c. Include man-hours and costs of labor and supervision directly attributable to the change. Use unit prices for change order labor and supervision that were included in original bid.
   d. Include a proposed change to the construction schedule or produce a FRAGNET showing the effect of the proposed change. As a minimum include changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
   e. Quotation Form: Format is at the Contractor’s discretion.
   f. Owner Construction Change Directive (OCCD): Include the OCCD signed by the Contractor.

B. Contractor-Initiated Change Request: If latent or changed conditions require modifications to the Contract, Contractor may submit a Change Request to Architect with a copy to SRP’s PM. Value Engineering suggestions may also be submitted as a Contractor-Initiated Change Request.

1. Include a statement outlining reasons for the change or the problem encountered, the proposed solution, and the effect of the change on the Work. Provide a complete description of the proposed change to include sketches or marked up drawings if appropriate. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.

2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.

3. Indicate applicable taxes, delivery charges, and equipment rental.
4. Include man-hours and costs of labor and supervision directly attributable to the change. Use unit prices for change order labor and supervision that were included in original bid.

5. Include a proposed change to the construction schedule or produce a FRAGNET showing the effect of the proposed change. As a minimum include, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.

6. Comply with requirements in Specification Section 012500-Substitution Procedures if the proposed change requires substitution of one product or system for product or system specified.

7. Quotation Form: Format at to the Contractor's discretion.

8. Owner Construction Change Directive (OCCD): Include the OCCD signed by the Contractor.

1.4 CHANGE ORDER PROCEDURES

A. For all projects, use an SRP Owner Construction Change Directive (OCCD) form to record the approval and signatures of SRP's Management, the Architect, and the General Contractor.

1. The OCCD is initiated and filled out by the GC. Then with the Contractor's cost proposal, the OCCD is submitted to the SRP PM. Once approved or rejected by the SRP PM, the OCCD is sent to the Architect, Procurement, and SRP management for approval.

2. The OCCD will be reviewed and signed by Procurement and the Manager of Design & Construction noting approval or disapproval.

3. Only upon approval by SRP Management is the OCCD a contractual change order that authorizes a change to the Work. In the event the Contract Amount or Contract Time is changed, SRP shall issue an Amendment to the Purchase Order.

1.5 CMAR CONTINGENCY USAGE

A. Contingency Log: The CMAR will maintain a spreadsheet format Contingency Log that tracks the usage of both Owner and Contractor Contingency funds. Approval to move funds from one contingency fund to another must be recorded in the minutes of the weekly OAC meeting and a copy of the minutes provided to SRP Procurement. The Contingency Log will be presented during the next OAC meeting whenever there has been or there is expected to be a use of contingency.

B. Owner Contingency: This type of contingency fund is used to pay the Contractor for the direct cost of changes that increase the Scope of Work. Changes to the Work that are deductive shall result in funds being transferred into the Owner Contingency. An OCCD shall be prepared by the CMAR for all uses of the Owner Contingency.

C. Contractor Contingency: This type of contingency fund is used to pay the Subcontractors for work that is not an increase in the scope of work. Reasons for this may be re-work caused by weather, errors or omissions in estimating, unseen existing conditions, etc. An OCCD shall be prepared by the CMAR for all uses of the Contractor Contingency. This fund will NOT be used to pay for overtime or additional crews to accelerate the Work to the benefit of the Subcontractor or CMAR. This fund will NOT be used to compensate for damage caused by negligence.
PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 The OCCD is required on sizes of projects and change orders.

3.2 See attached sample of OCCD format on the next page. The form will be supplied by the SRP PM.

END OF SECTION 012600
CONTRACTOR:
YOU ARE HEREBY DIRECTED TO MAKE THE FOLLOWING CHANGE(S) TO THE CONTRACT:

WORK AFFECTED:

WORK DESCRIPTION:

NOTE: CONTRACTOR SHALL PAY APPLICABLE PRIME CONTRACTING SALES (PRIVILEGE) TAX.

<table>
<thead>
<tr>
<th>PROPOSED ADJUSTMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. YOU ARE AUTHORIZED TO PROCEED AS FOLLOWS:</td>
</tr>
<tr>
<td>□ PROCEED IMMEDIATELY AND PROVIDE A CHANGE PROPOSAL BASED UPON METHOD SELECTED</td>
</tr>
<tr>
<td>□ IF (a) PROPOSAL IS NOT TIMELY:</td>
</tr>
<tr>
<td>□ OR (b) PROPOSAL IS NOT ACCEPTED AND OWNER DIRECTS THE CHANGE TO BE COMPLETED</td>
</tr>
<tr>
<td>□ OR (c) PROPOSAL IS NOT ACCEPTED AND OWNER DIRECTS THE CHANGE TO BE TERMINATED</td>
</tr>
<tr>
<td>□ THEN COST &amp; TIME ADJUSTMENT FOR THE WORK PERFORMED SHALL BE AS MUTUALLY AGREED</td>
</tr>
<tr>
<td>□ DO NOT PROCEED IMMEDIATELY AND PROVIDE A CHANGE PROPOSAL</td>
</tr>
</tbody>
</table>

2. THE PROPOSED BASIS OF THE CHANGE TO THE CONTRACT SUM OR GUARANTEED MAXIMUM PRICE IS:

| LUMP SUM |
| ADD |
| DED |
| OF $ |

| AN ACCEPTED LUMP SUM PROPOSAL (ENTER AMOUNT) |

| COST OF WORK (LBR. MTL. EQUIP. INSUR. TAXES AND BONDS) PLUS A FEE OF % AND A G.M.P. OF $ |

| ENTER % & AMOUNT |

3. THE CONTRACT TIME IS PROPOSED TO BE (ADJUSTED) [UNCHANGED]. THE PROPOSED ADJUSTMENT IS

| INCR |
| DECR |

| BY DAYS |

| SHALL BE BASED UPON THE ATTACHED CHANGE PROPOSAL |

WHEN SIGNED BY OWNER AND RECEIVED BY THE CONTRACTOR, THIS DOCUMENT BECOMES EFFECTIVE IMMEDIATELY AS A CONSTRUCTION CHANGE DIRECTIVE (CCD), AND THE CONTRACTOR SHALL PROCEED WITH THE CHANGE(S) UNLESS DIRECTED DIFFERENTLY ABOVE. A CHANGE ORDER WILL BE RECORDED UPON AGREEMENT.

SIGNATURE BY CONTRACTOR INDICATES AGREEMENT WITH THE PROPOSED ADJUSTMENT. IF THIS CCD REQUIRES A CHANGE PROPOSAL, THEN THE CONTRACTOR SHALL USE THIS TO PROVIDE THE CHANGE PROPOSAL. PROVIDE SUBSTANTIATION SUPPORTING THE PROPOSAL AMOUNT. ACCEPTANCE BY THE OWNER IS REQUIRED FOR AGREEMENT.

REQUESTED BY CONTRACTOR:

| Date | Patricia Pyle |

APPROVED FOR EXECUTION BY SRP:

| Date | Signature Authority |

ARCHITECTURAL APPROVAL:

| Date | Arsenio Duran |

SRP PROJECT MANAGER:

| Date | Jeff Davis |
SECTION 012900 - PAYMENT PROCEDURES

PART 1 - CONTRACT VALUE OVER $100,000

1.1 SUMMARY

A. This Section specifies administrative and procedural requirements to prepare and process Applications for Payment for Construction Contracts.

1.2 SCHEDULE OF VALUES (SOV)

A. Coordination:

1. Coordinate line items in the schedule of values (SOV) with the following:
   a. Items required as separate activities in Contractor's construction schedule.
   b. Phased work required due to building occupancy
   c. Breakdown of bid required in the RFP.

2. Submit the SOV to the SRP PM at earliest possible date but no later than 14 work days before the submittal of initial Application for Payment.

B. Format and Content:

1. The Project Specifications Table of Contents may serve as a guide to help establish the detail of line items for the SOV.

2. Identification: Include the following Project identification on the SOV:
   a. Project name and location.
   b. Name of Architect.
   c. Architect's project number.
   d. Contractor's name and address.
   e. Date of submittal.

3. Submit SOV on AIA Document G703 or Excel spreadsheet with format and content found in the AIA Document G703.

4. Provide a breakdown of the Contract Sum in enough detail to facilitate evaluation of Applications for Payment and progress reports. As a minimum, the breakdown of the SOV will include every line item required on the RFP Bid form. Provide a separate line item for:
   a. Each subcontract.
   b. GC on-site supervision
   c. GC Overhead (office management and support)
   d. GC Profit
   e. Provide multiple line items for each subcontract that is in excess of 10% (ten) percent of Contract Amount. (include line for tiered sub)
   f. Each allowance
   g. Self perform work
   h. Temporary facilities and other major cost items that are not direct cost of actual work-in-place

5. Round amounts to nearest whole dollar; total shall equal the Contract Sum.
6. Updating the SOV: Update and resubmit the SOV before the next Application for Payment when Change Orders or Owner Construction Change Directives result in a change in the Contract Sum.

7. All changes to the SOV require written approval by SRP Procurement.

1.3 APPLICATIONS FOR PAYMENT

A. Each Application for Payment shall be consistent with previous applications and payments as certified by Architect and paid for by SRP. Initial Application for Payment and final Application for Payment involve additional requirements.

B. Due Date:
   1. Submit draft Application for Payment (with all required attachments) via e-mail to SRP PM and Procurement by the 25th of the month.
   2. SRP will review. At SRP's discretion, SRP may require a project walk through by the A/E, SRP, and the Contractor to confirm accepted work-in-place.
   3. The SRP PM will e-mail an approval, thereby authorizing Contractor to submit the Application for Payment.

C. Forms: Use AIA Document G702 and AIA Document G703

D. Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. SRP will return incomplete applications without action.
   1. Entries shall match data on the SOV and Contractor's construction schedule. Use updated SOV if revisions were approved by SRP.
   2. Include amounts of approved Change Orders and Construction Change Directives issued before the 25th of the month submitted.
   3. All Pay Applications must show the SRP PO number on the top of the application form.

E. Transmission of Payment Applications: After the SRP PM has approved the draft, transmit (one) 1 signed and notarized original of the Application for Payment to SRP Accounts Payable. Do not include lien waivers or any attachments.
   1. Mail, e-mail, or fax the complete pay app as follows:
      a. Mail to the PO Box for processing by the Third Party accounts payable company.
      b. E-mail the pay app as a PDF or TIF attachment. Do not embed within the text of the message. Send to 888-443-4795@onlinecapturecenter.com
      c. Fax to 888-443-4795
   2. SRP shall process the approved Application for Payment and send a check or EFT in accordance with the terms of the Contract.

F. Attachments Required for the draft only:
   1. Waivers of Mechanic's Lien: With each Application for Payment, submit waivers of mechanic's lien from entities lawfully entitled to file a mechanic's lien arising out of the Contract and related to the Work covered by the payment.
      a. Submit partial waivers on each item for amount requested in previous application, after deduction for retainage, on each item.
      b. When an application shows completion of an item, submit conditional final or full waivers.
      c. SRP reserves the right to designate which entities involved in the Work must submit waivers.
      d. Waiver Forms: Submit waivers of lien on State of Arizona required forms.
2. Project Schedule: provide schedule with work updated no older than 7 days earlier (18th of the month).

3. Critical Path Schedule: For projects with duration greater than 60 days, provide a single critical path schedule showing the scheduled progression of the job. Do not show work breakdown structure or any other grouping that interferes with the ability to see the critical path as it progresses through the end of the project.

G. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with the submittal of first Application for Payment include the following:

1. List of subcontractors (unless unchanged from list provided at time of bid).
2. Schedule of values. (this is a submittal)
3. Contractor's project schedule (preliminary if not final) (this is a submittal).
4. Submittal schedule (preliminary if not final)
5. Submittal Log (this is a submittal).
6. List of Contractor's staff assignments.
7. List of Contractor's principal consultants.
8. Copies of County and State required permits.

H. Final Payment Application: Submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:

1. Evidence of completion of Project closeout requirements (see Section 017700 Closeout).
2. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
5. Evidence that claims have been settled.
6. Final meter readings for utilities, a measured record of stored fuel, and similar data as of when Owner took possession of and assumed responsibility for corresponding elements of the Work.
7. Final liquidated damages settlement statement.

PART 2 - CONTRACT VALUE LESS THAN $100,000

2.1 SCHEDULE OF VALUES (SOV)

A. Coordination:

1. Coordinate line items in the schedule of values (SOV) with the following:
   a. Items required as separate activities in Contractor's construction schedule.
   b. Phased work required due to building occupancy

2. Submit the SOV to the SRP PM at earliest possible date but no later than 14 work days before the submittal of initial Application for Payment.

B. Format and Content:

1. For Contracts under $100,000, use the RFP Bid Form as a guide to establish the detail of line items for the SOV. The breakdown of the SOV will include every line item required on the RFP Bid form.
2. Identification: Include the following Project identification on the SOV:
a. Project name and location.
b. Name of Architect.
c. Architect’s project number.
d. Contractor’s name and address.
e. Date of submittal.


4. Round amounts to nearest whole dollar; total shall equal the Contract Sum.

5. Temporary facilities and other major cost items that are not direct cost of actual work-in-place must be shown as separate line items in the schedule of values.

6. Updating the SOV: Update and resubmit the SOV before the next Application for Payment when Change Orders or Owner Construction Change Directives result in a change in the Contract Sum.

7. All changes to the SOV require written approval by SRP Procurement.

2.2 APPLICATIONS FOR PAYMENT

A. Due Date: Payment Applications shall be submitted to SRP as follows:

1. Submit draft Application for Payment (include all required attachments) via e-mail to SRP PM and Procurement by the 25th of the month.
2. SRP will review.
3. The SRP PM will e-mail an approval, thereby authorizing Contractor to submit the Application for Payment.

B. Forms: Use Contractor’s standard invoice form with Excel spreadsheet SOV.

C. Preparation: Complete every entry on form.

1. Entries shall match data on the SOV. Use updated SOV if revisions were made and approved by SRP.
2. Include amounts of approved Change Orders and Construction Change Directives issued before the 25th of the month submitted.
3. All Pay Applications must show the SRP PO number on the top of the invoice.

D. Transmission of Payment Applications: After approval of the draft by the SRP PM, transmit (one) 1 signed original of the Application for Payment to SRP Accounts Payable. Do not include lien waivers or any attachments.

1. Mail, e-mail, or fax the invoice form (pay app) as follows:
   a. Mail to the PO Box for processing by the Third Party accounts payable company.
   b. E-mail the entire pay app as a PDF or TIF attachment. Do not embed within the text of the message. Send to 888-443-4795@onlinecapturecenter.com
   c. Fax to 888-443-4795
2. SRP shall process the approved Application for Payment and send a check or EFT in accordance with the terms of the Contract.

E. Attachments Required for the draft only:

1. Waivers of Mechanic's Lien: With each Application for Payment, submit waivers of mechanic's lien from entities lawfully entitled to file a mechanic's lien arising out of the Contract and related to the Work covered by the payment.
a. Submit partial waivers on each item for amount requested in previous application, after deduction for retainage, on each item.

b. When an application shows completion of an item, submit conditional final or full waivers.

c. SRP reserves the right to designate which entities involved in the Work must submit waivers.

d. Waiver Forms: Submit waivers of lien on State of Arizona required forms.

PART 3 - EXECUTION (Not Used)

END OF SECTION 012900
SECTION 013100 - PROJECT MANAGEMENT

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes provisions for coordinating construction operations and reporting progress on the Project including the following:

1. Coordination drawings.
2. Requests for Information (RFIs).
3. Project Web site.
4. Project Meetings.
5. Project Reports
6. Project Schedules

1.2 DEFINITIONS

A. RFI: Request from Owner, Architect, or Contractor seeking information from each other.

B. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction project. Activities included in a construction schedule consume time and resources.

2. Predecessor Activity: An activity that precedes another activity in the network.
3. Successor Activity: An activity that follows another activity in the network.

C. CPM: Critical Path Method

D. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.

E. Float: The number of days between the early start and late start dates of an activity. Float time is not for the exclusive use or benefit of either Owner or Contractor, but is a jointly owned, expiring Project resource available to both parties as needed to meet schedule milestones and Contract completion.

1.3 SUBMITTALS

A. RFI Log

B. Start-up CPM Network Diagram: For all CMAR projects, or upon request of SRP PM, submit network diagram of size required to display entire network for entire construction period. Show logic ties for activities. Submit in PDF format.

C. Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period. Submit in PDF format.
D. CPM Reports: For all CMAR projects, or upon request of SRP PM, concurrent with CPM schedule, submit each of the following reports. Format for each activity in reports shall contain activity number, activity description, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float in calendar days.

1. Activity Report: List of all activities sorted by activity number and then early start date, or actual start date if known.
2. Logic Report: List of preceding and succeeding activities for all activities, sorted in ascending order by activity number and then early start date, or actual start date if known.
3. Total Float Report: List of all activities sorted in ascending order of total float.

E. Three Week Look-Ahead Schedule: Every week provide a 3-week schedule showing activities and subcontractors on a weekly basis at the OAC meeting. Include the last week’s actual activities as well. Submit paper copies in Excel or easily understood format.

F. Daily Construction Reports: Submit at weekly intervals (only when requested by the SRP PM.)

G. Coordination Drawings: Submit if required to integrate different components.

H. Schedule of Values

1.4 COORDINATION

A. Coordination: Coordinate construction operations across all sections of the Specifications. Coordinate construction operations included in different sections that depend on each other for proper installation, connection, and operation.

B. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to ensure orderly progress of the Work. Such administrative activities include:

1. Preparation of Contractor's construction schedule.
2. Preparation of the schedule of values.
3. Installation and removal of temporary facilities and controls.
4. Delivery and processing of submittals.
5. Progress meetings.
6. Pre-installation conferences.
7. Startup and adjustment of systems to include Commissioning.
8. Project closeout activities.

1.5 COORDINATION DRAWINGS

A. Coordination Drawings: Prepare coordination drawings in accordance with requirements in individual sections, where installation is not completely shown on Shop Drawings, where limited space necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity.

1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:
a. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
b. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Architect indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations are not changes to the Contract.

2. Review: Architect will review coordination drawings to confirm that the Work is being coordinated, but not for the details of the coordination, which are the Contractor's responsibility.

1.6 REQUESTS FOR INFORMATION (RFIs)

A. General: On discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI. Promptly submit RFIs to avoid delays in Contractor's work or work of subcontractors.

B. Content: Include a detailed description of item needing information or interpretation and the following:
   1. Project name.
   2. Date.
   3. Name of Contractor.
   5. RFI number, numbered sequentially.
   6. RFI subject.
   7. Specification Section numbers, titles, and related paragraphs.
   8. Drawing numbers and details.
   9. Field dimensions and conditions, as appropriate.
   10. Contractor's suggested resolution. If Contractor's solution(s) impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
   11. Contractor's signature.
   12. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to describe items needing interpretation.

C. RFI Forms: The following are acceptable forms:
   1. AIA Document G716
   2. Contractor generated form with substantially the same content as indicated above.

D. Transmitting: Send the RFI and all attachments electronically to the Architect with a copy to the SRP PM. If the attachments cannot be sent electronically, send the RFI electronically and then deliver the attachments as soon as possible to both parties. For tracking purposes, the RFI will not be considered as delivered until all attachments are delivered.

E. Architect's Action: Architect will review each RFI and respond. Allow [5] five working days for Architect's response for each RFI. RFIs received by Architect after 1:00 p.m. will be considered as received the following working day.

1. The following RFIs will be returned without action:
   a. Requests for approval of submittals or substitutions.
   b. Requests for information already indicated in the Contract Documents.
   c. Requests for adjustments in the Contract Time or the Contract Sum.
d. Requests for interpretation of Architect's actions on submittals.
e. Incomplete RFIs or inaccurately prepared RFIs.

2. Architect's action may include a request for additional information, in which case Architect's time for response will date from time of receipt of additional information.

3. Architect's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Request according to Specification Section 012600 "Contract Modification Procedures."
   a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect and SRP in writing within [5] five working days of receipt of the RFI response.


G. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log weekly. Include the following:
   1. Project Name.
   2. Contractor Name.
   3. Architect Name.
   4. RFI number (include RFIs that were dropped).
   5. Description of RFI.
   6. Date the RFI submitted.
   7. Date Architect's response received.
   8. RFI status (including final action by A/E)
   9. Notes as appropriate.

1.7 PROJECT WEB SITE

A. At no cost to SRP, the GC or CMAR may use a Project Web site to manage project communication and documentation until Final Completion. Project Web site may include some of the following functions:
   1. Project directory.
   2. Project correspondence.
   3. Meeting minutes.
   5. RFI forms and logs.
   6. Task and issue management.
   7. Photo documentation.
   8. Schedule and calendar management.
   10. Payment application forms.
   11. Drawing and specification document hosting, viewing, and updating.
   13. Reminder and tracking functions.

C. Upon completion of Project, provide [one] 1 complete archive copy of Project Web site files to Owner and to Architect in a digital storage format acceptable to the Architect.

D. Contractor, subcontractors, and other parties granted access by the Contractor to Project Web site shall execute a data licensing agreement in the form of an Agreement acceptable to the Owner and Architect.

1.8 PROJECT MEETINGS

A. General: Schedule and conduct meetings and conferences at Project site, unless otherwise indicated.

1. Attendees: Inform required participants of date and time of each meeting. Notify Owner and Architect of scheduled meeting dates and times.
2. Agenda: Prepare and distribute the meeting agenda
3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned within [three] 3 days of the meeting.

B. Preconstruction Conference: SRP will schedule and conduct a preconstruction conference before starting construction no later than [15] fifteen days after execution of the Agreement.

1. Attendees: Authorized representatives of SRP, Commissioning Authority, Architect (optional); Contractor (PM and Superintendent), the Working Forman from each major subcontractor; suppliers (optional); and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
2. Agenda:
   a. Introductions
   b. Meeting Purpose: Review expectations, allow GC & subs to ask questions.
   c. Project Background – why is this project important to SRP? Is it mission critical?
   d. What defines a successful project at SRP?
   e. Procurement: Their role in the entire project
   f. PO status? Change Requests and Change Orders procedures.
   g. Money disputes go through Procurement
   h. Applications for Payment & Retention
   i. Safety: SRP Philosophy, GC standards, PPE protocol per GC, Asbestos, Hot Work
   j. Project Reporting structure: Information flow, RFI, Submittal, Pay App flow
   k. Testing, Inspections: requirements exceed the code
   l. How does the GC manage quality? GC expectations of subcontractors
   m. SRP Inspections are not the contractor’s QC program
   n. Commissioning: Manufacturer’s installation and startup checklists, Functional Performance Tests
   o. Work hours, Restrictions, Site access and badging for personnel
   p. O&M Manuals.
   q. As-built drawings.
   r. Warranty.
   s. Lien Waivers and Final Pay App.
   t. Formal evaluation of GC and Subs = Business Review.
   u. Business Review is sent to GCs’ Business Development Mgr.

C. Pre-installation Meeting: Conduct a pre-installation conference at Project site before each construction activity that requires coordination with other construction.
1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise SRP PM and the SRP Construction Inspector of scheduled meeting dates.

2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:

   b. Related Submittals and RFIs.
   c. Purchases.
   d. Deliveries.
   e. Review of mockups.
   f. Possible conflicts.
   g. Compatibility problems.
   h. Time schedules.
   i. Weather limitations.
   j. Manufacturer's written recommendations.
   k. Compatibility of materials.
   l. Acceptability of substrates.
   m. Temporary facilities and controls.
   n. Space and access limitations.
   o. Testing and inspecting requirements.
   p. Installation procedures.
   q. Coordination with other work.
   r. Required performance results.
   s. Commissioning (if applicable)
   t. Safety to include protection of adjacent work.

3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.

4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.

5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.

D. Weekly Progress Meetings: Conduct Owner/Architect/Contractor (OAC) meetings (biweekly interval for smaller jobs as required by the RFP or the SRP PM).

1. Attendees: SRP representatives, Commissioning Authority, Architect, the Contractor, and every Subcontractor or supplier concerned with current progress or involved in planning future activities shall be present at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.

2. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.

   a. Contractor's Project Schedule: Review this at every meeting. Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule.

   b. Superintendent's Three Week Look Ahead Schedule: Review last week's accomplished activities versus what was scheduled. Present the activities scheduled for the next three weeks and discuss support needed and pre-requisite work needed.
c. RFI Log
d. Submittal Log
e. Change Requests
f. Deficiency Log & quality concerns
g. Review present and future needs of each entity present, including the following:
   1) Interface requirements (with other work or subcontractors).
   2) Sequence of operations.
   3) Deliveries.
   4) Off-site fabrication.
   5) Access.
   6) Site utilization.
   7) Temporary facilities and controls.
   8) Progress cleaning.
   9) Quality and work standards.
   10) Status of correction of deficient items.
   11) Field observations.

h. Round Table – each attendee may bring up any other item.

3. Minutes: Contractor will record and distribute the meeting minutes to each party present
   and to parties requiring information.

   a. Schedule Updating: Revise Contractor’s construction schedule after each
      progress meeting where revisions to the schedule have been made or recognized.
      Issue revised schedule concurrently with the report of each meeting.

E. Executive Meeting: In the event of actual or expected extraordinary conditions on the project,
   SRP may call for an Executive Meeting.
   1. Purpose: To provide for a problem solving environment above the level of the project
      team.
   2. Attendees: Management (not the project team members) from the Contractor, Architect,
      and SRP
   3. Agenda: SRP shall distribute an agenda prior to the meeting.
   4. Minutes: SRP shall publish minutes.

F. Business Review: After the project is complete and final payment transmitted, the SRP Buyer
   shall schedule a meeting to provide the Contractor with a written performance evaluation.

1.9 PROJECT REPORTS

A. Daily Construction Reports: Only when requested by the SRP PM or in the RFP, prepare a
   daily construction report recording the following information concerning events at Project site:

   1. List of subcontractors at Project site.
   2. Approximate count of personnel at Project site.
   3. Equipment at Project site.
   5. High and low temperatures and general weather conditions.
   6. Accidents or Emergency procedures.
   7. Meetings and significant decisions.
   8. Unusual events.
   9. Stoppages, delays, shortages, and losses.
   10. Orders and requests of authorities having jurisdiction.
11. Change Orders received and implemented.
12. Owner Construction Change Directives received and implemented.
13. Services connected and disconnected.
15. Partial completions and occupancies.

B. Field Condition Reports: Immediately on discovery of a difference between field conditions and the Contract Documents, prepare and submit a detailed report. Submit with a Request for Information. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

PART 2 - PRODUCTS

2.1 CONTRACTOR’S CONSTRUCTION SCHEDULE (< $250,000 CONTRACT VALUE)

A. General: Provide a project schedule based upon Critical Path Method.

B. Time Frame: Schedule shall extend from receipt of Purchase Order to Final Completion or as directed in writing by the SRP PM.
   1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.

C. Activities: Treat each story or separate area as a separate numbered activity for each principal element of the Work. Comply with the following:
   1. Use "one workday" as the unit of time for individual activities. Indicate nonworking days and holidays incorporated into the schedule.
   2. Activity Duration: Activities may not exceed [10] ten workdays, unless specifically allowed by SRP.
   3. Procurement Activities: Include separate procurement process activities for long lead items and major items, requiring a cycle of more than 30 days. Procurement cycle activities include submittals, approvals, purchasing, fabrication, and delivery.
   4. Submittal Review Time: Include review and re-submittal times indicated in Section 013300 "Submittal Procedures".
   5. Include activity for submittal of O&M Manuals; set logic so that this activity is a prerequisite for Substantial Completion milestone.
   6. Work by SRP: Include a separate activity for each portion of Work performed by SRP.
   7. Substantial Completion: Indicate anticipated date of substantial completion as a milestone, not a constraint.
   8. Startup and Commissioning: Coordinate with SRP PM to include time for these activities after Substantial Completion.

D. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.
   1. Phasing: Arrange list of activities on schedule by phase.
   2. Work Restrictions: Show the effect of the following items on the schedule:
      a. Coordination with existing construction.
      b. Limitations of continued occupancies.
      c. Uninterruptible services.
      d. Partial occupancy before Substantial Completion.
e. Use of premises restrictions.

E. Milestones: Include all milestones indicated in the Contract Documents in schedule, including Substantial Completion, and Final Completion.

F. Recovery Schedule: When periodic update indicates the Work is [10] ten or more workdays behind the current approved schedule, submit a separate recovery schedule indicating means by which Contractor intends to regain compliance with the schedule.

G. Critical Path Schedule: For projects with duration greater than 60 days, provide a single critical path schedule showing the scheduled progression of the job. Do not show work breakdown structure or any other grouping that interferes with the ability to see the critical path as it progresses through the end of the project.

H. Computer Scheduling Software: Prepare project schedules using recent version of a program developed specifically to manage construction schedules. Excel is only acceptable for 3-week look ahead schedules.

I. Schedule Updating: Concurrent with making revisions to schedule, to make SRP’s review easier, prepare spreadsheet or report showing the following:

1. Identification of activities that have changed.
2. Changes in activity durations in workdays.
3. Changes in the critical path.
4. Changes in total float or slack time.

2.2 CONTRACTOR’S CONSTRUCTION SCHEDULE (> $250,000 CONTRACT VALUE)

A. General: In addition to the requirements in Paragraph 2.1, provide the following.

B. CPM Schedule: Prepare Contractor’s construction schedule using a time-scaled CPM network analysis diagram for the Work. Cost loading of schedule is at Contractor’s option.

1. Develop network diagram in sufficient time to submit CPM schedule so it can be accepted for use no later than [20] twenty workdays after receipt of Purchase Order. Failure to include any work item required for performance of this Contract shall not excuse Contractor from completing the work within applicable completion dates.

C. Contract Modifications: For each proposed contract modification and concurrent with its submission, prepare a time-impact analysis using a network fragment (FRAGNET) to demonstrate the effect of the proposed change on the overall project schedule.

D. Initial Issue of Schedule: Prepare initial network diagram from a sorted activity list indicating straight “early start-total float.” Identify critical activities. If requested, prepare tabulated report showing the following:

1. Contractor or subcontractor and the Work or activity.
2. Description of activity.
3. Principal events of activity.
4. Immediate preceding and succeeding activities.
5. Early and late start dates.
6. Early and late finish dates.
PART 3 - EXECUTION

3.1 CONTRACTOR'S CONSTRUCTION SCHEDULE

A. Required Schedule Updates: At monthly intervals, update schedule to reflect actual construction progress and activities. As required by Section 012900 Payment Procedures, update the schedule one week before the pay application is due. Present and discuss this monthly update at the next regularly scheduled progress (OAC) meeting.

1. Revise schedule immediately after OAC meeting where revisions have been recognized or made. Issue the revised schedule concurrently with the report of each such meeting.
2. As the Work progresses, indicate final completion percentage for each activity.

B. Distribution: Distribute copies of approved schedule to architect, SRP, separate contractors, and other parties identified by contractor with a need-to-know schedule responsibility.
1. When revisions are made, distribute updated schedules to the same parties, and post in the same locations.

C. Display: Post copy of most current project schedule and 3-week look ahead schedule in contractor's field office.

END OF SECTION 013100
SECTION 013300 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes requirements for the submittal schedule and requirements for Shop Drawings, Product Data, Samples, and other submittals.

B. Related Sections:
   1. Section 017823 "Operation and Maintenance Requirements" for submitting operation and maintenance manuals.
   2. Section 017700 "Closeout Procedures" for submitting record Drawings.

1.2 DEFINITIONS

A. Submittal Schedule: A schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates.

B. Submittal Log: A spreadsheet document to track status of all submittals required by Specification Section.

1.3 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

A. Architect's Digital Data Files: The Architect will provide electronic copies of the Contract Drawings for Contractor's use in preparing submittals, Shop Drawings, and record drawings.

B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
   1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
   2. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.

C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.

D. Identification and Information: Place a permanent label or title block on each paper copy submittal item for identification.
   1. Indicate name of firm or entity that prepared each submittal on label or title block.
2. Provide a space on label or beside title block to record Contractor's review and approval markings and action taken by Architect and SRP.

3. Include the following information for processing and recording action taken:
   a. Project name.
   b. Date.
   c. Name of Architect.
   d. Name of Contractor.
   e. Name of subcontractor.
   f. Name of supplier or manufacturer.
   g. Submittal number or other unique identifier, including revision identifier.
      1) Submittal number shall use Specification Section number followed by a decimal point and then a sequential number (e.g., 061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., 061000.01.A).
   h. Number and title of appropriate Specification Section.
   i. Drawing number and detail references, as appropriate.
   j. Location(s) where product is to be installed, as appropriate.

E. Options: Identify options requiring selection by the Architect.

F. Deviations: Identify all deviations from the Contract Documents on submittals. A substitution of another product is not a deviation, it is a substitution.

G. Additional Copies: Submit one copy of submittal to SRP (the concurrent reviewer) in addition to specified number of copies to Architect.

H. Transmittal: Assemble each submittal individually and appropriately for transmittal and handling. Transmit each submittal using a transmittal form. Architect will return submittals without review if received from sources other than Contractor.
   1. Transmittal Form: Use AIA Document G810, or a project management software form with similar content.
   2. On an attached separate sheet, prepared on Contractor’s letterhead, record relevant information, requests for data, revisions other than those requested by Architect on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same identification information as related submittal.

I. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
   1. Note date and content of previous submittal.
   2. Note date and content of revision in label or title block and clearly indicate extent of revision.
   3. Resubmit submittals until they show approval stamped by Architect.

J. Distribution: Furnish copy of final submittal to manufacturers, subcontractors, suppliers, fabricators, and others as necessary for performance of construction activities. Show distribution on transmittal forms.

K. Use for Construction: Use only final submittals showing approval stamped by Architect.
PART 2 - PRODUCTS

2.1 SUBMITTAL PROCEDURES

A. General Submittal Procedure Requirements:

1. Post electronic submittals as PDF electronic files directly to the project's web site or A/E's FTP site specifically established for Project.

2. Submit electronic submittals via email as PDF electronic files.

3. Paper Submittals: This is project dependent. A/E, Contractor, and SRP shall decide at the Coordination Meeting on required number of submittal copies. Otherwise submit four paper copies of each submittal, unless otherwise indicated. Architect will return three copies.

4. Certificates and Certifications Submittals: Provide a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.
   a. Provide a digital signature with digital certificate on electronically-submitted certificates and certifications where indicated.
   b. Provide a notarized statement on original paper copy certificates and certifications where indicated.

5. Test and Inspection Reports Submittals: Comply with requirements specified in Section 014400 "Quality Requirements."

B. Submittal Log:

1. Produce a submittal log in spreadsheet format, using Excel or Project management software to track the status and dates of all submittals. Review this log at weekly OAC meetings. Track progress of submittals on the project schedule.

2. For small projects without Project Manual (project specific specifications), the A/E will list the required submittals on the drawings.

C. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.

1. If information must be specially prepared for submittal because standard published data are not suitable then submit as Shop Drawings, not as Product Data.

2. Mark each copy of each submittal to show which products and options are applicable.

3. Include the following information, as applicable:
   a. Manufacturer's catalog cuts and product specifications.
   b. Standard color charts.
   c. Statement of compliance with referenced standards.
   d. Application of testing agency labels and seals.
   e. Notation of coordination requirements.
   f. Availability and delivery time information.

4. For equipment, include the following in addition to the above, as applicable:
   a. Wiring diagrams showing factory-installed wiring.
   b. Printed performance curves.
c. Operational range diagrams.
d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.

5. Submit Product Data concurrent with Samples.

D. Shop Drawings: Prepare Project-specific information, to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.

1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
   a. Identification of products.
   b. Compliance with specified standards.
   c. Notation of coordination requirements.
   d. Notation of dimensions established by field measurement.
   e. Relationship and attachment to adjoining construction clearly indicated.
   f. Seal and signature of professional engineer if specified.

2. Submit Shop Drawings in the following format:
   a. On sheets at least 8½ by 11, but no larger than 30 by 42 inches.
   b. PDF electronic file where possible.

E. Samples: Submit samples for review of kind, color, pattern, and texture and for a comparison of these characteristics between submittal and actual component as delivered and installed.

1. Transmit samples that contain multiple, related components such as accessories together in one submittal package.

2. Identification: Attach label on unexposed side of Samples that includes the following:
   a. Generic description of Sample.
   b. Product name and name of manufacturer.
   c. Sample source.
   d. Number and title of applicable Specification Section.

3. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.


2.2 DELEGATED-DESIGN SERVICES (or DELAYED SUBMITTALS)

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.

1. If criteria indicated are not sufficient to perform services or certification required, submit a written RFI to Architect.

B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit signed PDF electronic file and [1] one paper copy of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.
1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

PART 3 - EXECUTION

3.1 CONTRACTOR’S REVIEW

A. Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect and SRP.

B. Approval Stamp: Stamp each submittal with a uniform, approval stamp as required in Para 1.3 D above.

3.2 ARCHITECT AND SRP ACTIONS

A. General: Architect and SRP will not review submittals that do not bear Contractor’s approval stamp and will return them without action.

B. Architect and SRP will review each submittal, make marks to indicate corrections or modifications required, and return it. Architect will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action.

C. Architect and Engineers will produce a Summary Page that shall contain the A/E’s action stamp and a summary or restatement of all review comments found in the submittal.

D. Incomplete submittals are not acceptable and shall be returned without review.

END OF SECTION 013300
SECTION 014000 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Defines SRP requirements for Contractor Quality Control and Owner Quality Assurance. As an Electric and Water Utility, SRP has many critical facilities. Because SRP builds, occupies, and maintains our facilities, SRP requires a service life of 50+ years for our facilities. This long service life drives the unique and stringent details and product requirements found in the drawings and specifications. Because our requirements exceed building codes, SRP has robust and demanding Quality Control requirements for Contractors and a comprehensive Quality Assurance program.

B. SRP requires that the Contractor be proactive and plan for quality construction rather than wait for SRP inspections to identify deviations from plans, specs, and acceptable workmanship.

C. SRP is the Code Inspector for all standard and special code compliance inspections. Special Inspections required by the building, mechanical, or plumbing codes are identified on the drawings or the SRP Inspection Planning Worksheet. Code and Special inspections are part of SRP’s Quality Assurance responsibilities and not a tool for the Contractor to use to replace Quality Control planning or inspections by the Contractor and Subcontractor of their work.

D. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.

E. Related Sections:
   1. Divisions 02 through 33 see Sections for specific test and inspection requirements.

1.2 DEFINITIONS

A. Proactive Quality Measures: Activities or actions taken prior to the work commencing or being completed to plan for quality, safety, and productivity. Tailboard meetings are an example of pro-active safety measures. Pre-task planning that reviews details on drawings with the work crew or creating a mockup are examples of proactive quality measures.

B. Reactive Quality Measures: Activities or actions taken during or after the work to check for quality. An inspection is a reactive quality measure.

C. Quality Control (QC): The responsibility of the Contractor. Planning, procedures, tests, inspections, and related actions by the Contractor before, during, and after execution of the Work to insure that products and construction comply with all requirements.

D. Quality Assurance (QA): The responsibility of SRP and the Architect. Procedures, inspections, and activities performed by SRP during and after execution of the Work to guard against defects and deficiencies and substantiate that construction complies with all requirements. QA also insures the Contractor is effectively performing Quality Control. Commissioning is a Quality Assurance activity.
E. Mockups: Full size physical assemblies constructed on-site. Mockups are constructed to verify selections made from sample submittals; to demonstrate aesthetic effects; to demonstrate acceptable quality of construction; to show interface between dissimilar materials; and to demonstrate compliance with specified installation tolerances. Mockups are not Samples. Approved mockups establish the standard by which the Work is judged.

F. Product Testing: Tests and inspections by an NRTL or a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.

G. Source Quality-Control Testing: Tests and inspections performed at the source, i.e., plant, mill, factory, or shop.


1.3 CONFLICTING REQUIREMENTS

A. Referenced Standards: If compliance with two or more standards results in conflicting requirements, then comply with the most stringent requirement or submit an RFI to Architect for a decision before proceeding.

B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. Refer uncertainties to Architect via RFI for a decision before proceeding.

1.4 SUBMITTALS

A. Quality Control Plan (project specific) that identifies the trained personnel, planning, proactive procedures, and reactive procedures the Contractor will use to meet the contract requirements, drawings, and specifications.

B. Testing Agency Qualifications: Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.

1.5 REPORTS AND DOCUMENTS

A. Test and Inspection Reports: Prepare and submit certified reports specified in other Sections. Include the following:

1. Date of issue.
2. Project title.
3. Name, address, and telephone number of testing agency.
4. Dates and locations of samples and tests or inspections.
5. Names of individuals making tests and inspections.
6. Description of the Work and test and inspection method.
8. Complete test or inspection data.
9. Test and inspection results and an interpretation of test results.
10. Record of weather conditions at time of sample taking, testing, and inspecting.
11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
12. Name and signature of laboratory inspector.
13. Recommendations on retesting and reinspecting.

B. Manufacturer’s Field Reports: Prepare written information documenting tests and inspections specified in other Sections. Include the following:

1. Name, address, and telephone number of representative making report.
2. Statement on condition of substrates and their acceptability for installation of product.
3. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
4. Results of operational and other tests and a statement of whether observed performance complies with requirements.
5. Other required items indicated in individual Specification Sections.

C. Permits, Licenses, and Certificates: For SRP records, submit copies of permits, licenses, certifications, inspection reports, receipts for fee payments, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

D. Deficiency Log: Create and maintain a log of all deficiencies identified with the work, regardless of source, until the deficiency is corrected. Similar to a Punch List but used throughout the project duration to identify and correct deficiencies earlier so that the Punch List is minimized. Deficiency Log to be maintained by the Project Superintendent, available to the SRP PM and Construction Inspector, and presented/discussed at OAC Meetings.

1.6 QUALIFICATIONS

A. Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.

B. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.

C. Professional Engineer Qualifications: A professional engineer who is licensed in Arizona and experienced (5 yr min.) in providing engineering services of the kind indicated.

D. Manufacturer’s Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products used in this Project. Normally, a sales representative of the distributor or local rep is not qualified to observe and inspect.

E. Mockups: Obtain Architect's approval of mockups before starting work, fabrication, or construction:

1. Build mockups in location and of size indicated.
2. Demonstrate the proposed range of aesthetic effects and workmanship.
3. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.

1.7 QUALITY CONTROL

A. Plan and perform all quality-control activities required to verify that the Work complies with requirements. Tests and inspections not explicitly assigned to SRP are Contractor's responsibility.
1. Where testing-inspection services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these services. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.

2. Submit certified written reports for testing or inspection services indicated as Contractor's responsibility.

B. Develop and submit to the SRP PM for approval a Quality Control Plan that identifies the proactive and reactive steps the Contractor will take with Subcontractors to insure quality rather than rely on SRP and Code Inspections. Minimum content for the QC Plan is:
   1. Identify contractor and subcontractor personnel responsible for Quality
   2. List and explain pro-active and pre-construction steps taken by project team to understand plans, specifications, RFIs, and changes.
   3. List and explain steps taken during construction to verify workmanship, dimensions, and that work is in accordance with the contract documents.
   4. List and explain steps taken during and after construction to verify work is ready for and will pass code or special inspection.

C. Maintain the Deficiency Log and manage the resolution of the deficiencies.

D. SRP Specifications exceed Building, Mechanical, and Plumbing codes. Review these specifications prior to starting work to prevent rework. SRP drawings contain many non-standard details. Review these details prior to ordering materials to prevent rework.

E. Manufacturer's Field Services: Where indicated, engage a manufacturer's representative to observe and inspect the Work. Manufacturer's representative services include examination of substrates and conditions, verification of materials, inspection of completed portions of the Work, and submittal of written reports.

F. Manufacturer's Installation and Startup Documents: Provide a completed manufacturer's installation and startup checklist for each individual piece of equipment and gear. These are also known as pre-functional checklists. See Section 019113 Commissioning for further details.

G. Coordination: Coordinate project schedule and sequence of activities to accommodate required quality-control and assurance services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.

H. Pre-Task Planning: Critical activities (such as communications cable replacement) or work at critical facilities may require an SRP lead Pre-Task Planning Meeting with the working foremen performing each activity or element of the work. The SRP PM will specify those activities for which a Pre-Task Planning Meeting must occur. The agenda worksheet is available from the PM.

I. Recording Inspections: Use the SRP issued yellow “Inspection Record” to record all Final Inspections. Some Special Inspectors may submit a separate inspection report, but should sign the Inspection Record. Turn all these over to the SRP PM at the end of the job, to support the issue of the Certificate of Final Completion.

J. Retesting/Reinspecting: Work that fails to comply with the Contract Documents shall be retested at Contractors expense, regardless of whether original tests or inspections were Contractor's or SRPs' responsibility.

1.8 QUALITY ASSURANCE

A. SRP Responsibilities:
1. Where testing-inspection services are SRP's responsibility, SRP will engage a qualified internal organization or a qualified testing agency to perform these services.

2. SRP will furnish Contractor with:
   a. Inspection Planning Worksheet that identifies all code and special inspections and the inspecting agency.
   b. Names, addresses, and telephone numbers of testing agencies engaged.
   c. Observe the Contractor's QC program and provide feedback
   d. Yellow Inspection Record form to record inspections and final inspections to be displayed on the jobsite.

B. Assistance to the Contractor: SRP recognizes that the specifications are stringent and above those found in commercial building. With advance notice by the Contractor, SRP will assist the Contractor by conducting reviews of plans and specifications with subcontractors.

C. Testing Agency Responsibilities: Cooperate with the SRP PM and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
   1. Notify SRP PM, and Contractor promptly of irregularities or deficiencies observed in the Work.
   2. Determine the location for test samples.
   3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
   4. Submit a certified written report of each test and inspection to the SRP PM.
   5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
   6. Do not perform any duties of Contractor.

D. Engineer Observations: The SRP PM schedules the Architect and Engineers to conduct periodic inspection of the work in place and work in progress. These observations will not satisfy any requirement for a code inspection. These observations are set up in the form of an allowance for a set number of visits to observe the work.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 PREPARING FOR INSPECTIONS

A. Subcontractors and Contractor's Superintendent shall:
   1. Review and inspect work for compliance with contract documents and standard workmanship prior to the SRP inspection.
   2. Provide access to the Work.
   3. Provide incidental labor and facilities necessary to facilitate tests and inspections.
   4. Insure adequate quantities of representative samples of materials to be tested.
   5. Assist in obtaining samples for testing.
   6. Provide satisfactory area for storage and field curing of test samples.
3.2 SCHEDULING INSPECTIONS

A. Use 3-week look ahead schedule to project dates for all inspections and observations.

B. Through the SRP PM, arrange code and special inspections 48 hrs in advance with 2 hr window.

C. Inspections are during normal working hours from 7am to 3pm.

D. After Project Working Hours or Weekend Inspections: If Contractor voluntarily arranges a pre-task planning meeting for a subcontractor’s work and invites SRP to witness, Inspections can be scheduled for that subcontractor’s work after the project’s normal working hours or weekends as an incentive to conduct pre-task planning.

E. The person who performed or supervised the work must be present and accompany all scheduled inspectors.

3.3 DOCUMENTING INSPECTIONS

A. SRP Inspectors will provide the Contractor with written inspection results. For deviations from the specifications or code the Inspector shall provide both pictures and specific references to the specification or code.

B. The Contractor is responsible for maintaining the yellow Inspection Record

C. For larger jobs where there will be more than one occurrence of an inspection, Contractor shall provide a ½ size set of drawings for all Inspectors to record the results of individual inspections.

3.4 REPAIR AND PROTECTION

A. Repair and protection are Contractor’s responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION
SECTION 015000 - TEMPORARY CONSTRUCTION FACILITIES

PART 1 - GENERAL

1.1 SUMMARY
The Contractor shall provide the labor, materials, equipment, and services necessary for all required temporary facilities. They shall be maintained in a proper, safe operating and sanitary condition for the duration of the Contract. Upon completion of the Contract, remove all temporary facilities from the premises and restore existing facilities to original or better condition.

1.2 REFERENCES

1.3 SUBMITTALS
A. Construction site plan (also called a Logistics Plan)
B. Traffic control plan
C. SWPPP permit
D. County Dust Control Permit

1.4 CONSTRUCTION SITE PLAN
Prior to starting work, submit for approval by SRP PM a site plan showing the locations and dimensions of temporary facilities (including layouts and details, equipment and material storage area, access and haul routes, avenues of ingress/egress to the fenced area and details of the fence installation, refueling area, locations for employee parking and parking of company vehicles). Identify any areas to be graveled to prevent the tracking of mud. Indicate if the use of a supplemental or other staging area is desired. Show locations of safety and construction fences, site trailers, construction entrances, trash dumpsters, temporary sanitary facilities, and worker parking areas.

PART 2 - PRODUCTS

2.1 TEMPORARY SIGNAGE
A. Bulletin Board:
   Immediately upon beginning of work, provide a weatherproof bulletin board not less than 36 by 48 inches in size for displaying the Equal Employment Opportunity poster, a copy of the wage decision contained in the contract, Wage Rate Information poster, and other information approved by the SRP PM. Locate the bulletin board at the project site in a conspicuous place approved by the SRP PM and easily accessible to all construction employees.

B. Project and Safety Signs:
   Create and display safety signs that indicate the boundary of the construction limits and the minimum required Personal Protective Equipment. These must be displayed at every man or vehicle entrance to the construction area. Project signs (when required by the SRP PM) must have a white background, display the GC and SRP logos, list the GC’s PM and Superintendent, the SRP PM and phone numbers for all.

2.2 TEMPORARY TRAFFIC CONTROL
A. Maintenance of Traffic:
   a. Conduct operations in a manner that will not close any thoroughfare or interfere in any way except with written permission of the SRP PM. Provide a Traffic Control Plan detailing the proposed controls to traffic movement for approval. The plan must be in accordance with
State and local regulations. The traffic control plan should indicate the route Emergency Vehicles should take to reach the worksite. The traffic control plan must be provided to the Security Guards at each guard station, when applicable.

b. Conduct work so as to minimize obstruction of traffic, and maintain traffic on at least half of the roadway width at all times. Obtain approval from the SRP PM prior to starting any activity that will obstruct traffic.

c. Provide, erect, and maintain, at contractors expense, lights, barriers, signals, passageways, overhead protection, detours, and other items, that may be required by the Life Safety authority having jurisdiction.

d. Minimize the interference with public traffic on roads selected for hauling material to and from the site. Investigate the adequacy of existing roads and their allowable load limit. Contractor is responsible for the repair of any damage to roads caused by construction operations.

B. Dust Control:

Dust Control must comply with latest State and County regulations when construction begins. It is the responsibility of the Contractor to secure all dust control permits.

C. Haul Roads: (when required)

The Contractor is responsible to maintain the serviceability and condition of any roads used by the Contractor in performing the work. The Contractor shall provide SRP workers and crews access via the existing roads or by constructing suitable detours. SRP shall be responsible for removing obstructions or repairing damage caused by SRP use. The Contractor may at their own expense construct access and haul roads necessary for proper prosecution of the work under this contract while providing necessary lighting, signs, barricades, and distinctive markings for the safe movement of traffic. Location, grade, width, and alignment of construction and hauling roads require approval by the SRP PM.

D. Barricades:

Erect and maintain temporary barricades to limit public access to hazardous areas. Whenever safe public access to paved areas such as roads, parking areas or sidewalks is prevented by construction activities or as otherwise necessary to ensure the safety of both pedestrian and vehicular traffic barricades will be required. Securely place barricades clearly visible with adequate illumination to provide sufficient visual warning of the hazard during both day and night. Use and locations must be confirmed by SRP PM and shown on Construction Site Plan prior to installation.

2.3 TEMPORARY WIRING

Provide temporary wiring in accordance with NFPA 241 and NFPA 70, Article 305-6(b), Assured Equipment Grounding Conductor Program. Include frequent inspection of all equipment and apparatus

2.4 TEMPORARY WALLS & FENCES

A. Temporary noise & dust wall:

Areas to be occupied during construction hours that are adjacent to construction areas require a temporary noise & dust wall. Occupied areas shall be separated from construction areas by walls designed to reduce dust, noise, and obscure visibility. SRP's standard is to use metals studs, with one side sheet rocked and insulted with batt insulation. This standard may be waived or modified by the SRP PM in writing. The temporary walls should be constructed for quick removal and reuse if the project has phases. Visqueen with insulation is not a satisfactory temporary wall.
B. Temporary dust partition
Where construction will occur after normal work hours and adjacent areas will be unoccupied, a temporary partition will suffice. A Visqueen barrier properly hung and sealed will be satisfactory.

C. Outside Fencing
Enclose the project work area and Contractor lay-down area with an 8 ft high temporary chain link fence and gates. Intent is to prevent access to the work area. Remove the fence upon completion and acceptance of the work. Where necessary to block public view of the construction, add screen/mesh material.

PART 3 - EXECUTION

3.1 EMPLOYEE PARKING
Contractor employees will park privately owned vehicles in an area designated by the SRP PM. This area will be within reasonable walking distance of the construction site. Contractor employee parking must not interfere with existing and established parking requirements of the SRP facility.

3.2 AVAILABILITY AND USE OF UTILITY SERVICES
A. Temporary Utilities
Where available, SRP shall provide water and electricity at no charge to the Contractor. Contractor shall provide other temporary utilities required for construction. Materials may be new or used, must be adequate for the required usage, in compliance with applicable building codes and standards, and safe for use.

B. Electricity
Provide connections, sized to provide service required for power and lighting. Locate feeder and branch wiring with area distribution boxes so that power is available throughout the project site by use of power cords. Provide transformers as required. Provide temporary lighting as required for safe and secure operations.

C. Water
Make connections to existing facilities to provide water for construction purposes. Coordinate with SRP PM for temporary backflow prevention device. Contractor is responsible to provide work force with adequate potable water and ice. If applicable, contractor is responsible for labeling of all temporary non-potable water sources.

D. Sanitation
a. All SRP office facilities to include cafeterias, toilets, telephones, etc are off limits unless specifically authorized by the SRP PM.

b. Provide and maintain within the construction area Porta-Potty style facilities approved by the SRP PM. Periodically empty wastes into a municipal, district, or station sanitary sewage system, or remove waste to a commercial facility. Maintain these conveniences at all times without nuisance.

E. Telephone and Internet Service
Utilize Contractor provided cell phones for all telephone requirements. SRP may provide telephone and broadband internet service at no charge for longer duration projects. Contact the SRP PM to request this service. All hardware and software provided by SRP remains the property of SRP and must be returned prior to the release of retention.
F. Fire Protection

Provide temporary fire protection equipment for the protection of personnel and property during construction. Coordinate requirements for equipment with the SRP PM. Remove debris and un-used or excess flammable materials from the construction site daily to minimize potential hazards.

3.3 CONTRACTOR’S TEMPORARY OFFICE OR STORAGE FACILITIES

A. Trailers or Mobile Storage Units

Office or storage trailers/units will be permitted, where space is available, subject to the approval of the SRP PM. The trailers/units shall be in good condition, free from visible damage rust and deterioration, and meet all applicable safety requirements. A sign not smaller than 24 by 24 inches shall be conspicuously placed on the trailer depicting the Contractor's name, business phone number, and emergency phone number. Trailers shall be anchored to resist high winds and meet applicable local standards for anchoring.

B. Outside Storage

Request this type of storage through the SRP PM. The storage area will be secured by the Contractor using a temporary chain link fence.

C. Storage in Existing Buildings

Storage of material may be allowed inside the buildings. Request this type of storage through the SRP PM. A security fence with a lockable gate may be required around the storage area. Remove at the completion of work.

3.4 PROJECT SAFETY FENCING

As soon as practicable, furnish and erect temporary project safety fencing at the work site. The safety fencing must be a high visibility orange colored, high density polyethylene grid or approved equal, a minimum of 42 inches high, supported and tightly secured to steel posts located on maximum 10 foot centers, constructed at the approved location. Maintain the safety fencing during the life of the contract and, upon completion and acceptance of the work, will become the property of the Contractor and be removed from the work site.

3.5 CLEANUP

A. SRP will furnish (at SRP expense) roll-off 20 or 40 yd dumpsters. Place construction debris, waste materials, packaging material and the like into the dumpsters daily.

B. Any dirt or mud tracked onto paved or surfaced roadways must be removed. In no instances will any debris or trash be buried, covered, or left on SRP property.

3.6 RESTORATION OF STORAGE AREA

Upon completion of the project remove the bulletin board, signs, barricades, haul roads, and any other temporary products from the site. After removal of trailers, materials, and equipment from within the fenced area, remove all temporary fences. Restore to the original or better condition, areas used by the Contractor for the storage of equipment or material, or other use. Gravel used to traverse grassed areas must be removed and the area restored to its original condition, including landscaping vegetation and features.

END OF SECTION 015000
SECTION 017700 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes requirements for contract closeout, including, but not limited to, the following:
   1. Substantial Completion procedures.
   2. Final Completion procedures.
   3. Warranties.
   4. Final cleaning.

B. Related Sections:
   Section 012900 Payment Procedures
   Section 017823 O&M Manuals
   Section 017839 Project Record Requirements
   Section 019113 Commissioning Requirements
   Divisions 02 through 23 for specific closeout and special cleaning

1.2 DEFINITIONS

A. Substantial Completion: This means the Work is ready for preoperational checkout for the purpose for which it was intended, and only minor items remain to be completed or corrected that would either not affect the operation as intended or could be completed prior to the scheduled date of the pre-operational check-out.

B. Final Acceptance: Sufficient tests and inspections have been made by SRP to determine that the Work meets all the requirements of the Contract Documents. Successful completion of the tests and inspections, as determined solely by SRP, shall constitute acceptance.

C. Final Completion: All technical, performance, and commercial requirements of the Contract Documents have been met and all required “affidavit” information, warranty certificates, unconditional lien waivers, O&M manuals, and As-Built drawings have been approved by SRP and SRP is prepared to issue the final payment (including retention).

D. Prefunctional Tests (PFT): Tests that occur prior to starting the equipment. These are normally the completion of the manufacturer's installation and startup checklists. This is a commissioning term.

E. Functional Performance Test (FPT): Test of the dynamic function and operation of equipment and systems. This commissioning test is performed after prefitional tests are completed.

1.3 SUBSTANTIAL COMPLETION

A. Prerequisites: Before SRP will declare and document achievement of Substantial Completion, the following must have been accepted or waived in writing by the SRP Project Manager (PM).
1. Prepare a list of items to be completed or corrected (Punch List). As a minimum, all unresolved items from the QC Deficiency List must be included on the Punch List.

2. Prepare and submit one set of As-built (Red Line) Drawings to the SRP PM.

3. Prepare and submit [1] one set of Operation and Maintenance manuals. Submit the O&M Manuals without actual warranty letter since date of Substantial Completion has not been determined.

4. All Prefunctional Tests must be completed, submitted, and accepted prior to declaration of Substantial Completion.

5. Submit the training schedule and all training outlines for approval.

6. Submit the updated schedule or 3 week schedule showing Functional Performance Tests.

7. All assets requiring asset tags are properly labeled with tags supplied by SRP.

8. Acceptance Test for Fire Protection Systems has been conducted by SRP Fire Marshall and a satisfactory report (with unresolved issues) or total acceptance has been recorded on the Inspection Report.

B. Inspection: Submit an e-mail request to the SRP PM for the Substantial Completion inspection by the A/E Team or SRP. On receipt of request, Architect or SRP will proceed with inspection or notify Contractor of unfulfilled prerequisites. Architect or SRP shall provide the following:

1. Prepare the Certificate of Substantial Completion after satisfactory inspection or notify Contractor of issues (whether on Contractor's punch list or items identified by A/E,) that must be completed or corrected before certificate will be issued.

2. Reinspection: Request reinspection when the Work identified in previous inspections is completed or corrected.

C. Functional Performance Testing: The final stage of Commissioning (Functional Performance Testing) will normally begin once SRP or A/E inspection for Substantial Completion has occurred.

1.4 FINAL ACCEPTANCE

A. Final Acceptance occurs after the completion of functional performance tests of designated systems and equipment.

B. Prerequisites:

1. Resolution of all issues on the installation and startup checklists.

2. Completion of Functional Performance Testing

3. Resolution of all Punch List and Commissioning Log issues.

4. Satisfactory completion of all Work.

C. Procedure:

1. In the event that some systems or parts of work were not accepted or approved during the Substantial Completion inspection, request a final acceptance inspection via e-mail to the SRP PM.

2. Schedule a meeting with the SRP PM and A/E to review all prerequisites in 1.4 B.

1.5 FINAL COMPLETION

A. Final Completion encompasses satisfactory completion of all technical requirements, functional performance requirements, all documentation, and all other contractual requirements.

B. Prerequisites:

2. Written certification of satisfactory resolution of all items on Punch List and Commissioning Issue Log (with signature and date).
3. Completion of all training.
4. Final acceptance of O&M manuals.
5. Final acceptance of Contractor’s Red Line Drawings by SRP and the A/E.
6. If applicable, final pest-control inspection report and warranty.
7. Final cleaning.

C. Procedure
1. Submit a final Application for Payment according to Section 012900 “Payment Procedures.”
2. Notify SRP PM of mailing of final Application for Payment.
3. Request date for Business Review Meeting.

1.6 PUNCH LIST
A. Organization of List: Identify each space or area affected with incomplete items and items needing correction including areas disturbed by Contractor that are outside the limits of construction
   1. Include name of problem, reason for problem, responsible subcontractor, date item added to list, date resolved, and initials of SRP person inspecting or accepting the corrected work.
   2. Submit Punch List in Excel electronic format.

1.7 WARRANTY
A. As defined in Paragraph 4.20 of the General Terms and Conditions of the contract, warranty is 2 years from date of Substantial Completion or 18 months from the date of Final Acceptance whichever is longer.

B. Submit Warranty documents in accordance with Section 017823 O&M Manuals.

PART 2 - PRODUCTS

2.1 MATERIALS
A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.
   1. Use cleaning products that meet Green Seal GS-37, or if GS-37 is not applicable, use products that comply with the California Code of Regulations maximum allowable VOC levels.
PART 3 - EXECUTION

3.1 FINAL CLEANING

A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.

B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.

1. Complete the following cleaning operations before requesting Final Completion:
   a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
   b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
   c. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
   d. Remove tools, construction equipment, machinery, and surplus material from Project site.
   e. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
   f. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
   g. Sweep concrete floors broom clean and wet mop in unoccupied spaces.
   h. Vacuum carpet and similar soft surfaces, removing debris and excess nap; shampoo if visible soil or stains remain.
   i. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.
   j. Remove labels that are not permanent.
   k. Touch up and restore marred, exposed finishes and surfaces. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or that already show evidence of repair or restoration.
      1) Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates.
   l. Wipe surfaces of mechanical and electrical equipment and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
   m. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.
   n. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
   o. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
   p. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out bulbs, and those noticeably dimmed by hours of use, and
defective and noisy starters in fluorescent and mercury vapor fixtures to comply
with requirements for new fixtures.
q. Leave Project clean and ready for occupancy.

C. Pest Control: Engage an experienced, licensed exterminator to make a final inspection and rid
Project of rodents, insects, and other pests. Prepare a report.

END OF SECTION 017700
SECTION 017823 - OPERATION AND MAINTENANCE MANUALS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes requirements for preparing Operation and Maintenance manuals.

B. See all Sections in Divisions 02 through 33 for specific operation and maintenance manual requirements for the Work.

1.2 SUBMITTALS

A. Manual: Submit [1] one of each manual in final form prior to desired date of Substantial Completion. The O&M Manual shall not contain the actual warranty letters since date of Substantial Completion has not been determined. SRP and the CxA will return comments within [15] fifteen workdays of submission.

B. Correct or modify the manual to comply with Architect and SRP comments. Submit [4] four copies of each final manual with warranty letters and one CD prior to final application for payment.

PART 2 - PRODUCTS

2.1 MANUALS

A. Organization: Unless otherwise indicated, organize each manual into a separate section or tab for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain a title page, warranty directory, table of contents (and tabs), and manual contents.

B. Title Page: Include the following information:

2. Name and address of Project.
3. Date of final submittal.
4. Name, address, and telephone number of Contractor.

C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and referenced to Specification Section number.

D. Warranty Directory: In Table format, list category, warranty duration, warranty expiration date, name of responsible company, contact name, and phone, and fax numbers. See Appendix A for example.

E. Manual Contents: Organize into sets of manageable size. Arrange contents numerically by Division or alphabetically by Category (electrical, HVAC, plumbing). If possible, assemble instructions for subsystems, equipment, and components of one system into the same binder.
1. Binders: Heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2 x 11 inch paper; with clear plastic sleeve on spine to hold label describing contents.
   a. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents. Indicate volume number for multiple-volume sets.

2. Dividers: Heavy duty dividers with plastic-covered tabs for each section. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number.

3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software diskettes for computerized electronic equipment.

4. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
   a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
   b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

2.2 EMERGENCY INFORMATION

A. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.

B. Emergency Procedures: Include instructions on stopping, shutdown instructions for each type of emergency, operating instructions for conditions outside normal operating limits, and required sequences for electric or electronic systems.

2.3 OPERATION INFORMATION

A. Basic Content: Include operation data required in individual Specification Sections to include equipment descriptions, operating standards, operating procedures, operating logs, wiring and control diagrams, and license requirements.

B. Operating Procedures: Include start-up, break-in, and control procedures; stopping and normal shutdown instructions; routine, normal, seasonal, and weekend operating instructions; and required sequences for electric or electronic systems.

C. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

D. Piped Systems: Diagram piping as installed.

2.4 PRODUCT MAINTENANCE INFORMATION

A. Maintenance Documentation: Manufacturers’ maintenance documentation including maintenance instructions, drawings, and diagrams for maintenance, nomenclature of parts and components. Include manufacturer's written recommendations and inspection procedures,
types of cleaning agents, methods of cleaning, schedule for cleaning and maintenance, and repair instructions.

B. Maintenance Procedures: Include test and inspection instructions, troubleshooting guide, disassembly instructions, and adjusting instructions that detail essential maintenance procedures.

C. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.

D. Spare and Repair Parts: Include manufacturer’s recommendations of spare and repair parts. Include a list of spare and repair parts turned over to SRP.

E. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.

F. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.

2.5 WARRANTY INFORMATION

A. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.
   1. Provide warranty certificates and other warranty information from manufacturers.
   2. Provide warranty letter from each subcontractor containing the following:
      a. Warranty coverage and contacts.
      b. Warranty start date (not earlier than date of substantial completion) and end date.

2.6 REQUIRED NUMBERS


PART 3 - EXECUTION

3.1 COMPLETION OF O&M MANUALS

A. Schedule: Incorporate the submission of the single draft manual and the four final manuals as activities or milestones on the project schedule. Submission of the draft manual is a prerequisite for Substantial Completion.

B. Payment: Final payment is conditioned upon the acceptance by SRP of the [4] four sets of final O&M Manuals.
## APPENDIX A: Example of Warranty Directory

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>WARRANTY</th>
<th>CONTRACTOR/MFG.</th>
<th>PHONE/FAX</th>
<th>CONTACT NAME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanical</td>
<td>2 yr</td>
<td>Mechanical Solutions</td>
<td>480-236-2852</td>
<td>Contact Person</td>
</tr>
<tr>
<td></td>
<td></td>
<td>123 Center Street</td>
<td>480-236-2200</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mesa, Arizona 85215</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air Handling Unit</td>
<td>2 yr.</td>
<td>Carrier, Inc.</td>
<td>650-236-5500</td>
<td>Contact Person</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Address</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>City, State</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electrical</td>
<td>2 yr</td>
<td>Delta Diversified</td>
<td>480-236-2852</td>
<td>Contact Person</td>
</tr>
<tr>
<td></td>
<td></td>
<td>123 Center Street</td>
<td>480-236-2200</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mesa, Arizona 85215</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sheet Metal</td>
<td>2 yr</td>
<td>KPML</td>
<td>480-236-2852</td>
<td>Contact Person</td>
</tr>
<tr>
<td></td>
<td></td>
<td>123 Center Street</td>
<td>480-236-2200</td>
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<td>Mesa, Arizona 85215</td>
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</tbody>
</table>
SECTION 017839 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 SUMMARY
   A. This Section includes requirements for Contractor generated Red Line (As-built) Drawings.
   B. See Division 01 Section "Operation and Maintenance Data" for O&M manual requirements.

1.2 REFERENCES
   A. SRP CAD Standards Manual Revision B, August 2007 available from SRP PM on CD-ROM.

1.3 SUBMITTALS
   A. Record Drawings: Comply with the following:

PART 2 - PRODUCTS

2.1 RED LINE DRAWINGS
   A. Record Prints: Maintain one set of black-line white prints of the Contract Drawings.
      1. Preparation: Mark Record Prints to show the actual installation where installation varies
         from that shown originally.
         a. Give particular attention to information on concealed elements that would be
            difficult to identify or measure and record later.
         b. Record data as soon as possible after obtaining it. Record and check the markup
            before enclosing concealed installations.
      2. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish
         between changes for different categories of the Work at same location.
      3. Note RFI, Construction Change Directive, Change Order numbers, and similar
         identification, where applicable.
      4. Before requesting inspection for Substantial Completion, submit the Red Line drawings to
         the SRP PM for review, comment, and transmission to the A/E.
   B. SRP Review: The SRP PM will review the Red Line drawings for completeness and accuracy.
      In the event of missing or incorrect information, SRP will return the Red Line drawings for
      further work and documentation of as-built conditions. If the quality of the Red Line drawings is
      poor, the SRP PM may declare that the first submission does not satisfy the prerequisite
      requirement for Substantial Completion.
C. Resubmission of Red Line drawings: Resubmit the Red Line drawings to the SRP PM. Upon successful review, these drawings will be transmitted to the A/E for review, comment, and when accepted incorporation to the electronic record drawings. Final acceptance of the Contractor's Red Line drawings by the A/E is a precondition for the Contractor's Final Completion.

D. Format: Identify and date each sheet of the Red Line drawing; include the designation "AS-BUILT DRAWING" in a prominent location.

2.2 MISCELLANEOUS RECORD SUBMITTALS

A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

PART 3 - EXECUTION

3.1 RECORDING AND MAINTENANCE

A. Maintenance of Record Documents and Samples: Store Record Documents and Samples in the field office apart from the Contract Documents used for construction. Do not use Project Record Documents for construction purposes. Maintain Record Documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to Red Line Documents for SRP and Architect's reference during normal working hours.

END OF SECTION 017839
SECTION 017900 – TRAINING

PART 1 - GENERAL

1.1 SUMMARY
A. This Section includes requirements for instructing Owner's personnel.

1.2 REFERENCES
A. Divisions 2-23 contain the specific systems and items for which training is required.

1.3 SUBMITTALS
A. Training Outline: Submit electronic copy of instructional outline for each training class. Include length of instruction time, and instructors’ names for each training class. Include learning objective and outline of training for each training class.

B. Training Plan: Submit an Excel spreadsheet that will track all training required by the specifications, listing the subcontractor responsible, instructor, status of training outline approval, proposed dates, and notes (as needed).

1.4 QUALITY ASSURANCE
A. Instructor Qualifications: A factory-authorized service representative experienced in operation and maintenance procedures. If provided by the manufacturer, must be experienced in planning and conducting training.

B. Pre-training Conference: Conduct conference at Project site. Attendees should be the GC, SRP, and CxA. Review training requirements, methods of training and procedures for training.

C. Coordinate content of training outlines with content of approved O&M manuals.

PART 2 - PRODUCTS

2.1 TRAINING PROGRAM
A. Program Structure: Develop a program that includes individual training modules as required by individual Specification Sections.

B. Training Classes: Develop a learning objective and training outline for each class. Include the knowledge that participant is expected to master. Include the following in each class:

1. Basis of System Design, Operational Requirements: Contractor may choose to have one training session instructed by the A/E team to satisfy this requirement. Explain choice of particular system and equipment, operating standards, regulatory requirements, equipment function, operating characteristics, and limiting conditions.
2. Operation & Shutdown: Include startup, break-in, control, and safety procedures; stopping and normal shutdown instructions; routine, normal, seasonal, and weekend operating instructions and required sequences for electric or electronic systems.


4. Emergencies: Include instructions on stopping; shutdown instructions; operating instructions for conditions outside normal operating limits; instructions on meaning of warnings, trouble indications, and error messages; and required sequences for electric or electronic systems.

5. Troubleshooting: Include diagnostic instructions, test, and inspection procedures.


7. Repairs: Include diagnosis, repair, and disassembly instructions; instructions for identifying parts; and review of spare parts needed for operation and maintenance.

8. Plan on one training class period for each required training subject unless the RFP requires more class periods.

PART 3 - EXECUTION

3.1 TRAINING OUTLINE REVIEW

A. Forward all training outlines to the SRP PM and the CxA (if hired on this project) for review of content, organization, and time. The training outlines may be reviewed by SRP’s O&M Manager for content.

B. The SRP PM will return the training outlines within [10] ten working days.

3.2 INSTRUCTION

A. Coordinator: Appoint a Contractor's staff member to serve as training coordinator to prepare instruction program and training modules, coordinate instructors, and to coordinate between Contractor and Owner for number of participants, instruction times, and location.

B. Scheduling: Schedule training with Owner through SRP PM with at least [7] seven work days advance notice.

C. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of a written performance-based test or assessment form.

END OF SECTION 017900
SECTION 019100 COMMISSIONING PROGRAM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. SRP’s Scope of Work Document or the Owner’s Project Requirements (OPR)
   B. Basis of Design (BOD) document from the AE.
   C. Roles and Responsibilities Matrix (found in the Bid documents)

1.2 SUMMARY
   A. Why SRP Commissions

   Commissioning is part of SRP’s Quality Assurance process that ensures a building or project’s complex range of systems is designed, installed, tested, and performs to SRP’s intent and operational needs.

   B. What SRP Expects From Commissioning.

   Depending on size and complexity of the project, expectations for Commissioning range from completing the manufacturer’s installation and startup checklists followed by a functional performance test to a fully integrated commission process that begins early in the design phase and ends when the warranty period is over.

C. The Roles and Responsibilities SRP, AE Team, and Construction Team have on this project.

   SRP has a Roles and Responsibilities Matrix (see Paragraph 1.4 Responsibilities) that defines the responsibilities of each organization in the Design Phase, Pre-Construction Phase, Construction Phase, Acceptance Phase, and Post Occupancy Phase.

D. This Section excludes Retro-Commissioning.

1.3 RELATED WORK
   013300 Submittals  Covers content and format of all submittals.
   017700 Closeout    Defines Substantial Completion and Functional Completion
   017823 O&M Manuals Defines O&M documentation
   015995 Mechanical Cx Describes details of testing to meet the Cx requirements.
   016995 Electrical Cx Describes details of testing to meet the Cx requirements.

1.4 RESPONSIBILITIES & MATRIX
   The Roles and Responsibilities Matrix will be completed by SRP and included in the Bid packages for the AE and the Construction Team. Here is an example of a completed matrix.
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<td><strong>Design Phase</strong></td>
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<tr>
<td>Develop Owners Project Requirements (OPR)</td>
<td>R</td>
<td>PM</td>
<td>RC</td>
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<td>Develop Basis of Design (BOD)</td>
<td>RC</td>
<td>OMS</td>
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<td>Develop O&amp;M Specifications (O&amp;M Spec Sections)</td>
<td>RC</td>
<td>OMS</td>
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<td><strong>Pre-Construction Phase</strong></td>
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<td>Submittal Review (Review Comments)</td>
<td>RC</td>
<td>OMS</td>
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<td>Develop O&amp;M Plan (Completed Plan)</td>
<td>RC</td>
<td>OMS</td>
<td>R</td>
<td>RC</td>
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<tr>
<td>Develop Pre-Functional Checklists (Checklists)</td>
<td>RC</td>
<td>OMS</td>
<td>R</td>
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<td>Develop Functional Testing Procedures (FPT)</td>
<td>RC</td>
<td>OMS</td>
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<td><strong>Construction Phase</strong></td>
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<td>Installation Verification (Installation Checklists)</td>
<td>S</td>
<td>R</td>
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<td>Equipment startup (Startup Checklists)</td>
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<td>OMS</td>
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<tr>
<td>Test &amp; Balance (TAB Report)</td>
<td>W</td>
<td>RC</td>
<td>R</td>
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<tr>
<td>System Integrity Verification (Resolution of install/startup issues)</td>
<td>S</td>
<td>OMS</td>
<td>W</td>
<td>R</td>
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<td>Operator Training (On-Site Training)</td>
<td>W</td>
<td>OMS</td>
<td>W</td>
<td>R</td>
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<td></td>
<td></td>
<td>P</td>
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<tr>
<td><strong>Post Occupancy Phase</strong></td>
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</tr>
<tr>
<td>Close Out Documentation (O&amp;M Manuals, Reports)</td>
<td>RC</td>
<td>PM</td>
<td>RC</td>
<td>R</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>S</td>
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<td>Compile Systems Manual (Completed Manual)</td>
<td>RC</td>
<td>OMS</td>
<td>R</td>
<td>S</td>
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<td></td>
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</tr>
<tr>
<td>Warranty follow-up (Scheduled &amp; Performed Follow-up)</td>
<td>S</td>
<td>OMS</td>
<td>R</td>
<td>S</td>
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<td></td>
<td></td>
<td>S</td>
<td>S</td>
</tr>
</tbody>
</table>

**Legend:**
- **R** - Responsible
- **S** - Support
- **RC** - Review/Comment
- **W** - Witness
- **P** - Perform

SRP PM, SRP Const. Inspector, GC General Contractor, O&M Supervisor, Sub Sub-Contractor, Architect/Engineer, 3rd Party O&M Agent.
1.4 DEFINITIONS AND DELIVERABLES

A. Design Phase

Owners Project Requirements (OPR) - A document written by the Owner’s Representative, which details the functional requirements of Project and expectations of how it will be used and operated. This document may include project and design goals, measurable performance criteria, budgets, schedules, success criteria, and supporting information dynamic document that provides the explanation of the ideas, concepts and criteria that are considered very important to SRP. SRP may furnish a detailed Scope Document that is equivalent to the OPR.

Deliverable: Written Document

Basis of Design (BOD) - The A/E team’s written record of the primary thought processes and assumptions behind design decisions. It records concepts, calculations, decisions, and product selections used to meet the OPR/Scope Document and to satisfy applicable regulatory requirements.

Deliverable: A written document or written in the drawings.

Commissioning Specification - A specific set of requirements that must be satisfied to insure that the equipment and systems installed meet all the Owners Project Requirements.

Deliverable: Approved Commissioning Specifications

B. Pre-Construction Phase

Commissioning Plan (Cx Plan) – the overall plan, drafted before and developed after bidding that provides the structure, schedule and coordination planning for the commissioning process. There is a design phase plan and a construction phase plan.

Deliverable: Project specific written plan.

Pre-functional Checklists – Checklist(s) of items to verify proper installation of equipment and startup of equipment. The manufacturer’s installation and startup checklists are the normal source documents. The Cx Agent may approve the manufacturer’s checklists or furnish more comprehensive checklists for use by the installing subcontractor. Pre-functional checklists are primarily static inspections and procedures to prepare the equipment for initial operation.

Deliverable: Installation Checklist and Startup Checklist for each type of equipment installed.

Functional Performance Testing Procedures (FPT) - Functional testing is the dynamic operation and testing of systems (rather than just components) under full operation. Systems are tested under various modes, various loads, simulated component failures, unoccupied, varying outside air temperatures, fire alarm, power failure, etc. The systems are run through all the control system’s sequences of operation and components are verified to be responding as the sequences state. The Cx Agent develops the functional test procedures in a sequential written form, oversees and documents the actual testing. FPTs are performed after pre-functional checklists, startup, and TAB are complete.

Deliverable: Written Functional Performance Test plan.

C. Construction Phase

Installation Verification – The completion of the Installation Checklists by the Subcontractors, with overview by the Cx Agent. This activity is complete when the Cx Agent has reviewed and approves the checklists for each discrete piece of equipment and any discrepancies or deviations are noted on the Issues Log (maintained by the Cx Agent).

Deliverables: Completed Installation Checklists and Issues Log
Equipment Startup - It is the initial energizing of dynamic equipment, including executing the approved startup checklist by installing contractor. Startup may be witnessed by the Cx Agent. It is part of the Pre-functional Tests. Deliverables: Completed Startup Checklists and Issues Log

Test and Balance (TAB) - Traditional air or water test and balancing to set up the system flows and pressures as specified. Deliverable: TAB report.

System Verification – Verification of resolution of items on Issues Log prior to start of Acceptance Phase (and functional performance testing). Deliverables: Completed Issues Log with resolutions and indication equipment is ready for FPT.

D. Acceptance Phase

Functional Performance Testing – The completion of the Functional Performance Test by the Subcontractors under the direction of the Cx Agent. Deliverables: Completed FPT and updated Issues Log.

Operator Training – Training using an approved training outline on the operations and maintenance of the equipment to the Owners’ personnel as outlined in the specifications. Deliverables: Training outline, attendance rosters.

E. Post Occupancy Phase

Closeout Documentation – Required documentation from the Cx Agent and Contracting team after Substantial Completion. SRP requires this documentation to achieve Final Completion. Deliverables: Commissioning Report, O&M Manuals, Warranty information.

Systems Manual – For LEED and non-LEED projects, the additional BOD, as-built, testing, sequence of operations etc information that supplements the O&M Manuals to provide Operations & Maintenance teams additional information on what was installed, why, how it was tested, and controls information. Deliverables: Completed Systems Manual

Warranty Follow-Up /Deferred Testing – When required, a test plan and test results for seasonal testing and the notes/action items from the meeting to review all trouble calls & problems 90 days prior to the expiration of the warranty. Deliverable: Document showing Warranty Follow-up meeting was conducted and resolution of issues identified.

PART 2 – PRODUCTS

2.1 EQUIPMENT/SYSTEMS TO BE COMMISSIONED

A. The following equipment is typically commissioned.
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PART 3 – EXECUTION (N/A)

END OF SPECIFICATION SECTION
SECTION 019113 GENERAL COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. SRP’s Scope of Work Document or the Owner’s Project Requirements (OPR)
B. Basis of Design (BOD) document from the AE.
C. Roles and Responsibilities Matrix (found in the Bid documents)

1.2 SUMMARY

A. Why SRP Commissions

Commissioning is part of SRP’s Quality Assurance process that ensures a building or project’s complex range of systems is designed, installed, tested, and performs to SRP’s intent and operational needs.

B. What SRP Expects From Commissioning.

Depending on size and complexity of the project, expectations for Commissioning range from completing the manufacturer’s installation and startup checklists followed by a functional performance test to a fully integrated commission process that begins early in the design phase and ends when the warranty period is over.

C. The Roles and Responsibilities SRP, AE Team, and Construction Team have on this project.

SRP has a Roles and Responsibilities Matrix (see Paragraph 1.4 Responsibilities) that defines the responsibilities of each organization in the Design Phase, Pre-Construction Phase, Construction Phase, Acceptance Phase, and Post Occupancy Phase.

D. This Section excludes Retro-Commissioning.

1.3 RELATED WORK

013300 Submittals Covers content and format of all submittals.
017700 Closeout Defines Substantial Completion and Functional Completion
017823 O&M Manuals Defines O&M documentation
015995 Mechanical Cx Describes details of testing to meet the Cx requirements.
016995 Electrical Cx Describes details of testing to meet the Cx requirements.

1.4 RESPONSIBILITIES & MATRIX

The Roles and Responsibilities Matrix will be completed by SRP and included in the Bid packages for the AE and the Construction Team. Here is an example of a completed matrix.
1.5 DEFINITIONS AND DELIVERABLES

Design Phase

Owners Project Requirements (OPR) - A document written by the Owner’s Representative, which details the functional requirements of Project and expectations of how it will be used and operated. This document may include project and design goals, measurable performance criteria, budgets, schedules, success criteria, and supporting information dynamic document that provides the explanation of the ideas, concepts and criteria that are considered very important to SRP. SRP may furnish a detailed Scope Document that is equivalent to the OPR.

Deliverable: Written Document

Basis of Design (BOD) - The A/E team’s written record of the primary thought processes and assumptions behind design decisions. It records concepts, calculations, decisions, and product selections used to meet the OPR/Scope Document and to satisfy applicable regulatory requirements. Includes the Sequence of Operations

Deliverable: A written document or written in the drawings.

Commissioning Specification - A specific set of requirements that must be satisfied to insure that the equipment and systems installed meet all the Owners Project Requirements.

Deliverable: Approved Commissioning Specifications
Pre-Construction Phase

Commissioning Plan (Cx Plan) – the overall plan, drafted before and developed after bidding that provides the structure, schedule and coordination planning for the commissioning process. There is a design phase plan and a construction phase plan.
Deliverable: Project specific written plan.

Pre-functional Checklists – Checklist(s) of items to verify proper installation of equipment and startup of equipment. The manufacturer’s installation and startup checklists are the normal source documents. The Cx Agent may approve the manufacturer’s checklists or furnish more comprehensive checklists for use by the installing subcontractor. Pre-functional checklists are primarily static inspections and procedures to prepare the equipment for initial operation.
Deliverable: Installation Checklist and Startup Checklist for each type of equipment installed.

Functional Performance Testing Procedures (FPT) - Functional testing is the dynamic operation and testing of systems (rather than just components) under full operation. Systems are tested under various modes, various loads, simulated component failures, unoccupied, varying outside air temperatures, fire alarm, power failure, etc. The systems are run through all the control system’s sequences of operation and components are verified to be responding as the sequences state. The Cx Agent develops the functional test procedures in a sequential written form, oversees and documents the actual testing. FPTs are performed after pre-functional checklists, startup, and TAB are complete.
Deliverable: Written Functional Performance Test plan.

Construction Phase

Installation Verification – The completion of the Installation Checklists by the Subcontractors, with overview by the Cx Agent. This activity is complete when the Cx Agent has reviewed and approves the checklists for each discrete piece of equipment and any discrepancies or deviations are noted on the Issues Log (maintained by the Cx Agent).
Deliverable: Completed Installation Checklists and Issues Log

Equipment Startup - It is the initial energizing of dynamic equipment, including executing the approved startup checklist by installing contractor. Startup may be witnessed by the Cx Agent. It is part of the Pre-functional Tests.
Deliverable: Completed Startup Checklists and Issues Log

Test and Balance (TAB) - Traditional air or water test and balancing to set up the system flows and pressures as specified.
Deliverable: TAB report.

System Verification – Verification of resolution of items on Issues Log prior to start of Acceptance Phase (and functional performance testing).
Deliverable: Completed Issues Log with resolutions and indication equipment is ready for FPT.

Acceptance Phase

Functional Performance Testing – The completion of the Functional Performance Test by the Subcontractors under the direction of the Cx Agent.
Deliverable: Completed FPT and updated Issues Log.
Operator Training – Training using an approved training outline on the operations and maintenance of each equipment to the Owners’ personnel as outlined in the specifications.  
**Deliverable:** Training outline, attendance rosters.

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PART 3 – EXECUTION (N/A)

END OF SPECIFICATION SECTION
SECTION 024116 - REMODEL DEMOLITION

PART 1 GENERAL

1.1 SUMMARY:
A. This section describes performing the necessary demolition work. The extent of the demolition is that work necessary or required so that the alterations, remodeling and related work can be performed and completed in accordance with the Contract Document.

1.2 PROJECT CONDITIONS
A. Existing construction indicated was obtained from existing drawings. Verify all existing conditions and notify the Project Architect of any discrepancies before proceeding with the work.
B. Perform the removal, cutting, drilling, etc., of existing work with extreme care and use small tools in order not to jeopardize the structural integrity of the building.
C. Safety shore existing construction wherever required to allow the safe installation of new work.
D. All cutting of existing concrete and masonry (if applicable) shall be done with saws and core drills. Do not use jackhammers.
E. Site Investigation - bidders are expected to visit the site to form their own conclusions as to the character of the work under this section.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 DEMOLITION
A. Demolition work shall be performed by experienced personnel exercising proper care to prevent injury to the public, workmen and adjoining property.
B. Debris from the demolition shall not be allowed to accumulate within the building or on the site.
C. Unless specifically stated otherwise, all demolished materials shall be placed in SRP supplied dumpsters and be removed from the site by SRP.
D. Carefully remove all materials that are scheduled for reuse and protect same.
E. Exercise all possible care to control excessive dust during the construction to keep problems to a minimum. All equipment and surfaces shall be covered prior to demolition work. Prior to leaving site, the entire area shall be thoroughly clean unless specifically authorized otherwise by Project Architect.
F. Unless noted otherwise, all demolition work shall be provided after business hours.
G. The Contractor shall control noise and dust during the demolition. Noise transmission to adjacent occupied areas shall not exceed 60 db during normal work hours. Radios within the facilities shall be prohibited.
H. All existing finishes and/or surfaces that are required to be removed shall be cleaned/repaired and/or prepared to receive the new required finish and/or surfaces.
I. All existing finishes and/or surfaces that are required to receive a new finish shall be cleaned/repaired and/or prepared as required.
J. Rebuild/Repair/Refinish any existing finishes and/or surfaces which has to be removed to allow for new work. Rebuild/repair and/or refinish work shall be required to match and blend into the existing adjacent area (unless noted otherwise in the Construction Documents).
K. Unless noted otherwise in the Construction Documents, every effort to reuse materials within a given area shall be exercised unless it is deemed not to be the least cost alternative.

END SECTION
SECTION 033000 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes.

B. Related Sections:
   1. Section 312000 "Earth Moving" for drainage fill under slabs-on-grade.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Design Mixtures: For each concrete mixture.

C. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement.

D. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer detailing fabrication, assembly, and support of formwork.

E. Welding certificates.

F. Material certificates.

G. Material test reports.

H. Floor surface flatness and levelness measurements.

1.3 QUALITY CONTROL

A. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
   1. Manufacturer certified according to NRMCA’s "Certification of Ready Mixed Concrete Production Facilities."

B. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4/D 1.4M, "Structural Welding Code - Reinforcing Steel."

D. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
   1. ACI 301, "Specifications for Structural Concrete,"
   2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

E. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

F. Preinstallation Conference: Conduct conference at Project site.

PART 2 - PRODUCTS

2.1 FORM-FACING MATERIALS

   A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

   B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

2.2 STEEL REINFORCEMENT

   A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

   B. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.
      2. Epoxy-Coated Reinforcing Bars: ASTM A 775/A 775M, epoxy coated, with less than 2 percent damaged coating in each 12-inch bar length.

   C. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, plain, fabricated from as-drawn steel wire into flat sheets.


   E. Galvanized-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, plain, fabricated from galvanized-steel wire into flat sheets.

   F. Epoxy-Coated Welded Wire Reinforcement: ASTM A 884/A 884M, Class A coated, Type 1, deformed steel.
G. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice.

2.3 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:

1. Portland Cement: ASTM C 150, Type I/II Type III Type V. Supplement with the following:
   a. Fly Ash: ASTM C 618, Class F.
   b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

B. Normal-Weight Aggregates: ASTM C 33, graded.

1. Maximum Coarse-Aggregate Size: 1 inch nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.


2.4 ADMIXTURES


B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.5 FIBER REINFORCEMENT

A. Synthetic Micro-Fiber: Polypropylene micro-fibers engineered and designed for use in concrete, complying with ASTM C 1116/C 1116M, Type III, 1/2 to 1-1/2 inches long.
2.6 WATERSTOPs

A. Flexible Rubber Waterstops: CE CRD-C 513, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.

B. Chemically Resistant Flexible Waterstops: Thermoplastic elastomer rubber waterstops, for embedding in concrete to prevent passage of fluids through joints; resistant to oils, solvents, and chemicals. Factory fabricate corners, intersections, and directional changes.

C. Flexible PVC Waterstops: CE CRD-C 572 for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.

D. Self-Expanding Butyl Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, 3/4 by 1 inch.

E. Self-Expanding Rubber Strip Waterstops: Manufactured rectangular or trapezoidal strip, bentonite-free hydrophilic polymer modified chloroprene rubber, for adhesive bonding to concrete, 3/8 by 3/4 inch.

2.7 VAPOR RETARDERS

A. Sheet Vapor Retarder: ASTM E 1745. Include manufacturer's recommended adhesive or pressure-sensitive tape.

B. Sheet Vapor Retarder: Polyethylene sheet, ASTM D 4397, not less than 10 mils thick.

2.8 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

F. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, non-dissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering.

G. Clear, Solvent-Borne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.
1. VOC Content: Curing and sealing compounds shall have a VOC content of 200 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

H. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.

1. VOC Content: Curing and sealing compounds shall have a VOC content of 200 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.9 RELATED MATERIALS


2.10 CONCRETE MIXTURES

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.

B. Cementitious Materials: With written permission of the Engineer, use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.

C. Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use water-reducing, high-range water-reducing, or admixture in concrete, as required, for placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.

D. Proportion normal-weight concrete mixture as follows:

1. Minimum Compressive Strength: See Table 1 at 28 days.
2. Maximum Water-Cementitious Materials Ratio: See Table 1
3. Slump Limit: See Table 1.
4. Air Content: 5.5 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch nominal maximum aggregate size.
5. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for 1-inch nominal maximum aggregate size.
6. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent.
7. Synthetic Micro-Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 1.0 lb/cu. yd.

E. Proportion structural lightweight concrete mixture as follows:

1. Minimum Compressive Strength: 3000 psi at 28 days.
2. Calculated Equilibrium Unit Weight: 105 lb/cu. ft., plus or minus 3 lb/cu. ft. as determined by ASTM C 567.
3. Slump Limit: 4 inches, plus or minus 1 inch.
4. Air Content: 6 percent, plus or minus 2 percent at point of delivery for nominal maximum aggregate size greater than 3/8 inch.
5. Air Content: 7 percent, plus or minus 2 percent at point of delivery for nominal maximum aggregate size 3/8 inch or less.
6. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent.
7. Synthetic Micro-Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 1.0 lb/cu. yd.

2.11 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.12 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and furnish batch ticket information.

1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 FORMWORK

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

C. Chamfer exterior corners and edges of permanently exposed concrete.

3.2 EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
3.3 VAPOR RETARDERS

A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder according to ASTM E 1643 and manufacturer's written instructions.

1. Lap joints 6 inches and seal with manufacturer's recommended tape.

3.4 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.

1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

3.5 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.

2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.

D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

E. Waterstops: Install in construction joints and at other joints indicated according to manufacturer's written instructions.

3.6 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.

B. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of
weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.

1. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.

C. Cold-Weather Placement: Comply with ACI 306.1.

D. Hot-Weather Placement: Comply with ACI 301.

3.7 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces not exposed to public view.

B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces exposed to public view, to receive a rubbed finish, to be covered with a coating or covering material applied directly to concrete.

C. Rubbed Finish: Apply the following to smooth-formed finished as-cast concrete where indicated:

1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.

2. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix one part portland cement to one and one-half parts fine sand with a 1:1 mixture of bonding admixture and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.

3. Cork-Floated Finish: Wet concrete surfaces and apply a stiff grout. Mix one part portland cement and one part fine sand with a 1:1 mixture of bonding agent and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.

D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.
3.8 FINISHING FLOORS AND SLABS

A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbyied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch in one direction.
   1. Apply scratch finish to surfaces indicated and to receive concrete floor toppings.

C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.
   1. Apply float finish to surfaces indicated.

D. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
   1. Apply a trowel finish to surfaces indicated, exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
   2. Finish and measure surface so gap at any point between concrete surface and an unleveled, freestanding, 10-ft.-long straightedge resting on two high spots and placed anywhere on the surface does not exceed 1/8 inch.

E. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces indicated where ceramic or quarry tile is to be installed by either thickset or thin-set method. While concrete is still plastic, slightly scarify surface with a fine broom.
   1. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.

F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and elsewhere as indicated.

3.9 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
C. Cure concrete according to ACI 308.1, by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days.
2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
   a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound will not interfere with bonding of floor covering used on Project.
4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.10 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.

3.11 QUALITY ASSURANCE

A. Testing and Inspecting: SRP will self perform field tests and inspections and prepare test reports.
<table>
<thead>
<tr>
<th>Mix Design #</th>
<th>Use</th>
<th>Min. Compressive Strength @28 Days, £c (psi)</th>
<th>Gradation* Size No.</th>
<th>Coarse Aggregate Nominal Size Range</th>
<th>Maximum Slump</th>
<th>Maximum W. C. Ratio (by wt.)</th>
<th>Admixtures</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Direct Embedded Steel Pole Backfill</td>
<td>1,000</td>
<td>8</td>
<td>3/8” to No. 8</td>
<td>8” ± 1”</td>
<td>0.60</td>
<td>Air-Entraining (3-5%) Superplasticizer***</td>
</tr>
<tr>
<td>2</td>
<td>Canal Bottom</td>
<td>2,000</td>
<td>57</td>
<td>1” to No. 4</td>
<td>5”</td>
<td>0.65</td>
<td>Air-Entraining</td>
</tr>
<tr>
<td>3</td>
<td>Slipform</td>
<td>2,000</td>
<td>7</td>
<td>1/2” to No. 4</td>
<td>4”</td>
<td>***</td>
<td>Air-Entraining</td>
</tr>
<tr>
<td>4</td>
<td>General</td>
<td>2,500</td>
<td>67</td>
<td>3/4” to No. 4</td>
<td>4”</td>
<td>0.60</td>
<td>Air-Entraining **</td>
</tr>
<tr>
<td>5</td>
<td>Shotcrete</td>
<td>3,000</td>
<td>8+</td>
<td>3/8” to No. 8</td>
<td>4”</td>
<td>0.47</td>
<td>Air Entraining</td>
</tr>
<tr>
<td>6</td>
<td>Cast-in-place Pipe up to 30” dia.</td>
<td>3,000</td>
<td>7</td>
<td>1/2” to No. 4</td>
<td>3”</td>
<td>0.55</td>
<td>Air-Entraining **</td>
</tr>
<tr>
<td>7</td>
<td>Cast-in-place Pipe 36” to 48” dia.</td>
<td>3,000</td>
<td>6</td>
<td>3/4” to 3/8”</td>
<td>3”</td>
<td>0.55</td>
<td>Air Entraining</td>
</tr>
<tr>
<td>8</td>
<td>Cast-in-place Pipe Larger than 48” dia.</td>
<td>3,000</td>
<td>57</td>
<td>1” to No. 4</td>
<td>3”</td>
<td>0.55</td>
<td>Air-Entraining **</td>
</tr>
<tr>
<td>9</td>
<td>Structural Concrete</td>
<td>3,000</td>
<td>57</td>
<td>1” to No. 4</td>
<td>5”</td>
<td>0.55</td>
<td>Air-Entraining **</td>
</tr>
<tr>
<td>10</td>
<td>Structural Concrete</td>
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<td>5”</td>
<td>0.50</td>
<td>Air-Entraining **</td>
</tr>
<tr>
<td>11</td>
<td>Structural Concrete</td>
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<td>1” to No. 4</td>
<td>5”</td>
<td>0.45</td>
<td>Air-Entraining **</td>
</tr>
</tbody>
</table>

*Gradation size numbers in accordance with the "Standard Specification for Concrete Aggregates", ASTM C33, Table 2.
*An Air-Entraining admixture must be used if the concrete is to be placed at a location with an elevation above 4,000 feet.
*Cement content not less than 423 lb./cu. yd.

* Modification of ASTM C33 gradation with 78% to 85% of coarse aggregate passing the 3/8” sieve.
** Air Entraining may be eliminated if fly ash is used in mix design.
*** Daracem 100 (or approved equal), 10-20 oz./cwt.

END OF SECTION 033000
SECTION 033713 - SHOTCRETE

PART 1 - GENERAL

1.1 SUMMARY
   A. Section includes shotcrete applied by wet-mix process.

1.2 PREINSTALLATION MEETINGS
   A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of product.
   B. Design Mixtures: For each shotcrete mixture.
   C. Shop Drawings: For support and anchor details; details of fabricating, bending, and placing reinforcement; and locations of proposed construction joints.
   D. Samples: For each exposed product and for each color and finish specified.

1.4 INFORMATIONAL SUBMITTALS
   A. Material certificates.

1.5 QUALITY CONTROL

PART 2 - PRODUCTS

2.1 REINFORCING MATERIALS
   A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
   B. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.
   C. Plain-Steel Wire: ASTM A 82/A 82M, as drawn.
D. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, plain, fabricated from as-drawn steel wire into flat sheets.


F. Galvanized-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, plain, fabricated from galvanized-steel wire into flat sheets.

2.2 SHOTCRETE MATERIALS

A. Portland Cement: ASTM C 150, Type I or Type III. Use only one brand and type of cement for Project.
   1. Fly Ash: ASTM C 618, Class C or Class F.
   2. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or Grade 120.

B. Normal-Weight Aggregates: ASTM C 33, from a single source, and as follows:
   1. Combined Aggregate Size: ACI 506R or ASTM C 1436, Grading [No. 1] [No. 2] sieve analysis.

C. Synthetic Fiber: [Monofilament] [or] [fibrillated] polypropylene fibers engineered and designed for use in shotcrete, complying with ASTM C 1116/C 1116M, Type III.

2.3 ADMIXTURES

A. General: ASTM C 1141, Class A (liquid), but limited to the following admixture materials. Provide admixtures for shotcrete that contain not more than 0.1 percent chloride ions. Certify compatibility of admixtures with each other and with other cementitious materials.

2.4 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry, or cotton mats.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Clear, [Waterborne] [Solvent-Borne], Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.

2.5 SHOTCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of shotcrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 506.2.
B. Cementitious Materials: Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.

C. Limit water-soluble chloride ions to maximum percentage by weight of cement or cementitious materials permitted by ACI 301.

D. Design-Mixture Adjustments: Subject to compliance with requirements, shotcrete design-mixture adjustments may be proposed when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant.

2.6 SHOTCRETE MIXTURES

A. Shotcrete Mixture <Insert drawing designation>: Proportion mixture to provide shotcrete with the following properties:

1. Compressive Strength (28 Days): [4000 psi] [3500 psi].
2. Air Content: Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight wet-mix shotcrete having an air content before pumping of [7] [8] <Insert number> percent with a tolerance of plus or minus 1-1/2 percent.
3. Synthetic Fiber: Uniformly disperse in shotcrete mix, according to manufacturer's written instructions, at a rate of [1.5 lb/cu. yd.] [5 lb/cu. yd.].
4. Color: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials that weaken shotcrete bonding.

3.2 APPLICATION

A. Apply temporary protective coverings and protect adjacent surfaces against deposit of rebound and overspray or impact from nozzle stream.

B. Apply shotcrete according to ACI 506.2.

C. Apply [dry-mix shotcrete materials within 45 minutes after predampening] [and] [wet-mix shotcrete materials within 90 minutes after batching].

D. Deposit shotcrete continuously in multiple passes, to required thickness, without cold joints and laminations developing. Place shotcrete with nozzle held perpendicular to receiving surface. Begin shotcreting in corners and recesses.
1. Remove and dispose of rebound and overspray materials during shotcreting to maintain clean surfaces and to prevent rebound entrapment.

E. Maintain reinforcement in position during shotcreting. Place shotcrete to completely encase reinforcement and other embedded items. Maintain steel reinforcement free of overspray, and prevent buildup against front face during shotcreting.

F. Do not place subsequent lifts until previous lift of shotcrete is capable of supporting new shotcrete.

G. Do not permit shotcrete to sag, slough, or dislodge.

H. Remove hardened overspray, rebound, and laitance from shotcrete surfaces to receive additional layers of shotcrete; dampen surfaces before shotcreting.

I. Do not disturb shotcrete surfaces before beginning finishing operations.

J. Installation Tolerances: Place shotcrete without exceeding installation tolerances permitted by ACI 117, increased by a factor of two.

K. Cold-Weather Shotcreting: Mix, place, and protect shotcrete according to ACI 306.1. Protect shotcrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

L. Hot-Weather Shotcreting: Mix, place, and protect shotcrete according to recommendations of ACI 305R when hot-weather conditions and high temperatures would seriously impair quality and strength of shotcrete:

3.3 SURFACE FINISHES

A. General: Finish shotcrete according to descriptions in ACI 506R.

B. Natural Finishes:

1. Gun Finish: Natural undisturbed finish as sprayed.
2. Rod Finish: Rough-textured finish obtained by screeding or cutting exposed face of shotcrete to plane with cutting rod, edge of trowel, or straightedge after initial set. Do not push or float with flat part of trowel.
3. Broom Finish: Rough-textured finish obtained by screeding or cutting exposed face of shotcrete to plane with cutting rod, edge of trowel, or straightedge after initial set; followed by uniform brooming.

3.4 CURING

A. Protect freshly placed shotcrete from premature drying and excessive cold or hot temperatures.

B. Begin curing immediately after placing and finishing but not before free water, if any, has disappeared from shotcrete surface.
C. Curing Exposed Surfaces: Cure shotcrete by one of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with water, continuous water-fog spray, water-saturated absorptive covers, or moisture-retaining covers. Lap and seal sides and ends of covers.

2. Curing Compound: Apply uniformly in continuous operation by power spray according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

   a. Apply curing compound to natural gun finish or flash-coat shotcrete at rate of 1 gal./100 sq. ft..

3.5 REPAIRS

A. Remove and replace shotcrete that is delaminated or exhibits laminations, voids, or sand/rock pockets.

3.6 CLEANING

A. Immediately remove and dispose of rebound and overspray materials from final shotcrete surfaces and areas not intended for shotcrete placement.

END OF SECTION 033713
PART 1 - GENERAL

1.1 SUMMARY

A. Section includes cast-in-place [perlite aggregate] [vermiculite aggregate] [cellular] lightweight insulating concrete.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Include plans, sections, and details showing roof slopes, lightweight insulating concrete thicknesses, embedded insulation board, roof penetrations, roof perimeter terminations and curbs, control and expansion joints, and roof drains.

C. Design mixtures.

1.3 INFORMATIONAL SUBMITTALS

A. Product certificates.

B. Material test reports.

C. Research/evaluation reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An Installer who employs and retains, throughout the project, supervisors who are trained and approved by manufacturer.

B. Fire-Resistance Ratings: Where indicated, provide lightweight insulating concrete identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency.

C. FM Approvals Listing: Provide lightweight insulating concrete evaluated by FM Approvals as part of a roof assembly and listed in FM Approvals' "RoofNav" for Class 1 or noncombustible construction, as applicable.

D. Provide vermiculite aggregates containing no detectable asbestos as determined by method specified in 40 CFR 763, Subpart E, Appendix E, Section 1, "Polarized Light Microscopy."

E. Preinstallation Conference: Conduct conference at Project site.
PART 2 - PRODUCTS

2.1 MATERIALS

A. Cementitious Material: Portland cement, ASTM C 150, Type I/II or Type III. Supplement with fly ash, ASTM C 618, Class C or F.

B. Lightweight Mineral Aggregate: ASTM C 332, Group I, vermiculite or perlite.

C. Foaming Agent: ASTM C 869.

D. Water: Clean, potable.


F. Joint Filler: ASTM C 612, Class 2, glass-fiber type; compressing to one-half thickness under a load of 25 psi.

G. Steel Wire Mesh: Cold-drawn steel wire, galvanized, 0.041-inch diameter, woven into 2-inch hexagonal mesh, and reinforced with a longitudinal 0.062-inch- diameter wire spaced 3 inches apart.

H. Galvanized Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, 2 by 2 inches, W0.5 by W0.5, fabricated from galvanized steel wire into flat sheets.

I. Molded-Polystyrene Insulation Board: ASTM C 578, Type I, 0.90-lb/cu. ft. minimum density.
   1. Provide units with manufacturer's standard keying slots of approximately 3 percent of board's gross surface area.

2.2 AGGREGATE LIGHTWEIGHT INSULATING CONCRETE

A. Produce lightweight insulating concrete using the minimum amount of water necessary to produce a workable mix.
   1. Do not exceed maximum air content recommended by aggregate manufacturer.

B. Perlite Aggregate Mix: Lightweight insulating concrete produced from cementitious materials, water, air-entraining admixture, and perlite mineral aggregates.
   1. As-Cast Unit Weight: 38 to 44 lb/cu. ft. at point of placement, when tested according to ASTM C 138/C 138M.
   2. Oven-Dry Unit Weight: 24 to 30 lb/cu. ft., when tested according to ASTM C 495.
   3. Compressive Strength: Minimum 125 psi, when tested according to ASTM C 495.

035216-2
REV:02/11 LIGHTWEIGHT INSULATING CONCRETE
C. Vermiculite Aggregate Mix: Lightweight insulating concrete produced from cementitious materials, water, air-entraining admixture, and vermiculite mineral aggregates.

1. As-Cast Unit Weight: 45 to 49 lb/cu. ft. at point of placement, when tested according to ASTM C 138/C 138M.
2. Oven-Dry Unit Weight: 23 to 26 lb/cu. ft., when tested according to ASTM C 495.
3. Compressive Strength: Minimum 140 psi, when tested according to ASTM C 495.

2.3 CELLULAR LIGHTWEIGHT INSULATING CONCRETE

A. Produce cellular lightweight insulating concrete with the following minimum physical properties using cementitious materials, air-producing liquid-foaming agents, and the minimum amount of water necessary to produce a workable mix.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Celcore Incorporated.
   b. Cellular Concrete LLC, Mearlcrete Division.
   c. Elastizell Corporation of America.
   d. Lite-Crete Inc.
   e. Siplast.
   f. <Insert manufacturer's name>.

2. As-Cast Unit Weight: 34 to 42 lb/cu. ft. at point of placement, when tested according to ASTM C 138/C 138M.
3. Oven-Dry Unit Weight: 26 to 32 lb/cu. ft., when tested according to ASTM C 495.
4. Compressive Strength: Minimum 190 psi, when tested according to ASTM C 495.

PART 3 - EXECUTION

3.1 PREPARATION

A. Control Joints: Install control joints at perimeter of roof deck and at junctures with vertical surfaces, including curbs, walls, and vents, for full depth of lightweight insulating concrete. Fill control joints with joint filler.

B. Wire Mesh: Place steel wire mesh with longest dimension perpendicular to steel deck ribs. Cut mesh to fit around roof openings and projections. Terminate mesh at control joints. Lap sides and ends of mesh at least 6 inches.

C. Welded Wire Reinforcement: Place steel welded wire reinforcement with longest dimension perpendicular to steel deck ribs. Cut reinforcement to fit around roof
openings and projections. Terminate reinforcement at control joints. Lap sides and ends of reinforcement at least 6 inches.

3.2 MIXING AND PLACING

A. Mix and place lightweight insulating concrete according to manufacturer's written instructions, using equipment and procedures to avoid segregation of mixture and loss of air content.

B. Install insulation board according to lightweight insulating concrete manufacturer's written instructions.

C. Deposit and screed lightweight insulating concrete in a continuous operation until an entire panel or section of roof area is completed. Do not vibrate or work mix except for screeding or floating. Place to depths and slopes indicated.

D. Finish top surface smooth, free of ridges and depressions, and maintain surface in condition to receive subsequent roofing system.

E. Begin curing operations immediately after placement, and air cure for not less than three days, according to manufacturer's written instructions.

F. If ambient temperature falls below 32 deg F, protect lightweight insulating concrete from freezing and maintain temperature recommended by manufacturer for 72 hours after placement.

END OF SECTION 035216
SECTION 035300 - CONCRETE TOPPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Emery-aggregate concrete floor topping.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.3 INFORMATIONAL SUBMITTALS

A. Product test reports.

PART 2 - PRODUCTS

2.1 CONCRETE FLOOR TOPPINGS

A. Emery-Aggregate Concrete Floor Topping: Factory-prepared and dry-packaged mixture of graded, crushed emery aggregate containing not less than 50 percent aluminum oxide, not less than 24 percent ferric oxide, and not more than 8 percent silica; portland cement or blended hydraulic cement; plasticizers; and other admixtures to which only water needs to be added at Project site.

1. Products: Subject to compliance with requirements, provide one of the following:
   b. CONSPEC, by Dayton Superior; Conspec Emery Topping.
   c. Dayton Superior Corporation; Emery Tuff Top.
   d. L&M Construction Chemicals, Inc.; Emerytop 400.
   e. Metalcrete Industries; Met-Top E.
   f. US Concrete Materials, LLC; Florundum Emery 1-T Premix.

2. Compressive Strength (28 Days): 10,000 psi, ASTM C 109/C 109M.

B. Iron-Aggregate Concrete Floor Topping: Factory-prepared and dry-packaged mixture of graded iron aggregate, portland cement, plasticizers, and other admixtures to which only water needs to be added at Project site.
1. **Products**: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
   b. BASF Construction Chemicals, LLC; Mastertop Anvil-Top 300.
   c. CONSPEC, by Dayton Superior; Conplate Floor Topping.
   d. EDOCO, by Dayton Superior; Burke Iron Topping.
   e. Euclid Chemical Company (The); Super Euco-Top.
   f. Metalcrete Industries; Metalcrete.
   g. US Concrete Materials, LLC; Ferrotop.

2. **Compressive Strength (28 Days)**: 12,000 psi; ASTM C 109/C 109M.

2.2 **CURING MATERIALS**

A. **Evaporation Retarder**: Waterborne, monomolecular film forming; manufactured for application to fresh concrete.

B. **Absorptive Cover**: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

C. **Moisture-Retaining Cover**: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

D. **Water**: Potable.

E. **Clear, Waterborne, Membrane-Forming Curing Compound**: ASTM C 309, Type 1, Class B, 25 percent solids content, minimum.

2.3 **RELATED MATERIALS**

A. **Semirigid Joint Filler**: Two-component, semirigid, 100 percent solids, [epoxy resin with a Type A Shore durometer hardness of 80] [aromatic polyurea with a Type A Shore durometer hardness range of 90 to 95] per ASTM D 2240.

B. **Joint-Filler Strips**: [ASTM D 1751, asphalt-saturated cellulosic fiber] [or] [ASTM D 1752, cork or self-expanding cork].

C. **Portland Cement**: ASTM C 150, Type I or II.

D. **Sand**: ASTM C 404, fine aggregate passing No. 16 sieve.

E. **Water**: Potable.

F. **Acrylic-Bonding Agent**: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
G. Epoxy Adhesive: ASTM C 881/C 881M, Type V, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class and grade to suit requirements.

2.4 MIXING

A. Bonding Slurry: Mix portland cement with water to a thick paint consistency.

B. Bonding Slurry: Mix 1 part portland cement and \([1-1/2] \) \([2]\) \([2-1/2]\) parts sand with water and an acrylic-bonding agent according to manufacturer's written instructions to a thick paint consistency.

C. Floor Topping: Mix concrete floor topping materials and water in appropriate drum-type batch machine mixer or truck mixer according to manufacturer's written instructions.

PART 3 - EXECUTION

3.1 PREPARATION

A. Existing Concrete: Remove existing surface treatments and deteriorated and unsound concrete. Mechanically abrade base slabs to produce a heavily scarified surface profile with an amplitude of 1/4 inch.

1. Prepare and clean existing base slabs according to concrete floor topping manufacturer's written instructions. Fill voids, cracks, and cavities in base slabs.
2. Saw cut contraction and construction joints in existing concrete to a depth of 1/2 inch and fill with semirigid joint filler.
3. To both sides of joint edges and at perimeter of existing base slab mechanically remove a 4-inch-wide and 0-to 1-inch deep, tapered wedge of concrete and retexture surface.

B. Install joint-filler strips where topping abuts vertical surfaces.

3.2 FLOOR TOPPING APPLICATION

A. Start floor topping application in presence of manufacturer's technical representative.

B. Monolithic Floor Topping: After textured-float finish is applied to fresh concrete of base slabs specified in Section 033000 "Cast-in-Place Concrete," place concrete floor topping while concrete is still plastic.

C. Deferred Floor Topping: Within 72 hours of placing base slabs, mix and scrub bonding slurry into dampened concrete to a thickness of 1/16 to 1/8 inch, without puddling. Place floor topping while slurry is still tacky.

D. Existing Concrete: Apply epoxy-bonding adhesive, mixed according to manufacturer's written instructions, and scrub into dry base slabs to a thickness of 1/16 to 1/8 inch, without puddling. Place floor topping while adhesive is still tacky.
E. Place concrete floor topping continuously in a single layer, tamping and consolidating to achieve tight contact with bonding surface. Do not permit cold joints or seams to develop within pour strip.

1. Screed surface with a straightedge and strike off to correct elevations.
2. Slope surfaces uniformly where indicated.
3. Begin initial floating using bull floats to form a uniform and open-textured surface plane free of humps or hollows.

F. Finishing: Consolidate surface with power-driven floats as soon as concrete floor topping can support equipment and operator. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until concrete floor topping surface has a uniform, smooth, granular texture.

1. Hard Trowel Finish: After floating surface, apply first trowel finish and consolidate concrete floor topping by power-driven trowel without allowing blisters to develop. Continue troweling passes and restraighten until surface is smooth and uniform in texture.

G. Construction Joints: Construct joints true to line with faces perpendicular to surface plane of concrete floor topping, at locations indicated or as approved by Architect.

1. Coat face of construction joint with epoxy adhesive at locations where concrete floor topping is placed against hardened or partially hardened concrete floor topping.

H. Contraction Joints: Form weakened-plane contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into concrete floor topping when cutting action will not tear, abrade, or otherwise damage surface and before random contraction cracks develop.

1. Form joints in concrete floor topping over contraction joints in base slabs, unless otherwise indicated.
2. Construct contraction joints for a combined depth equal to topping thickness and not less than one-fourth of base-slab thickness.
3. Construct contraction joints for a depth equal to one-half of concrete floor topping thickness, but not less than 1/2 inch deep.

3.3 PROTECTING AND CURING

A. General: Protect freshly placed concrete floor topping from premature drying and excessive cold or hot temperatures.

B. Evaporation Retarder: Apply evaporation retarder to concrete floor topping surfaces in hot, dry, or windy conditions before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying floor topping, but before float finishing.

C. Begin curing immediately after finishing concrete floor topping. Cure by one or a combination of the following methods, according to concrete floor topping manufacturer's written instructions:
1. Moisture Curing: Keep surfaces continuously moist for not less than 7 days.
2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete for not less than seven days.
3. Curing Compound: Apply uniformly in two coats in continuous operations by power spray or roller according to manufacturer's written instructions.

3.4 JOINT FILLING

A. Prepare and clean contraction joints and install semirigid joint filler, according to manufacturer's written instructions, once topping has fully cured.

B. Install semirigid joint filler full depth of contraction joints. Overfill joint and trim semirigid joint filler flush with top of joint after hardening.

3.5 REPAIRS

A. Defective Topping: Repair and patch defective concrete floor topping areas, including areas that have not bonded to concrete substrate.

END OF SECTION 035300
SECTION 042000 - UNIT MASONRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concrete masonry units (CMU's).
2. Concrete building brick.
3. Decorative concrete masonry units.
4. Pre-faced concrete masonry units.
5. Concrete facing brick.
6. Face brick.
7. Building (common) brick.
8. Hollow brick.

B. Related Sections:

1. Section 055000 "Metal Fabrications" for furnishing steel lintels and shelf angles for unit masonry.
2. Section 076200 "Sheet Metal Flashing and Trim" for furnishing manufactured reglets installed in masonry joints.

1.2 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Owner will engage a qualified independent testing agency to perform preconstruction testing indicated below. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.

1. Clay Masonry Unit Test: For each type of unit required, according to ASTM C 67 for compressive strength.
2. Concrete Masonry Unit Test: For each type of unit required, according to ASTM C 140 for compressive strength.
4. Mortar Test (Property Specification): For each mix required, according to ASTM C 780 for compressive strength.
5. Grout Test (Compressive Strength): For each mix required, according to ASTM C 1019.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.
B. Shop Drawings: For reinforcing steel. Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement.

C. Samples for Verification: For each type and color of exposed masonry unit and colored mortar.

D. Material Certificates: For each type and size of product indicated. For masonry units include data on material properties, material test reports substantiating compliance with requirements.

E. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
   1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C 109/C 109M for compressive strength, ASTM C 1506 for water retention, and ASTM C 91 for air content.
   2. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.

1.4 QUALITY ASSURANCE

A. Masonry Standard: Comply with ACI 530.1/ASCE 6/TMS 602 unless modified by requirements in the Contract Documents.

B. Sample Panels: Build sample panels to verify selections made under sample submittals and to demonstrate aesthetic effects. Comply with requirements in Section 014000 "Quality Requirements" for mockups.
   1. Build sample panels for each type of exposed unit masonry construction in sizes approximately 48 inches long by 48 inches high.

1.5 PROJECT CONDITIONS

A. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

B. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
PART 2 - PRODUCTS

2.1 MASONRY UNITS, GENERAL

A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects will be exposed in the completed Work.

B. Fire-Resistance Ratings: Where indicated, provide units that comply with requirements for fire-resistance ratings indicated as determined by testing according to ASTM E 119, by equivalent masonry thickness, or by other means, as acceptable to authorities having jurisdiction.

2.2 CONCRETE MASONRY UNITS

A. Shapes: Provide shapes indicated and for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.

B. Integral Water Repellent: Provide units made with liquid polymeric, integral water repellent admixture that does not reduce flexural bond strength for exposed units.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. ACM Chemistries; RainBloc.
   b. BASF Aktiengesellschaft; Rheopel Plus.
   d. <Insert manufacturer's name; product name or designation>.

C. CMUs: ASTM C 90.

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of [2150 psi] [2800 psi] [3050 psi].
2. Density Classification: [Medium weight] [Normal weight]

D. Concrete Building Brick: ASTM C 55.

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of [2800 psi] [3050 psi] [3750 psi] [4050 psi].
2. Density Classification: [Medium weight] [Normal weight].

E. Decorative CMUs: ASTM C 90.

1. Products: Subject to compliance with requirements, provide the following:
   a. <Insert, in separate subparagraphs, manufacturer's name; product name or designation>.
2. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of [2150 psi] [2800 psi] [3050 psi].
3. Density Classification: [Lightweight] [Medium weight] [Normal weight].
4. Pattern and Texture:

F. Pre-faced CMUs: Lightweight hollow concrete units complying with ASTM C 90, with manufacturer's standard smooth resinous facing complying with ASTM C 744.

1. Products: Subject to compliance with requirements, provide the following:
   a. <Insert, in separate subparagraphs, manufacturer's name; product name or designation>.

2. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of [2150 psi] [2800 psi] [3050 psi]
3. Size: Manufactured with pre-faced surfaces having 1/16-inch- wide returns of facing to create 1/4-inch- wide mortar joints.
4. Colors and Patterns: As selected by Architect.

G. Concrete Facing Brick: ASTM C 1634.

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of [3750 psi] [4050 psi] <Insert value>.
2. Density Classification: [Lightweight] [Medium weight] [Normal weight].
4. Texture: [Split-face finish] [Ground-face finish] <Insert description>.
   a. Match Architect's samples.
5. Colors: As selected by Architect from manufacturer's full range.

2.3 CONCRETE AND MASONRY LINTELS

A. General: Provide one of the following:

B. Concrete Lintels: ASTM C 1623, matching CMUs in color, texture, and density classification; and with reinforcing bars indicated. Provide lintels with net-area compressive strength not less than CMUs.

C. Concrete Lintels: Precast or formed-in-place concrete lintels complying with requirements in Section 033000 "Cast-in-Place Concrete," and with reinforcing bars indicated.
D. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs with reinforcing bars placed as indicated and filled with coarse grout.

2.4 BRICK

A. General: Provide shapes indicated and as follows:

1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
2. Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.

B. Face Brick: Facing brick complying with ASTM C 216 or hollow brick complying with ASTM C 652, Class H40V (void areas between 25 and 40 percent of gross cross-sectional area).

1. Products: Subject to compliance with requirements, provide the following:
   a. <Insert, in separate subparagraphs, manufacturer’s name; product name or designation for acceptable face brick>.

2. Grade: [SW] [MW or SW].
3. Type: [FBX] [FBS] [FBA] [FBX or HBX] [FBS or HBS] [FBA or HBA].
4. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of [3350 psi] [4150 psi] [4950 psi] [6200 psi] [6600 psi] [8250 psi] <Insert value>.
5. Initial Rate of Absorption: Less than 30 g/30 sq. in. per minute when tested per ASTM C 67.
6. Efflorescence: Provide brick that has been tested according to ASTM C 67 and is rated "not effloresced."
7. Surface Coating: Brick with colors or textures produced by application of coatings shall withstand 50 cycles of freezing and thawing per ASTM C 67 with no observable difference in the applied finish when viewed from 10 feet.
8. Size (Actual Dimensions): [3-1/2 inches wide by 2-1/4 inches high by 7-1/2 inches long] [or] [3-5/8 inches wide by 2-1/4 inches high by 7-5/8 inches long].
9. Size (Actual Dimensions): [3-1/2 inches] [or] [3-5/8 inches] wide by 2-1/4 inches high by 8 inches long.
10. Size (Actual Dimensions): [3-1/2 inches wide by 2-3/4 inches high by 7-1/2 inches long] [or] [3-5/8 inches wide by 2-13/16 inches high by 7-5/8 inches long].
11. Size (Actual Dimensions): [3-1/2 inches wide by 3-1/2 inches high by 7-1/2 inches long] [or] [3-5/8 inches wide by 3-5/8 inches high by 7-5/8 inches long].
12. Size (Actual Dimensions): [3-1/2 inches wide by 3-1/2 inches high by 11-1/2 inches long] [or] [3-5/8 inches wide by 3-5/8 inches high by 11-5/8 inches long].
13. Size (Actual Dimensions): [3-1/2 inches wide by 7-1/2 inches high by 7-1/2 inches long] [or] [3-5/8 inches wide by 7-5/8 inches high by 7-5/8 inches long].

C. Building (Common) Brick: ASTM C 62, Grade MW or SW.

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of [1700 psi] [2100 psi] [3350 psi] [4150 psi] [4950 psi] [6200 psi] [6600 psi] [8250 psi] <Insert value>.

2. Size: Match size of face brick.

D. Hollow Brick: ASTM C 652, [Grade SW] [Grade MW or SW], [Class H40V (void areas between 25 and 40 percent of gross cross-sectional area)] [Class H60V (void areas between 40 and 60 percent of gross cross-sectional area)], [Type HBX] [Type HBS] [Type HBA] [Type HBB].

1. Products: Subject to compliance with requirements, provide the following:
   a. <Insert, in separate subparagraphs, manufacturer's name; product name or designation for acceptable hollow brick>.

2. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of [3350 psi] [4150 psi] [4950 psi] [6200 psi] [6600 psi] [8250 psi] <Insert value>.

3. Efflorescence: Provide brick that has been tested according to ASTM C 67 and is rated "not effloresced."

4. Surface Coating: Brick with colors or textures produced by application of coatings shall withstand 50 cycles of freezing and thawing per ASTM C 67 with no observable difference in the applied finish when viewed from 10 feet.

5. Size (Actual Dimensions): [5-1/2 inches wide by 3-1/2 inches high by 11-1/2 inches long] [or] [5-5/8 inches wide by 3-5/8 inches high by 11-5/8 inches long].

6. Size (Actual Dimensions): [7-1/2 inches wide by 3-1/2 inches high by 11-1/2 inches long] [or] [7-5/8 inches wide by 3-5/8 inches high by 11-5/8 inches long].

2.5 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

B. Hydrated Lime: ASTM C 207, Type S.

C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

D. Masonry Cement: ASTM C 91.

1. Products: Subject to compliance with requirements, provide one of the following:
b. Cemex S.A.B. de C.V.; [Brikset Type N] [Citadel Type S] [Dixie Type S] [Kosmortar Type N] [Richmortar] [Victor Plastic Cement].
c. Essroc, Italcementi Group; [Brixment] [or] [Velvet].
d. Holcim (US) Inc.; [Mortamix Masonry Cement] [Rainbow Mortamix Custom Buff Masonry Cement] [White Mortamix Masonry Cement].
e. Lafarge North America Inc.; [Magnolia Masonry Cement] [Lafarge Masonry Cement] [Trinity White Masonry Cement].
f. Lehigh Cement Company; [Lehigh Masonry Cement] [Lehigh White Masonry Cement].

E. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C 979. Use only pigments with a record of satisfactory performance in masonry mortar.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Davis Colors; True Tone Mortar Colors.
   b. Lanxess Corporation; Bayferrox Iron Oxide Pigments.
   c. Solomon Colors, Inc.; SGS Mortar Colors.

F. Colored Cement Product: Packaged blend made from portland cement and hydrated lime or masonry cement and mortar pigments, all complying with specified requirements, and containing no other ingredients.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Colored Portland Cement-Lime Mix:
      2) Holcim (US) Inc.; Rainbow Mortamix Custom Color Cement/Lime.
      4) Lehigh Cement Company; Lehigh Custom Color Portland/Lime Cement.
   b. Colored Masonry Cement:
      1) Capital Materials Corporation; Flamingo Color Masonry Cement.
      2) Cemex S.A.B. de C.V.; Richcolor Masonry Cement.
      3) Essroc, Italcementi Group; Brixment-in-Color.
      4) Holcim (US) Inc.; Rainbow Mortamix Custom Color Masonry Cement.
      5) Lafarge North America Inc.; U.S. Cement Custom Color Masonry Cement.
      6) Lehigh Cement Company; Lehigh Custom Color Masonry Cement.

G. Aggregate for Mortar: ASTM C 144.

1. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.
2. White-Mortar Aggregates: Natural white sand or crushed white stone.
3. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

I. Epoxy Pointing Mortar: ASTM C 395, epoxy-resin-based material formulated for use as pointing mortar for structural-clay tile facing units (and approved for such use by manufacturer of units); in color indicated or, if not otherwise indicated, as selected by Architect from manufacturer's colors.

J. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Euclid Chemical Company (The); Accelguard 80.
      c. Sonneborn Products, BASF Aktiengesellschaft; Trimix-NCA.

K. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with CMUs containing integral water repellent by same manufacturer.
   1. Products: Subject to compliance with requirements provide one of the following:
      a. ACM Chemistries; RainBloc for Mortar.
      b. BASF Aktiengesellschaft; Rheopel Mortar Admixture.

L. Water: Potable.

2.6 REINFORCEMENT

A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60.

B. Masonry Joint Reinforcement, General: ASTM A 951/A 951M.
   1. Interior Walls: Hot-dip galvanized, carbon steel.
   2. Exterior Walls: Stainless steel.
   3. Wire Size for Side Rods: \([0.148\text{-inch}] [0.187\text{-inch}]\) diameter.
   4. Wire Size for Cross Rods: \([0.148\text{-inch}] [0.187\text{-inch}]\) diameter.
   5. Wire Size for Veneer Ties: \([0.148\text{-inch}] [0.187\text{-inch}]\) diameter.
   6. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.
   7. Provide in lengths of not less than 10 feet, with prefabricated corner and tee units.

C. Masonry Joint Reinforcement for Single-Wythe Masonry: Either ladder or truss type with single pair of side rods.

D. Masonry Joint Reinforcement for Multiwythe Masonry:
   1. Ladder type with 1 side rod at each face shell of hollow masonry units more than 4 inches wide, plus 1 side rod at each wythe of masonry 4 inches wide or less.
2. Tab type, either ladder or truss design, with 1 side rod at each face shell of backing wythe and with rectangular tabs sized to extend at least halfway through facing wythe but with at least 5/8-inch cover on outside face.

3. Adjustable (two-piece) type, either ladder or truss design, with one side rod at each face shell of backing wythe and with separate adjustable ties with pintle-and-eye connections having a maximum adjustment of 1-1/4 inches. Size ties to extend at least halfway through facing wythe but with at least 5/8-inch cover on outside face.

E. Masonry Joint Reinforcement for Veneers Anchored with Seismic Masonry-Veneer Anchors: Single 0.187-inch- diameter, stainless-steel continuous wire.

2.7 TIES AND ANCHORS

A. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated.

3. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Wire Ties, General: Unless otherwise indicated, size wire ties to extend at least halfway through veneer but with at least 5/8-inch cover on outside face. Outer ends of wires are bent 90 degrees and extend 2 inches parallel to face of veneer.

C. Individual Wire Ties: Rectangular units with closed ends and not less than 4 inches wide.


D. Adjustable Anchors for Connecting to Structural Steel Framing: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. Anchor Section for Welding to Steel Frame: Crimped 1/4-inch- diameter, hot-dip galvanized steel wire.
2. Tie Section: Triangular-shaped wire tie, sized to extend within 1 inch of masonry face, made from 0.25-inch- diameter, hot-dip galvanized steel wire.

E. Adjustable Anchors for Connecting to Concrete: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. Connector Section: Dovetail tabs for inserting into dovetail slots in concrete and attached to tie section; formed from [0.060-inch- thick, steel sheet, galvanized after fabrication] [01.05-inch- thick, steel sheet, galvanized after fabrication].
2. Tie Section: Triangular-shaped wire tie, sized to extend within 1 inch of masonry face, made from 0.25-inch diameter, hot-dip galvanized steel wire.

3. Corrugated Metal Ties: Metal strips not less than 7/8 inch wide with corrugations having a wavelength of 0.3 to 0.5 inch and an amplitude of 0.06 to 0.10 inch made from [0.060-inch-thick, steel sheet, galvanized after fabrication] [0.075-inch-thick, steel sheet, galvanized after fabrication] [0.015-inch-thick, steel sheet, galvanized after fabrication] [0.075-inch-thick, steel sheet, galvanized after fabrication] with dovetail tabs for inserting into dovetail slots in concrete and sized to extend to within 1 inch of masonry face.

F. Partition Top anchors: 0.105-inch thick metal plate with 3/8-inch-diameter metal rod 6 inches long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from steel, hot-dip galvanized after fabrication.

G. Rigid Anchors: Fabricate from steel bars 1-1/2 inches wide by 1/4 inch thick by 24 inches long, with ends turned up 2 inches or with cross pins unless otherwise indicated.

1. Corrosion Protection: [Hot-dip galvanized to comply with ASTM A 153/A 153M] [Epoxy coating 0.020 inch thick].

H. Adjustable Masonry-Veneer Anchors:

1. General: Provide anchors that allow vertical adjustment but resist tension and compression forces perpendicular to plane of wall, for attachment over sheathing to wood or metal studs, and as follows:
   a. Structural Performance Characteristics: Capable of withstanding a 100-lbf load in both tension and compression without deforming or developing play in excess of 0.05 inch.

2. Contractor's Option: Unless otherwise indicated, provide any of the following types of anchors:

3. Screw-Attached, Masonry-Veneer Anchors: Units consisting of a wire tie and a metal anchor section.
   a. Products: Subject to compliance with requirements, provide one of the following:
      1) Dayton Superior Corporation, Dur-O-Wal Division; [D/A 213] [or] [D/A 210 with D/A 700-708].
      2) Heckmann Building Products Inc.; 315-D with 316.
      3) Hohmann & Barnard, Inc.; [DW-10] [DW-10HS] [or] [DW-10-X].
      4) Wire-Bond; [1004, Type III] [or] [RJ-711].
   b. Anchor Section: Rib-stiffened, sheet metal plate with screw holes top and bottom, having slotted holes for inserting wire tie.
   c. Fabricate sheet metal anchor sections and other sheet metal parts from [0.075-inch-thick, steel sheet, galvanized after fabrication] [1.05-inch-thick, steel sheet, galvanized after fabrication].
   d. Wire Ties: Triangular-, rectangular-, or T-shaped wire ties fabricated from [0.187-inch-] [0.25-inch-] diameter, hot-dip galvanized steel wire.

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4. Seismic Masonry-Veneer Anchors: Units consisting of a metal anchor section and a connector section designed to engage a continuous wire embedded in the veneer mortar joint.

   a. Products: Subject to compliance with requirements, provide one of the following:
      1) Dayton Superior Corporation, Dur-O-Wal Division; D/A 213S.
      2) Hohmann & Barnard, Inc.; DW-10-X-Seismiclip.
      3) Wire-Bond; RJ-711 with Wire-Bond clip.

   b. Anchor Section: Rib-stiffened, sheet metal plate with screw holes top and bottom, having slotted holes for inserting connector section.

   c. Connector Section: Rib-stiffened, sheet metal bent plate, sheet metal clip, or wire tie and rigid PVC extrusion designed to engage continuous wire. Size connector to extend at least halfway through veneer but with at least 5/8-inch cover on outside face.

   d. Fabricate sheet metal anchor sections and other sheet metal parts from [0.075-inch thick, steel sheet, galvanized after fabrication] [1.05-inch-thick, steel sheet, galvanized after fabrication].

   e. Fabricate wire connector sections from [0.187-inch] [0.25-inch] diameter, hot-dip galvanized, carbon-steel wire.

I. Anchor Bolts: Headed or L-shaped steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers; hot-dip galvanized to comply with ASTM A 153/A 153M, Class C; of dimensions indicated.

2.8 EMBEDDED FLASHING MATERIALS

A. Metal Flashing: Provide metal flashing complying with [SMACNA's "Architectural Sheet Metal Manual"] [Section 076200 "Sheet Metal Flashing and Trim"] and as follows:

   1. Metal Drip Edge: Fabricate from stainless steel. Extend at least 3 inches into wall and 1/2 inch out from wall, with outer edge bent down 30 degrees and hemmed.

   2. Metal Sealant Stop: Fabricate from stainless steel. Extend at least 3 inches into wall and out to exterior face of wall. At exterior face of wall, bend metal back on itself for 3/4 inch and down into joint 1/4 inch to form a stop for retaining sealant backer rod.


B. Flexible Flashing: Use one of the following unless otherwise indicated:

   1. Copper-Laminated Flashing: 7-oz./sq. ft. copper sheet bonded between 2 layers of glass-fiber cloth. Use only where flashing is fully concealed in masonry.

      a. Products: Subject to compliance with requirements, provide one of the following:
         1) Advanced Building Products Inc.: [Copper Fabric Flashing] [Copper Sealtite 2000].
2) Dayton Superior Corporation, Dur-O-Wal Division; Copper Fabric Thru-Wall Flashing.
3) Hohmann & Barnard, Inc.; H & B C-Fab Flashing.
4) Phoenix Building Products; Type FCC-Fabric Covered Copper.
5) Sandell Manufacturing Co., Inc.; Copper Fabric Flashing.
6) York Manufacturing, Inc.; Multi-Flash 500.
7) <Insert manufacturer's name; product name or designation>.

2. Rubberized-Asphalt Flashing: Composite flashing product consisting of a pliable, adhesive rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film to produce an overall thickness of not less than 0.040 inch.
   a. Products: Subject to compliance with requirements, provide one of the following:
      1) Advanced Building Products Inc.; Peel-N-Seal.
      2) Carlisle Coatings & Waterproofing; CCW-705-TWF Thru-Wall Flashing.
      3) Dayton Superior Corporation, Dur-O-Wal Division; Dur-O-Barrier Thru-Wall Flashing.
      4) Fiberweb, Clark Hammerbeam Corp.; Aquaflash 500.
      6) Heckmann Building Products Inc.; No. 82 Rubberized-Asphalt Thru-Wall Flashing.
      7) Hohmann & Barnard, Inc.; Textroflash.
      8) W. R. Meadows, Inc.; Air-Shield Thru-Wall Flashing.
      9) Polyguard Products, Inc.; [Polyguard 300] [Polyguard 400].
     10) Sandell Manufacturing Co., Inc.; Sando-Seal.

   a. Products: Subject to compliance with requirements, provide one of the following:

   b. DuPont; Thru-Wall Flashing.
      1) Hohmann & Barnard, Inc.; Flex-Flash.
      2) Hyload, Inc.; Hyload Cloaked Flashing System.
      3) Mortar Net USA, Ltd.; Total Flash.

4. EPDM Flashing: Sheet flashing product made from ethylene-propylene-diene terpolymer, complying with ASTM D 4637, 0.040 inch thick.
   a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      1) Carlisle Coatings & Waterproofing; Pre-Kleened EPDM Thru-Wall Flashing.
      2) Firestone Specialty Products; FlashGuard.
      3) Heckmann Building Products Inc.; No. 81 EPDM Thru-Wall Flashing.
4) Hohmann & Barnard, Inc.; Epra-Max EPDM Thru-Wall Flashing.
5) Sandell Manufacturing Co., Inc.; EPDM Flashing.

C. Solder and Sealants for Sheet Metal Flashings: As specified in Section 076200 "Sheet Metal Flashing and Trim."

D. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

2.9 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; formulated from [neoprene] [urethane] [or] [PVC].

B. Preformed Control-Joint Gaskets: Made from [styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805] [or] [PVC, complying with ASTM D 2287, Type PVC-65406] and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

D. Weep/Vent Products: Use one of the following unless otherwise indicated:

1. Cellular Plastic Weep/Vent: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, full height and width of head joint and depth 1/8 inch less than depth of outer wythe, in color selected from manufacturer's standard.

   a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      1) Advanced Building Products Inc.; Mortar Maze weep vent.
      2) Blok-Lok Limited; Cell-Vent.
      3) Dayton Superior Corporation, Dur-O-Wal Division; Cell Vents.
      4) Heckmann Building Products Inc.; No. 85 Cell Vent.
      5) Hohmann & Barnard, Inc.; Quadro-Vent.
      6) Wire-Bond; Cell Vent.

2. Mesh Weep/Vent: Free-draining mesh; made from polyethylene strands, full height and width of head joint and depth 1/8 inch less than depth of outer wythe; in color selected from manufacturer's standard.

   a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      1) Mortar Net USA, Ltd.; Mortar Net Weep Vents.
3. **Vinyl Weep Hole/Vent:** T-shaped units made from flexible PVC, consisting of a louvered vertical leg, flexible wings to seal against ends of masonry units, and a top flap to keep mortar out of the head joint; in color selected by Architect.
   
   a. **Products:** Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      
      1) Hohmann & Barnard, Inc.; #343 Louvered Weep Hole.
      2) Williams Products, Inc.; Williams-Goodco Brick Vent.
      3) Wire-Bond; Louvered Weepholes.

E. **Cavity Drainage Material:** Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.
   
   1. **Products:** Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      
      a. Advanced Building Products Inc.; [Mortar Break] [Mortar Break II].
      b. Archovations, Inc.; CavClear Masonry Mat.
      c. Dayton Superior Corporation, Dur-O-Wal Division; Polytite MortarStop.
      d. Mortar Net USA, Ltd.; Mortar Net

   2. **Provide one of the following configurations:**
      
      a. Strips, full-depth of cavity and 10 inches high, with dovetail shaped notches 7 inches deep.
      b. Strips, not less than [3/4 inch] [1-1/2 inches] thick and 10 inches high, with dimpled surface designed to catch mortar droppings and prevent weep holes from clogging with mortar.
      c. Sheets or strips full depth of cavity and installed to full height of cavity.

2.10 **MASONRY-CELL INSULATION**

A. **Loose-Granular Fill Insulation:** Perlite complying with ASTM C 549, Type II (surface treated for water repellency and limited moisture absorption) or Type IV (surface treated for water repellency and to limit dust generation).

B. **Molded-Polystyrene Insulation Units:** Rigid, cellular thermal insulation formed by the expansion of polystyrene-resin beads or granules in a closed mold to comply with ASTM C 578, Type I. Provide specially shaped units designed for installing in cores of masonry units.
   
   1. **Products:** Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      
      a. Concrete Block Insulating Systems; Korfil.
      b. Shelter Enterprises Inc.; Omni Core.
2.11 CAVITY-WALL INSULATION

A. Extruded-Polystyrene Board Insulation: ASTM C 578, [Type IV] [Type X], closed-cell product extruded with an integral skin.

B. Polyisocyanurate Board Insulation: ASTM C 1289, Type I (aluminum-foil-faced), Class 2 (glass-fiber-reinforced).

C. Adhesive: Type recommended by insulation board manufacturer for application indicated.

2.12 MASONRY CLEANERS

A. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Diedrich Technologies, Inc.
   b. EaCo Chem, Inc.
   c. ProSoCo, Inc.

2.13 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.
2. Use [portland cement-lime] [or] [masonry cement] mortar unless otherwise indicated.
3. For exterior masonry, use [portland cement-lime] [or] [masonry cement] mortar.
4. For reinforced masonry, use [portland cement-lime] [or] [masonry cement] mortar.
5. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated.
1. For masonry below grade or in contact with earth, use [Type M] [Type S].
2. For reinforced masonry, use [Type S] [Type N].
3. For mortar parget coats, use [Type S] [or] [Type N].
4. For exterior, above-grade, load-bearing and non-load-bearing walls and parapet walls; for interior load-bearing walls; for interior non-load-bearing partitions; and for other applications where another type is not indicated, use Type N.
5. For interior non-load-bearing partitions, Type O may be used instead of Type N.

D. Pigmented Mortar: Use colored cement product or select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored cement products.

1. Pigments shall not exceed 10 percent of portland cement by weight.
2. Pigments shall not exceed 5 percent of masonry cement by weight.
3. Application: Use pigmented mortar for exposed mortar joints with the following units:
   a. Decorative CMUs.
   b. Pre-faced CMUs.
   c. Concrete facing brick.
   d. Face brick.
   e. Hollow brick.
   f. Glazed structural-clay facing tile.

E. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.

1. Mix to match Architect's sample.
2. Application: Use colored aggregate mortar for exposed mortar joints with the following units:
   a. Decorative CMUs.
   b. Pre-faced CMUs.
   c. Concrete facing brick.
   d. Face brick.
   e. Hollow brick.
   f. Glazed structural-clay facing tile.

F. Grout for Unit Masonry: Comply with ASTM C 476.

1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
2. Proportion grout in accordance with ASTM C 476, Table 1.
3. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143/C 143M.

G. Epoxy Pointing Mortar: Mix epoxy pointing mortar to comply with mortar manufacturer’s written instructions.
1. Application: Use epoxy pointing mortar for exposed mortar joints with the following units:
   a. Pre-faced CMUs.
   b. Glazed structural-clay facing tile.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

B. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.

C. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. per minute when tested per ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.

3.2 TOLERANCES

A. Dimensions and Locations of Elements:

   1. For dimensions in cross section or elevation do not vary by more than plus 1/2 inch or minus 1/4 inch.
   2. For location of elements in plan do not vary from that indicated by more than plus or minus 1/2 inch.
   3. For location of elements in elevation do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.

B. Lines and Levels:

   1. For bed joints and top surfaces of bearing walls do not vary from level by more than 1/4 inch in 10 feet, or 1/2 inch maximum.
   2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
   3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.
   4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
   5. For lines and surfaces do not vary from straight by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.
C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.
2. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.
3. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch.

3.3 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

C. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

D. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

E. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

3.4 MORTAR BEDDING AND JOINTING

A. Lay hollow CMUs as follows:

1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.

B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Lay structural-clay tile as follows:

1. Lay vertical-cell units with full head joints unless otherwise indicated. Provide bed joints with full mortar coverage on face shells and webs.
2. Lay horizontal-cell units with full bed joints unless otherwise indicated. Keep drainage channels, if any, free of mortar. Form head joints with sufficient mortar so excess will be squeezed out as units are placed in position. Butter both sides of units to be placed, or butter one side of unit already in place and one side of unit to be placed.

3. Maintain joint thicknesses indicated except for minor variations required to maintain bond alignment. If not indicated, lay walls with 1/4- to 3/8-inch-thick joints.

4. Where epoxy-mortar pointed joints are indicated, rake out setting mortar to a uniform depth of 1/4 inch and point with epoxy mortar to comply with epoxy-mortar manufacturer's written instructions.

D. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

E. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

3.5 COMPOSITE MASONRY

A. Bond wythes of composite masonry together using one of the following methods:

1. Individual Metal Ties: Provide ties as shown installed in horizontal joints, but not less than one metal tie for [4.5 sq. ft.] [2.67 sq. ft.] [1.77 sq. ft.] of wall area spaced not to exceed [36 inches] [24 inches] [16 inches] o.c. horizontally and 16 inches o.c. vertically. Stagger ties in alternate courses. Provide additional ties within 12 inches of openings and space not more than 36 inches apart around perimeter of openings. At intersecting and abutting walls, provide ties at no more than 24 inches o.c. vertically.

   a. Where bed joints of both wythes align, use ladder-type reinforcement extending across both wythes.
   b. Where bed joints of wythes do not align, use adjustable (two-piece) type reinforcement with continuous horizontal wire in facing wythe attached to ties.

B. Collar Joints: Solidly fill collar joints by parging face of first wythe that is laid and shoving units of other wythe into place.

C. Corners: Provide interlocking masonry unit bond in each wythe and course at corners unless otherwise indicated.

D. Intersecting and Abutting Walls: Unless vertical expansion or control joints are shown at juncture, bond walls together as follows:

   1. Provide individual metal ties not more than [8 inches] [16 inches] o.c.
   2. Provide continuity with masonry joint reinforcement by using prefabricated T-shaped units.
3. Provide rigid metal anchors not more than [24 inches] [48 inches] o.c. If used with hollow masonry units, embed ends in mortar-filled cores.

3.6 CAVITY WALLS

A. Bond wythes of cavity walls together using one of the following methods:

1. Individual Metal Ties: Provide ties as shown installed in horizontal joints, but not less than one metal tie for [4.5 sq. ft.] [2.67 sq. ft.] [1.77 sq. ft.] of wall area spaced not to exceed [36 inches] [24 inches] [16 inches] o.c. horizontally and 16 inches o.c. vertically. Stagger ties in alternate courses. Provide additional ties within 12 inches of openings and space not more than 36 inches apart around perimeter of openings. At intersecting and abutting walls, provide ties at no more than 24 inches o.c. vertically.


   a. Where bed joints of both wythes align, use [ladder-type reinforcement extending across both wythes] [tab-type reinforcement].

   b. Where bed joints of wythes do not align, use adjustable (two-piece) type reinforcement[ with continuous horizontal wire in facing wythe attached to ties].

   c. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable (two-piece) type reinforcement[ with continuous horizontal wire in facing wythe attached to ties] to allow for differential movement regardless of whether bed joints align.

B. Keep cavities clean of mortar droppings and other materials during construction. Bevel beds away from cavity, to minimize mortar protrusions into cavity. Do not attempt to trowel or remove mortar fins protruding into cavity.

C. Parge cavity face of backup wythe in a single coat approximately 3/8 inch thick. Trowel face of parge coat smooth.

D. Coat cavity face of backup wythe to comply with Section 071113 "Bituminous Dampproofing."

E. Apply air barrier to face of backup wythe to comply with [Section 072713 "Modified Bituminous Sheet Air Barriers."] [Section 072726 "Fluid-Applied Membrane Air Barriers."]

F. Installing Cavity-Wall Insulation: Place small dabs of adhesive, spaced approximately 12 inches o.c. both ways, on inside face of insulation boards, or attach with plastic fasteners designed for this purpose. Fit courses of insulation between wall ties and other confining obstructions in cavity, with edges butted tightly both ways. Press units firmly against inside wythe of masonry or other construction as shown.
3.7 MASONRY-CELL INSULATION

A. Pour granular insulation into cavities to fill void spaces. Maintain inspection ports to show presence of insulation at extremities of each pour area. Close the ports after filling has been confirmed. Limit the fall of insulation to 1 story high, but not more than 20 feet.

B. Install molded-polystyrene insulation units into masonry unit cells before laying units.

3.8 MASONRY JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.

1. Space reinforcement not more than 16 inches o.c.
2. Space reinforcement not more than 8 inches o.c. in foundation walls and parapet walls.
3. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings[ in addition to continuous reinforcement].

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

3.9 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

A. Anchor masonry to structural steel and concrete where masonry abuts or faces structural steel or concrete to comply with the following:

1. Provide an open space not less than [1/2 inch] [1 inch] [2 inches] wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
3. Space anchors as indicated, but not more than 24 inches o.c. vertically and 36 inches o.c. horizontally.

3.10 ANCHORING MASONRY VENEERS

A. Anchor masonry veneers to [wall framing] [and] [concrete and masonry backup] with[ seismic] masonry-veneer anchors to comply with the following requirements:

1. Fasten [screw-attached] [and] [seismic] anchors [through sheathing to wall framing] [and] [to concrete and masonry backup] with metal fasteners of type indicated. Use two fasteners unless anchor design only uses one fastener.
2. Embed [tie sections] [connector sections and continuous wire] in masonry joints. Provide not less than 2 inches of air space between back of masonry veneer and face of sheathing.

3. Locate anchor sections to allow maximum vertical differential movement of ties up and down.

4. Space anchors as indicated, but not more than 16 inches o.c. vertically and [32 inches] [24 inches] o.c. horizontally with not less than 1 anchor for each [3.5 sq. ft.] [2.67 sq. ft.] of wall area. Install additional anchors within 12 inches of openings and at intervals, not exceeding 36 inches, around perimeter.

3.11 FLASHING, WEEP HOLES, CAVITY DRAINAGE, AND VENTS

A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated. Install vents at shelf angles, ledges, and other obstructions to upward flow of air in cavities, and where indicated.

B. Install flashing as follows unless otherwise indicated:

1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.

2. At lintels and shelf angles, extend flashing a minimum of 6 inches into masonry at each end. At heads and sills, extend flashing 6 inches at ends and turn up not less than 2 inches to form end dams.

3. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall and adhere flexible flashing to top of metal drip edge.

4. Install metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall and adhere flexible flashing to top of metal flashing termination.

C. Install weep holes in head joints in exterior wythes of first course of masonry immediately above embedded flashing and as follows:

1. Use specified weep/vent products to form weep holes.

2. Space weep holes 24 inches o.c. unless otherwise indicated.

3. Cover cavity side of weep holes with plastic insect screening at cavities insulated with loose-fill insulation.

D. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in "Miscellaneous Masonry Accessories" Article.

E. Install vents in head joints in exterior wythes at spacing indicated. Use specified weep/vent products to form vents.

1. Close cavities off vertically and horizontally with blocking in manner indicated. Install through-wall flashing and weep holes above horizontal blocking.
3.12 REINFORCED UNIT MASONRY INSTALLATION

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.

1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.

2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.

1. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.

2. Limit height of vertical grout pours to not more than \[60 \text{ inches}\] \[12.67 \text{ ft.}\] 

3.13 FIELD QUALITY ASSURANCE

A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas, as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.

B. Inspections: Special inspections according to the "International Building Code."

1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.

2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.

3. Place grout only after inspectors have verified proportions of site-prepared grout.

C. Testing Prior to Construction: One set of tests.

D. Testing Frequency: One set of tests for each 5000 sq. ft. of wall area or portion thereof.

E. Clay Masonry Unit Test: For each type of unit provided, according to ASTM C 67 for compressive strength.

F. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C 140 for compressive strength.
G. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, according to ASTM C 780.

H. Mortar Test (Property Specification): For each mix provided, according to ASTM C 780. Test mortar for compressive strength.

I. Grout Test (Compressive Strength): For each mix provided, according to ASTM C 1019.

3.14 PARGING

A. Parge exterior faces of below-grade masonry walls, where indicated, in 2 uniform coats to a total thickness of 3/4 inch.

B. Use a steel-trowel finish to produce a smooth, flat, dense surface. Form a wash at top of parging and a cove at bottom.

C. Damp-cure parging for at least 24 hours and protect parging until cured.

3.15 REPAIRING, POINTING, AND CLEANING

A. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

B. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

   1. Test cleaning methods on sample wall panel; leave one-half of panel uncleared for comparison purposes.
   2. Protect surfaces from contact with cleaner.
   3. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
   5. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.
   6. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.

3.16 MASONRY WASTE DISPOSAL

A. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.

   1. Do not dispose of masonry waste as fill within 18 inches of finished grade.
B. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION
SECTION 051200 - STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 SUMMARY
A. Section includes structural steel and grout.
B. Related Sections:
   1. Section 051213 "Architecturally Exposed Structural Steel Framing" for additional requirements for architecturally exposed structural steel.

1.2 DEFINITIONS
A. Structural Steel: Elements of structural-steel frame, as classified by AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

1.3 PERFORMANCE REQUIREMENTS
A. Connections: Provide details of simple shear connections required by the Contract Documents to be selected or completed by structural-steel fabricator to withstand loads indicated and comply with other information and restrictions indicated.
   1. Select and complete connections using schematic details indicated and AISC 360.
   2. Use [LRFD; data are given at factored-load level] [ASD; data are given at service-load level].
B. Moment Connections: Type PR, partially and FR, fully restrained.

1.4 SUBMITTALS
A. Product Data: For each type of product indicated.
B. Shop Drawings: Show fabrication of structural-steel components.
C. Qualification Data: For qualified Installer, fabricator, and testing agency.
D. Welding certificates.
E. Mill test reports for structural steel, including chemical and physical properties.
F. Source quality-control reports.
1.5 QUALITY CONTROL

A. Fabricator Qualifications:  A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD.

B. Installer Qualifications:  A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category CSE.

C. Welding Qualifications:  Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

D. Comply with applicable provisions of the following specifications and documents:
   1. AISC 303.
   2. AISC 360.
   3. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

E. Preinstallation Conference: Conduct conference at Project site.

PART 2 - PRODUCTS

2.1 STRUCTURAL-STEEL MATERIALS

A. Recycled Content of Steel Products:  Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. W-Shapes:  [ASTM A 992/A 992M] [ASTM A 572/A 572M, Grade 50].

C. Channels, Angles[, M] [, S]-Shapes:  [ASTM A 36/A 36M] [ASTM A 572/A 572M, Grade 50].

D. Plate and Bar:  [ASTM A 36/A 36M] [ASTM A 572/A 572M, Grade 50].

E. Cold-Formed Hollow Structural Sections:  ASTM A 500, Grade B or C, structural tubing.

F. Steel Pipe:  ASTM A 53/A 53M, Grade E or S, Grade B.

G. Welding Electrodes:  Comply with AWS requirements.

2.2 BOLTS, CONNECTORS, AND ANCHORS

A. High-Strength Bolts, Nuts, and Washers:  ASTM A 325, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade C, heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers; all with plain finish.

   1. Direct-Tension Indicators:  ASTM F 959, Type 325, compressible-washer type with plain finish.
B. High-Strength Bolts, Nuts, and Washers: ASTM A 490, Type 1, heavy-hex steel structural bolts or tension-control, bolt-nut-washer assemblies with splined ends; ASTM A 563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers with plain finish.

1. Direct-Tension Indicators: ASTM F 959, Type 490, compressible-washer type with plain finish.

C. Zinc-Coated High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade DH heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers.

1. Finish: Hot-dip or mechanically deposited zinc coating.
2. Direct-Tension Indicators: ASTM F 959, Type 325, compressible-washer type with mechanically deposited zinc coating finish.

D. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, heavy-hex or round head assemblies consisting of steel structural bolts with splined ends, heavy-hex carbon-steel nuts, and hardened carbon-steel washers.

1. Finish: Mechanically deposited zinc coating.

E. Shear Connectors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.

F. Unheaded Anchor Rods: ASTM F 1554, Grade 55, weldable.


G. Headed Anchor Rods: ASTM F 1554, Grade 55, weldable, straight.


H. Threaded Rods: [ASTM A 36/A 36M] [ASTM A 193/A 193M, Grade B7].


I. Clevises and Turnbuckles: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1035.

2.3 PRIMER

A. Low-Emitting Materials: Paints and coatings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
B. Primer: Comply with Section 099113 "Exterior Painting" and Section 099123 "Interior Painting," Section 099600 "High-Performance Coatings." Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."

C. Primer: SSPC-Paint 25, Type I or Type II, zinc oxide, alkyd, linseed oil primer.

D. Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.

2.4 GROUT

A. Metallic, Shrinkage-Resistant Grout: ASTM C1107, factory-packaged, metallic aggregate grout, mixed with water to consistency suitable for application and a 30-minute working time.

B. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.5 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC 360.

B. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

2.6 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: Pretensioned or Slip critical.

B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

2.7 SHOP PRIMING

A. Shop prime steel surfaces except the following:

1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
2. Surfaces to be field welded.
3. Surfaces to be high-strength bolted with slip-critical connections.
4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
5. Galvanized surfaces.

B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:

1. SSPC-SP 2, "Hand Tool Cleaning."
2. SSPC-SP 3, "Power Tool Cleaning."

C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

2.8 SOURCE QUALITY CONTROL

A. Testing Agency: Owner will engage an independent testing and inspecting agency to perform shop tests and inspections and prepare test reports.

1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.

B. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

C. Bolted Connections: Shop-bolted connections will be tested and inspected according to RCSC’s "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

D. Welded Connections: In addition to visual inspection, shop-welded connections will be tested and inspected according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

1. Liquid Penetrant Inspection: ASTM E 165.
2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
4. Radiographic Inspection: ASTM E 94.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify, with steel Erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.


1. Set plates for structural members on wedges, shims, or setting nuts as required.
2. Weld plate washers to top of baseplate.
3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
4. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

C. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."

3.3 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: Pretensioned or Slip critical.

B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
3.4 FIELD QUALITY ASSURANCE

A. Testing Agency: SRP will engage a qualified independent testing and inspecting agency to inspect field welds and high-strength bolted connections.

B. Bolted Connections: Bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

C. Welded Connections: Field welds will be visually inspected according to AWS D1.1/D1.1M.

1. In addition to visual inspection, field welds will be tested and inspected according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

   a. Liquid Penetrant Inspection: ASTM E 165.
   b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
   c. Ultrasonic Inspection: ASTM E 164.
   d. Radiographic Inspection: ASTM E 94.

D. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY
   A. Section Includes:
      1. Roof deck.
      2. Composite floor deck.

1.2 SUBMITTALS
   A. Product Data: For each type of deck, accessory, and product indicated.
   B. Shop Drawings:
      1. Include layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.
   C. Welding certificates.
   D. Product certificates.
   E. Evaluation reports.
   F. Field quality-control reports.

1.3 QUALITY CONTROL
   A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
   B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.3, "Structural Welding Code - Sheet Steel."

1.4 DELIVERY, STORAGE, AND HANDLING
   A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.
   B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.
PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."

B. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

C. Low-Emitting Materials: Paints and coatings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.2 ROOF DECK

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. ASC Profiles, Inc.; a Blue Scope Steel company.
   2. Canam United States; Canam Group Inc.
   3. CMC Joist & Deck.
   5. Cordeck.
   6. DACS, Inc.
   8. Marlyn Steel Decks, Inc.
   9. New Millennium Building Systems, LLC.
   11. Roof Deck, Inc.
   12. Valley Joist; Subsidiary of EBSCO Industries, Inc.
   14. Wheeling Corrugating Company; Div. of Wheeling-Pittsburgh Steel Corporation.
   15. <Insert manufacturer's name>.

B. Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 31, and with the following:
1. Prime-Painted Steel Sheet: ASTM A 1008/A 1008M, Structural Steel (SS), Grade 40 minimum, shop primed with manufacturer's standard baked-on, rust-inhibitive primer.
2. Galvanized-Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 40 zinc coating.
3. Galvanized and Shop-Primed Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 40, G60 zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer.
4. Deck Profile: As indicated.
5. Profile Depth: As indicated
6. Design Uncoated-Steel Thickness: As indicated.

2.3 COMPOSITE FLOOR DECK
A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. ASC Profiles, Inc.; a Blue Scope Steel company.
   2. Canam United States; Canam Group Inc.
   3. CMC Joist & Deck.
   5. Cordeck.
   6. DACS, Inc.
   8. Marlyn Steel Decks, Inc.
   9. New Millennium Building Systems, LLC.
   11. Roof Deck, Inc.
   13. Wheeling Corrugating Company; Div. of Wheeling-Pittsburgh Steel Corporation.
B. Composite Floor Deck: Fabricate panels, with integrally embossed or raised pattern ribs and interlocking side laps, to comply with "SDI Specifications and Commentary for Composite Steel Floor Deck," in SDI Publication No. 31, with the minimum section properties indicated, and with the following:
1. **Prime-Painted Steel Sheet**: ASTM A 1008/A 1008M, Structural Steel (SS), Grade 40 minimum, with top surface phosphatized and unpainted and underside surface shop primed with manufacturers' standard gray baked-on, rust-inhibitive primer.

2. **Galvanized Steel Sheet**: ASTM A 653/A 653M, Structural Steel (SS), Grade 33, G60 zinc coating.

3. **Galvanized and Shop-Primed Steel Sheet**: ASTM A 653/A 653M, Structural Steel (SS), Grade 33, G60 zinc coating; with unpainted top surface and cleaned and pretreated bottom surface primed with manufacturer's standard gray baked-on, rust-inhibitive primer.

4. Profile Depth As indicated.

5. Design Uncoated-Steel Thickness: 0.0474 inch.

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### 2.4 NONCOMPOSITE FORM DECK

**A. Manufacturers**: Subject to compliance with requirements, provide products by one of the following:

1. ASC Profiles, Inc.; a Blue Scope Steel company.
2. Canam United States; Canam Group Inc.
3. CMC Joist & Deck.
5. Cordeck.
6. DACS, Inc.
7. Marlyn Steel Decks, Inc.
8. New Millennium Building Systems, LLC.
10. Roof Deck, Inc.
11. Valley Joist; Subsidiary of EBSCO Industries, Inc.
13. Wheeling Corrugating Company; Div. of Wheeling-Pittsburgh Steel Corporation.

**B. Noncomposite Form Deck**: Fabricate ribbed-steel-sheet noncomposite form-deck panels to comply with "SDI Specifications and Commentary for Noncomposite Steel Form Deck," in SDI Publication No. 31, with the minimum section properties indicated, and with the following:

1. **Uncoated Steel Sheet**: ASTM A 1008/A 1008M, Structural Steel (SS), Grade 40 minimum.
2. **Prime-Painted Steel Sheet**: ASTM A 1008/A 1008M, Structural Steel (SS), Grade 40 minimum, with underside surface shop primed with manufacturer's standard baked-on, rust-inhibitive primer Gray top surface.
3. **Galvanized Steel Sheet**: ASTM A 653/A 653M, Structural Steel (SS), Grade 40 G60 zinc coating.
4. Galvanized and Shop-Primed Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33 G60 zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer.

5. Profile Depth: [9/16 inch] [15/16 inch] [1-5/16 inches] [1-1/2 inches].

6. Design Uncoated-Steel Thickness: [0.0149 inch] [0.0179 inch] [0.0239 inch] [0.0295 inch] [0.0358 inch] [0.0474 inch] [0.0598 inch].

2.5 ACCESSORIES

A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.

B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.

C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 minimum diameter.

D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.

E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi, not less than 0.0359-inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.

F. Flat Sump Plates: Single-piece steel sheet, 0.0747 inch thick, of same material and finish as deck. For drains, cut holes in the field.

G. Galvanizing Repair Paint: [ASTM A 780] [SSPC-Paint 20 or MIL-P-21035B, with dry film containing a minimum of 94 percent zinc dust by weight].

H. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 31, manufacturer's written instructions, and requirements in this Section.

B. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.

C. Place deck panels flat and square and fasten to supporting frame without warp or deflection.
D. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.

E. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.

F. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

G. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to deck manufacturer's written instructions.

H. Roof Sump Pans and Sump Plates: Install over openings provided in roof deck and mechanically fasten flanges to top of deck. Space mechanical fasteners not more than 12 inches apart with at least one fastener at each corner.
   
   1. Install reinforcing channels or zees in ribs to span between supports and mechanically fasten.

I. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Mechanically fasten to substrate to provide a complete deck installation.
   
   1. Weld cover plates at changes in direction of roof-deck panels unless otherwise indicated.

J. Pour Stops and Girder Fillers: Weld steel-sheet pour stops and girder fillers to supporting structure according to SDI recommendations unless otherwise indicated.

K. Floor-Deck Closures: Weld steel-sheet column closures, cell closures, and Z-closures to deck, according to SDI recommendations, to provide tight-fitting closures at open ends of ribs and sides of deck.

3.2 QUALITY ASSURANCE

A. Testing Agency: SRP will engage a qualified testing agency to perform tests and inspections.

B. Field welds will be subject to inspection.

C. Testing agency will report inspection results promptly and in writing to SRP and Architect.

D. Remove and replace work that does not comply with specified requirements.

E. Additional inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.
3.3 PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Repair Painting: Wire brush and clean rust spots, welds, and abraded areas on both surfaces of prime-painted deck immediately after installation, and apply repair paint.

END OF SECTION
SECTION 055000 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Miscellaneous steel framing and supports.
2. Prefabricated building columns.
3. Shelf angles.
4. Metal ladders.
5. Ladder safety cages.
6. Metal floor plate and supports.
7. Structural-steel door frames.
8. Miscellaneous steel trim.
9. Metal bollards.
10. Pipe and Downspout guards.
11. Abrasive metal nosings treads and thresholds.
12. Loose bearing and leveling plates.

B. Products furnished, but not installed, under this Section:

1. Loose steel lintels.
2. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
3. Steel weld plates and angles for casting into concrete.

1.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design ladders, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance of Aluminum Ladders: Aluminum ladders, including landings, shall withstand the effects of loads and stresses within limits and under conditions specified in ANSI A14.3.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.
1.3 SUBMITTALS

A. Product Data: For the following:
   1. Prefabricated building columns.
   2. Metal nosings and treads.
   3. Paint products.

B. Shop Drawings: Show fabrication and installation details for metal fabrications.
   1. Include plans, elevations, sections, and details of metal fabrications and their
      connections. Show anchorage and accessory items.

C. Samples: For each type and finish of extruded nosing and tread.

D. Delegated-Design Submittal: For installed products indicated to comply with
   performance requirements and design criteria, including analysis data signed and
   sealed by the qualified professional engineer responsible for their preparation.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces without
   blemishes.

2.2 FERROUS METALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Stainless-Steel Bars and Shapes: ASTM A 276, Type 304 or Type 316L.

C. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with
   ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.

D. Rolled-Stainless-Steel Floor Plate: ASTM A 793.

E. Abrasive-Surface Floor Plate: Steel plate [with abrasive granules rolled into surface]
   [or] [with abrasive material metallically bonded to steel].
   1. Products: Subject to compliance with requirements, available products that may
      be incorporated into the Work include, but are not limited to, the following:
      a. IKG Industries, a division of Harsco Corporation; Mebac.
      b. SlipNOT Metal Safety Flooring, a W. S. Molnar company; SlipNOT.
      c. <Insert manufacturer’s name; product name or designation>.

F. Steel Tubing: ASTM A 500, cold-formed steel tubing.
G. Steel Pipe: ASTM A 53/A 53M, standard weight (Schedule 40) unless otherwise indicated.

2.3 NONFERROUS METALS

A. Aluminum Extrusions: ASTM B 221, Alloy 6063-T6.


C. Aluminum Castings: ASTM B 26/B 26M, Alloy 443.0-F.


E. Bronze Castings: ASTM B 584, Alloy UNS No. C83600 (leaded red brass) or No. C84400 (leaded semired brass).


2.4 FASTENERS

A. General: Unless otherwise indicated, provide Type 304 or Type 316 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, at exterior walls.

1. Provide stainless-steel fasteners for fastening aluminum.
2. Provide stainless-steel fasteners for fastening stainless steel.
4. Provide bronze fasteners for fastening bronze.

B. Cast-in-Place Anchors in Concrete: Either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F 2329.

C. Post-Installed Anchors: Torque-controlled expansion anchors.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, unless otherwise indicated.

D. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, 1-5/8 by 7/8 inches by length indicated with anchor straps or studs not less than 3 inches long at not more than 8 inches o.c. Provide with temporary filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B 633, Class Fe/Zn 5, as needed for fastening to inserts.
2.5 MISCELLANEOUS MATERIALS

A. Low-Emitting Materials: Paints and coatings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Shop Primers: Provide primers that comply with [Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."] [Section 099600 "High-Performance Coatings."] [Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."]

C. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

D. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.

E. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

F. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.


H. Concrete: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained, concrete with a minimum 28-day compressive strength of 3000 psi.

2.6 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Use connections that maintain structural value of joined pieces.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges. Remove sharp or rough areas on exposed surfaces.

C. Weld corners and seams continuously to comply with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. At exposed connections, finish exposed welds and surfaces smooth and blended.

D. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Locate joints where least conspicuous.
E. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

F. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors not less than 24 inches o.c.

2.7 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.

C. Fabricate steel girders for wood frame construction from continuous steel shapes of sizes indicated.

1. Where wood nailers are attached to girders with bolts or lag screws, drill or punch holes at 24 inches o.c.

D. Fabricate steel pipe columns for supporting wood frame construction from steel pipe with steel baseplates and top plates as indicated. Drill or punch baseplates and top plates for anchor and connection bolts and weld to pipe with fillet welds all around. Make welds the same size as pipe wall thickness unless otherwise indicated.

2.8 PREFABRICATED BUILDING COLUMNS

A. General: Provide prefabricated building columns consisting of load-bearing structural-steel members protected by concrete fireproofing encased in an outer non-load-bearing steel shell. Fabricate connections to comply with details shown or as needed to suit type of structure indicated.

B. Fire-Resistance Ratings: Provide prefabricated building columns listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction for ratings indicated, based on testing according to ASTM E 119.

1. Fire-Resistance Rating: As indicated.

2.9 SHELF ANGLES

A. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 3/4-inch bolts, spaced not more than 6 inches from ends and 24 inches o.c., unless otherwise indicated.

B. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete.
C. Galvanize shelf angles located in exterior walls.

D. Prime shelf angles located in exterior walls with zinc-rich primer.

E. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete.

2.10 METAL LADDERS

A. General:
   1. Comply with ANSI A14.3 unless otherwise indicated.
   2. For elevator pit ladders, comply with ASME A17.1.

B. Steel Ladders:
   1. Space siderails 18 inches apart unless otherwise indicated.
   2. Space siderails of elevator pit ladders 12 inches apart.
   4. Rungs: 3/4-inch diameter steel bars.
   5. Fit rungs in centerline of siderails; plug-weld and grind smooth on outer rail faces.
   6. Provide nonslip abrasive surfaces on top of each rung.
   7. Galvanize exterior ladders, including brackets and fasteners.
   8. Prime exterior ladders, including brackets and fasteners, with zinc-rich primer.

C. Aluminum Ladders:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. ACL Industries, Inc.
      b. Alco-Lite Industrial Products.
      c. Halliday Products.
      d. O'Keeffe's Inc.
      e. Precision Ladders, LLC.
      f. Royalite Manufacturing, Inc.
      g. Thompson Fabricating, LLC.
      h. <Insert manufacturer's name>.

   2. Space siderails 18 inches apart unless otherwise indicated.
   3. Siderails: Continuous extruded-aluminum channels or tubes, not less than 2-1/2 inches deep, 3/4 inch wide, and 1/8 inch thick.
   4. Rungs: Extruded-aluminum tubes, not less than 3/4 inch deep and not less than 1/8 inch thick, with ribbed tread surfaces.
2.11 LADDER SAFETY CAGES
A. Fabricate ladder safety cages to comply with ANSI A14.3. Assemble by welding or with stainless-steel fasteners.
B. Provide primary hoops at tops and bottoms of cages and spaced not more than 20 feet o.c. Provide secondary intermediate hoops spaced not more than 48 inches o.c. between primary hoops.
C. Galvanize steel ladder safety cages, including brackets and fasteners.
D. Prime steel ladder safety cages, including brackets and fasteners, with [zinc-rich primer.] [primer specified in Section 099600 "High-Performance Coatings."]

2.12 METAL FLOOR PLATE
A. Fabricate from [rolled-steel floor] [rolled-stainless-steel floor] [rolled-aluminum-alloy tread] [abrasive-surface floor] plate.
   1. Thickness: As indicated.
B. Provide angle supports to match ladder materials as indicated.
C. Provide flush or stainless-steel aluminum bar drop handles for lifting removable sections, one at each end of each section.

2.13 STRUCTURAL-STEEL DOOR FRAMES
A. Fabricate structural-steel door frames from steel shapes fully welded together, with 5/8-by-1-1/2-inch steel channel stops. Plug-weld built-up members and continuously weld exposed joints. Reinforce frames and drill and tap as necessary to accept finish hardware.
   1. Provide with integrally welded steel strap anchors for securing door frames into adjoining concrete or masonry.
B. Galvanize [exterior] steel frames.
C. Prime [exterior] steel frames with [zinc-rich primer.] [primer specified in Section 099600 "High-Performance Coatings."]

2.14 MISCELLANEOUS STEEL TRIM
A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.
B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.
C. Galvanize [exterior] miscellaneous steel trim.

D. Prime [exterior] miscellaneous steel trim with [zinc-rich primer.] [primer specified in Section 099600 "High-Performance Coatings."]

2.15 METAL BOLLARDS

A. Fabricate metal bollards from Schedule 40 steel pipe steel shapes, as indicated.
   1. Cap bollards with 1/4-inch-thick steel plate.

B. Fabricate bollards with 3/8-inch-thick steel baseplates for bolting to concrete slab. Drill baseplates at all four corners for 3/4-inch anchor bolts.

C. Fabricate sleeves for bollard anchorage from steel pipe or tubing with 1/4-inch-thick steel plate welded to bottom of sleeve.

D. Prime bollards with [zinc-rich primer.] [primer specified in Section 099600 "High-Performance Coatings."]

2.16 PIPE GUARDS

A. Fabricate pipe guards from 3/8-inch-thick by 12-inch-wide steel plate, bent to fit flat against the wall or column at both ends and to fit around pipe with 2-inch clearance between pipe and pipe guard. Drill each end for two 3/4-inch anchor bolts.

B. Galvanize pipe guards.

C. Prime pipe guards with zinc-rich primer.

2.17 ABRASIVE METAL [NOSINGS, TREADS, AND THRESHOLDS]

A. Cast-Metal Units: Cast [iron] [aluminum] [brass (leaded red or semired brass)] [nickel silver (leaded nickel bronze)], with an integral-abrasive, as-cast finish.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. American Safety Tread Co., Inc.
      b. Balco Inc.
      c. Barry Pattern & Foundry Co., Inc.
      d. Granite State Casting Co.
      e. Safe-T-Metal Company, Inc.
      f. Wooster Products Inc.
      g. <Insert manufacturer’s name>.

B. Extruded Units: Aluminum, with abrasive filler in an epoxy-resin binder.
1. **Manufacturers**: Subject to compliance with requirements, [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

   a. ACL Industries, Inc.
   b. American Safety Tread Co., Inc.
   c. Amstep Products.
   d. Armstrong Products, Inc.
   e. Balco Inc.
   f. Granite State Casting Co.
   g. Wooster Products Inc.
   h. <Insert manufacturer's name>.

2. Provide ribbed units, with abrasive filler strips projecting 1/16 inch above aluminum extrusion.

3. Provide solid-abrasive-type units without ribs.

   C. Provide anchors for embedding units in concrete, either integral or applied to units, as standard with manufacturer.

   D. Drill for mechanical anchors and countersink. Locate holes not more than 4 inches from ends and not more than 12 inches o.c.

   E. Apply bituminous paint to concealed surfaces of cast-metal units.

   F. Apply clear lacquer to concealed surfaces of extruded units.

2.18 **LOOSE BEARING AND LEVELING PLATES**

   A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.

2.19 **LOOSE STEEL LINTELS**

   A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated.

   B. Galvanize loose steel lintels located in exterior walls.

   C. Prime loose steel lintels located in exterior walls with zinc-rich primer.

2.20 **STEEL WELD PLATES AND ANGLES**

   A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.
2.21 FINISHES, GENERAL

A. Comply with NAAMM’s "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish metal fabrications after assembly.

2.22 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.

B. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.
   1. Shop prime with universal shop primer unless zinc-rich primer is indicated.

C. Preparation for Shop Priming: Prepare surfaces to comply with SSPC-SP 3, "Power Tool Cleaning"

D. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. At exposed connections, finish exposed welds and surfaces smooth and blended.
D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

3.2 INSTALLING METAL BOLLARDS

A. Fill metal-capped bollards solidly with concrete and allow concrete to cure seven days before installing.

B. Anchor bollards to existing construction with anchor bolts or through bolts. Provide four 3/4-inch bolts at each bollard unless otherwise indicated.

C. Anchor bollards in concrete with pipe sleeves preset and anchored into concrete or in formed or core-drilled holes. Fill annular space around bollard solidly with nonshrink, nonmetallic grout.

D. Anchor bollards in place with concrete footings. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured.

E. Fill bollards solidly with concrete, mounding top surface to shed water.

3.3 INSTALLING BEARING AND LEVELING PLATES


B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.

C. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.4 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA1 for touching up shop-painted surfaces.

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION
SECTION 061000 - ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Framing with dimension lumber.
2. Framing with engineered wood products.
3. Shear wall panels.
4. Rooftop equipment bases and support curbs.
5. Wood blocking and nailers.
7. Wood sleepers.
8. Plywood backing panels.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product.

1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements.
2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements.

1.3 INFORMATIONAL SUBMITTALS

A. Material Certificates: For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.

B. Evaluation Reports: For the following, from ICC-ES:

1. Wood-preservative-treated wood.
2. Fire-retardant-treated wood.
3. Engineered wood products.
4. Shear panels.
5. Power-driven fasteners.
7. Expansion anchors.
8. Metal framing anchors.
PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

A. Certified Wood: Materials shall be produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship:

1. Dimension lumber framing.
2. Laminated-veneer lumber.
5. Rim boards.

B. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.
2. For exposed lumber indicated to receive a stained or natural finish, mark grade stamp on end or back of each piece or omit grade stamp and provide certificates of grade compliance issued by grading agency.
3. Provide dressed lumber, S4S, unless otherwise indicated.

C. Maximum Moisture Content of Lumber: 15 percent for 2-inch nominal thickness or less, 19 percent for more than 2-inch nominal thickness unless otherwise indicated.

D. Engineered Wood Products: Provide engineered wood products acceptable to authorities having jurisdiction and for which current model code research or evaluation reports exist that show compliance with building code in effect for Project.

1. Allowable Design Stresses: Provide engineered wood products with allowable design stresses, as published by manufacturer, that meet or exceed those indicated. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.

2.2 WOOD-PRESERVATIVE-TREATED LUMBER

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction not in contact with the ground, Use Category UC3b for exterior construction not in contact with the ground, and Use Category UC4a for items in contact with the ground.]
1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium. Do not use inorganic boron (SBX) for sill plates.

B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or that does not comply with requirements for untreated material.

C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

D. Application: Treat items indicated on Drawings, and the following: Retain first subparagraph below if Project includes wood adjacent to roofing or waterproofing.

1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
2. Wood sills, sleepers, blocking, Furring, stripping, contact with masonry or concrete.
3. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
4. Wood framing members that are less than 18 inches above the ground in crawlspaces or unexcavated areas.
5. Wood floor plates that are installed over concrete slabs-on-grade.

2.3 FIRE-RETARDANT-TREATED MATERIALS

A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.

1. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D 2898. Use for exterior locations and where indicated.
2. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D 3201 at 92 percent relative humidity. Use where exterior type is not indicated.

C. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent.

D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.
E. Application: Treat [all rough carpentry unless otherwise indicated.] [Items indicated on Drawings, and the following:]
   1. Framing for raised platforms.
   2. Framing for stages.
   3. Concealed blocking.
   4. Framing for non-load-bearing partitions.
   5. Framing for non-load-bearing exterior walls.
   6. Roof construction.
   7. Plywood backing panels.

2.4 DIMENSION LUMBER FRAMING

A. Non-Load-Bearing Interior Partitions: [Construction or No. 2] [Construction, Stud, or No. 3] [Standard, Stud, or No. 3] grade.
   1. Application: Interior partitions not indicated as load-bearing.
   2. Species:
      a. Mixed southern pine; SPIB.
      b. Northern species; NLGA.
      c. Eastern softwoods; NeLMA.
      d. Western woods; WCLIB or WWPA.

B. Framing Other Than Non-Load-Bearing Interior Partitions: Construction or No. 2 grade.
   1. Application: Framing other than interior partitions not indicated as load-bearing.
   2. Species:
      a. Hem-fir (north); NLGA.
      b. Southern pine; SPIB.
      c. Douglas fir-larch; WCLIB or WWPA.
      d. Mixed southern pine; SPIB.
      e. Spruce-pine-fir; NLGA.
      f. Douglas fir-south; WWPA.
      g. Hem-fir; WCLIB or WWPA.
      h. Douglas fir-larch (north); NLGA.
      i. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.

C. Framing Other Than Non-Load-Bearing Interior Partitions: Any species and grade with a modulus of elasticity of at least [1,500,000 psi] [1,300,000 psi] [1,100,000 psi] [1,000,000 psi] [900,000 psi] and an extreme fiber stress in bending of at least [1000 psi] [850 psi] [700 psi] [600 psi] [500 psi] for 2-inch nominal thickness and 12-inch nominal width for single-member use.
   1. Application: Framing other than interior partitions not indicated as load-bearing.

D. Exposed Framing: Provide material hand-selected for uniformity of appearance and freedom from characteristics, on exposed surfaces and edges, that would impair finish.
appearance, including decay, honeycomb, knot-holes, shake, splits, torn grain, and wane.

1. Application: Exposed exterior and interior framing indicated to receive a stained or natural finish.
2. Species and Grade: [As indicated above for load-bearing construction of same type] <Insert species and grade>.

2.5 ENGINEERED WOOD PRODUCTS

A. Engineered Wood Products, General: Products shall [contain no urea formaldehyde.] [comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."]

B. Laminated-Veneer Lumber: Structural composite lumber made from wood veneers with grain primarily parallel to member lengths, evaluated and monitored according to ASTM D 5456 and manufactured with an exterior-type adhesive complying with ASTM D 2559.

1. Extreme Fiber Stress in Bending, Edgewise: [3100 psi] [2900 psi] [2600 psi] [2250 psi] for 12-inch nominal-depth members.
2. Modulus of Elasticity, Edgewise: [2,000,000 psi] [1,800,000 psi] [1,500,000 psi]

C. Wood I-Joists: Prefabricated units, I-shaped in cross section, made with solid or structural composite lumber flanges and wood-based structural panel webs, let into and bonded to flanges. Provide units complying with material requirements of and with structural capacities established and monitored according to ASTM D 5055.

1. Web Material: Either oriented strand board or plywood, complying with DOC PS 1 or DOC PS 2, Exposure 1.
2. Structural Properties: Provide units with depths and design values not less than those indicated.
3. Provide units complying with APA PRI-400, factory marked with APA trademark indicating nominal joist depth, joist class, span ratings, mill identification, and compliance with APA standard.

D. Rim Boards: Product designed to be used as a load-bearing member and to brace wood I-joists at bearing ends, complying with research/evaluation report for I-joists.

1. Material: All-veneer product glued-laminated wood or product made from any combination solid lumber, wood strands, and veneers.
2. Thickness: [1 inch] [1-1/8 inches] [1-1/4 inches].
3. Provide performance-rated product complying with APA PRR-401, rim board grade, factory marked with APA trademark indicating thickness, grade, and compliance with APA standard.
2.6 SHEAR WALL PANELS

A. Manufacturers: Subject to compliance with requirements, provide products by the following: available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. **Basis-of-Design Product**: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Shear Transfer Systems.
2. Simpson Strong-Tie Co., Inc.
3. Weyerhaeuser Company.
4. <Insert manufacturer's name>.

C. Wood-Framed Shear Wall Panels: Prefabricated assembly consisting of wood perimeter framing, tie downs, and Exposure I, Structural I plywood or OSB sheathing.

   1. Products shall contain no urea formaldehyde.

D. Steel-Framed Shear Wall Panels: Prefabricated assembly consisting of cold-formed galvanized steel panel, steel top and bottom plates, and wood studs.

E. Allowable Design Loads: Provide products with allowable design loads, as published by manufacturer, that meet or exceed those of basis-of-design products. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.

2.7 MISCELLANEOUS LUMBER

A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:

   1. Blocking.
   2. Nailers.
   3. Rooftop equipment bases and support curbs.
   5. Furring.

B. For items of dimension lumber size, provide Construction or No. 2 grade lumber of any species.

C. For concealed boards, provide lumber with 19 percent maximum moisture content and any of the following species and grades:

   1. Mixed southern pine; No. 2 or 3 grade; SPIB.
2. Eastern softwoods; No. 2 or 3 Common grade; NeLMA.
3. Northern species; No. 2 or 3 Common grade; NLGA.
4. Western woods; Construction or No. 2 grade; WCLIB or WWPA.

2.8 PLYWOOD BACKING PANELS

A. Equipment Backing Panels: DOC PS 1, [Exterior, AC] [Exterior, C-C Plugged] [Exposure 1, C-D Plugged], [fire-retardant treated,] in thickness indicated or, if not indicated, not less than [1/2-inch] [3/4-inch] nominal thickness.

1. Plywood shall comply with the testing and product requirements of the California Department of Health Services’ "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.9 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.

1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M of Type 304 stainless steel.


C. Bolts: Steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers.

2.10 METAL FRAMING ANCHORS

A. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Cleveland Steel Specialty Co.
2. KC Metals Products, Inc.
3. Phoenix Metal Products, Inc.
4. Simpson Strong-Tie Co., Inc.
5. USP Structural Connectors.
6. <Insert manufacturer's name>.

C. Allowable Design Loads: Provide products with allowable design loads, as published by manufacturer, that meet or exceed those of basis-of-design products. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.


1. Use for interior locations unless otherwise indicated.

E. Hot-Dip, Heavy-Galvanized Steel Sheet: ASTM A 653/A 653M; structural steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); G185 coating designation; and not less than 0.036 inch thick.

1. Use for wood-preservative-treated lumber and where indicated.

2.11 MISCELLANEOUS MATERIALS

A. Sill-Sealer Gaskets: Glass-fiber-resilient insulation, fabricated in strip form, for use as a sill sealer; 1-inch nominal thickness, compressible to 1/32 inch; selected from manufacturer's standard widths to suit width of sill members indicated.

B. Sill-Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to suit width of sill members indicated.

C. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber or rubberized-asphalt compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 0.025 inch.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry to and similar supports to comply with requirements for attaching other construction.

B. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.

C. Framing with Engineered Wood Products: Install engineered wood products to comply with manufacturer's written instructions.

D. Install fire-retardant treated plywood backing panels with classification marking of testing agency exposed to view.
E. Shear Wall Panels: Install shear wall panels to comply with manufacturer's written instructions.

F. Metal Framing Anchors: Install metal framing anchors to comply with manufacturer's written instructions. Install fasteners through each fastener hole.

G. Do not splice structural members between supports unless otherwise indicated.

H. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.

I. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.

J. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:

1. NES NER-272 for power-driven fasteners.
3. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's International Residential Code for One- and Two-Family Dwellings.

3.2 PROTECTION

A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

B. Protect rough carpentry from weather. If, despite protection, rough carpentry becomes sufficiently wet that moisture content exceeds that specified, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 061000
SECTION 062023 - INTERIOR FINISH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interior trim.
2. Interior hardboard and board paneling.
4. Interior railings.

B. Related Requirements:

1. None

1.2 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product.

B. Samples: For each type of paneling.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Certified Wood: The following wood products shall be produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship":

1. Interior trim.
2. Interior hardboard and board paneling.
4. Interior railings.

B. Low-Emitting Materials: Composite wood products shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Lumber: DOC PS 20.

1. Factory mark each piece of lumber with grade stamp of inspection agency indicating grade, species, moisture content at time of surfacing, and mill.
a. For exposed lumber, mark grade stamp on end or back of each piece, or omit grade stamp and provide certificates of grade compliance issued by inspection agency.

D. Softwood Plywood: DOC PS 1.

E. Hardboard: AHA A135.4.

F. MDF: ANSI A208.2, Grade 130 <Insert grade>, made with binder containing no urea-formaldehyde resin.

G. Particleboard: ANSI A208.1, Grade M-2, made with binder containing no urea-formaldehyde resin.

H. Melamine-Faced Particleboard: Particleboard complying with ANSI A208.1, Grade M-2, finished on both faces with thermally fused, melamine-impregnated decorative paper and complying with requirements of NEMA LD3, Grade VGL, for test methods 3.3, 3.4, 3.6, 3.8, and 3.10.


2.2 FIRE-RETARDANT-TREATED MATERIALS

A. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E 84, with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.

1. Kiln dry lumber and plywood after treatment to a maximum moisture content of 19 and 15 percent respectively.

B. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.

1. For exposed lumber and plywood indicated to receive a stained or natural finish, mark back of each piece.

C. Application: Where indicated.

2.3 INTERIOR TRIM

A. Softwood Lumber Trim:

1. Species and Grade: Eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine; [C Select (Choice)] [D Select (Quality)] [Finish or 1 Common (Colonial)] [Premium or 2 Common (Sterling)]; NeLMA, NLGA, or WWPA.

2. Species and Grade: Douglas fir-larch or Douglas fir south, C & Better finish; NLGA, WCLIB, or WWPA.

3. Species and Grade: Southern pine, C & Better finish; SPIB.
4. Species and Grade: Western red cedar, [**Grade A**] [**Grade B**]; NLGA, WCLIB, or WWPA.
5. Maximum Moisture Content: 15 percent.

**B. Hardwood Lumber Trim:**

1. Species and Grade: [**Red oak**] [**White maple**] [**Alder**] [**Aspen, basswood, cottonwood, sap gum, sycamore, white maple, or yellow poplar**] [**A Finish**] [**B Finish**]; NHLA.
2. Maximum Moisture Content: 13 percent.

**C. Softwood Moldings for Transparent Finish (Stain or Clear Finish):** WMMPA WM 4, N-grade wood moldings. Made to patterns included in WMMPA WM 12.

1. Species: [**Eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine**] [**Southern pine**] [**Western red cedar**] [**Douglas fir**]
2. Maximum Moisture Content: 15 percent.

**D. Hardwood Moldings for Transparent Finish (Stain or Clear Finish):** WMMPA HWM 2, N-grade wood moldings made to patterns included in WMMPA HWM 1.

1. Species: [**Red oak**] [**White maple**] [**Aspen, basswood, cottonwood, sap gum, sycamore, white maple, or yellow poplar**]
2. Maximum Moisture Content: 9 percent.

**E. Moldings for Opaque Finish (Painted Finish):** Made to patterns included in WMMPA WM 12.

   a. Species: [**Eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine**].
   b. Maximum Moisture Content: 15 percent.

2. Hardwood Moldings: WMMPA HWM 2, P-grade.
   a. Species: [**Aspen, basswood, cottonwood, gum, magnolia, soft maple, tupelo, or yellow poplar**].
   b. Maximum Moisture Content: 9 percent.

3. Optional Material: Primed MDF.

**F. Molding Patterns:**

1. Base Pattern: [**WM 623, 9/16-by-3-1/4-inch ogee**] [**WM 713, 9/16-by-3-1/4-inch ranch**] [**WM 753, 9/16-by-3-1/4-inch beaded-edge**] [**WM 620, 9/16-by-4-1/4-inch ogee**] [**WM 750, 9/16-by-4-1/4-inch beaded-edge**] base.

2.4 PANELING

A. Hardwood Veneer Plywood Paneling: Manufacturer's stock hardwood plywood panels complying with HPVA HP-1, made without urea-formaldehyde adhesive.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated or comparable product by one of the following:
      a. Chesapeake Hardwood Products, Inc.
      b. Georgia-Pacific Corp.
      c. Holland Southwest International.
      d. <Insert manufacturer's name>.
   2. Face Veneer Species and Cut: [Rotary-cut white birch] [Plain-sliced red oak] [Plain-sliced hickory] <Insert species and cut>.
   3. Veneer Matching: Selected for similar color and grain.
   4. Thickness: 5/32 inch, 1/4 inch, 5/16 inch
   5. Face Pattern: Manufacturer's standard grooved pattern.
   6. Finish: As selected by Architect from manufacturer's full range.

B. Hardboard Paneling: Interior factory-finished hardboard paneling complying with AHA 135.5.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated or comparable product by one of the following:
      a. Chesapeake Hardwood Products, Inc.
      b. Georgia-Pacific Corp.
      c. Marlite.
      d. <Insert manufacturer's name>.
   2. Thickness: 5/32 inch or 1/4 inch.
   3. Finish: [Class I] [Class II].
   4. Surface-Burning Characteristics: As follows, tested according to ASTM E 84:
      a. Flame-Spread Index: 25 or less.
      b. Smoke-Developed Index: 450 or less.

C. Board Paneling: Interior wood-board paneling complying with WMMPA WM 9.
   1. Species: [Eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine] [Southern pine] [Western red cedar] [Figured red gum] <Insert species>.
   2. Grade: [Clear No. 1] [Clear No. 2] [Knotty No. 1].
   3. Maximum Moisture Content: 15 percent.
D. Board Paneling:

1. Species and Grade: Eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine; [C Select (Choice)] [D Select (Quality)] [Finish or 1 Common (Colonial)] [Premium or 2 Common (Sterling)]; NeLMA, NLGA, or WWPA.
2. Species and Grade: Southern pine, [B & B] [C & Btr] [No. 2] Paneling; SPIB.
3. Species and Grade: Western red cedar, [Clear Heart] [Grade A] [Grade B]; NLGA, WCLIB, or WWPA.

2.5 SHELVING

A. Shelving: Made from [the following material] [one of the following materials], 3/4 inch thick.

1. MDF with [radiused] [or] [solid-wood] front edge.
2. MDO softwood plywood with solid-wood edge.
3. Melamine-faced particleboard with radiused and filled or applied-PVC front edge.
4. Softwood Boards: Eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine; [C Select (Choice) Finish or 1 Common (Colonial)]; NeLMA, NLGA, or WWPA; kiln dried.
5. Softwood Boards: Douglas fir-larch, Douglas fir south, or hem-fir; [Superior or C & Btr] finish; NLGA, WCLIB, or WWPA; or southern pine, [B & B] finish; SPIB; kiln dried.

B. Shelf Cleats: [3/4-by-3-1/2-inch boards] [3/4-by-5-1/2-inch boards] [3/4-by-5-1/2-inch boards with hole and notch to receive clothes rods], as specified above for [shelving] [lumber trim].

C. Shelf Brackets without Rod Support: BHMA A156.16, B04041; prime-painted formed steel.

2.6 RAILINGS

A. Interior Railings: Clear, kiln-dried [red oak] [hard maple] [yellow poplar] <Insert species>.

B. Balusters: Clear, kiln-dried, [red oak] [hard maple] [yellow poplar] <Insert species>.

C. Newel Posts: Clear, kiln-dried, [red oak] [hard maple] [yellow poplar] <Insert species>.

2.7 MISCELLANEOUS MATERIALS

A. Low-Emitting Materials: Adhesives shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
B. Glue: Aliphatic-resin, polyurethane, or resorcinol wood glue recommended by manufacturer for general carpentry use.
   1. Wood glue shall have a VOC content of 30 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Paneling Adhesive: Comply with paneling manufacturer's written recommendations for adhesives.
   1. Adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.1 PREPARATION
   A. Before installing interior finish carpentry, condition materials to average prevailing humidity in installation areas for a minimum of 24 hours unless longer conditioning is recommended by manufacturer.

3.2 INSTALLATION, GENERAL
   A. Install interior finish carpentry level, plumb, true, and aligned with adjacent materials. Use concealed shims where necessary for alignment.
      1. Scribe and cut interior finish carpentry to fit adjoining work. Refinish and seal cuts as recommended by manufacturer.
      2. Countersink fasteners, fill surface flush, and sand unless otherwise indicated.
      3. Install to tolerance of 1/8 inch in 96 inches for level and plumb. Install adjoining interior finish carpentry with 1/32-inch maximum offset for flush installation and 1/16-inch maximum offset for reveal installation.

3.3 STANDING AND RUNNING TRIM INSTALLATION
   A. Install with minimum number of joints practical, using full-length pieces from maximum lengths of lumber available. Cope or Miter at returns, miter at outside corners, and cope at inside corners to produce tight-fitting joints with full-surface contact throughout length of joint. Use scarf joints for end-to-end joints.

3.4 PANELING INSTALLATION
   A. Plywood Paneling: Select and arrange panels on each wall to minimize noticeable variations in grain character and color between adjacent panels. Leave 1/4-inch gap to be covered with trim at top, bottom, and openings. Install with uniform tight joints between panels.
1. Attach panels to supports with manufacturer's recommended panel adhesive and fasteners. Space fasteners and adhesive as recommended by panel manufacturer.
2. Conceal fasteners to greatest practical extent.

B. Hardboard Paneling: Install according to manufacturer's written recommendations. Leave 1/4-inch gap to be covered with trim at top, bottom, and openings. Butt adjacent panels with moderate contact. Use fasteners with prefinished heads matching paneling color.

C. Board Paneling: Arrange in random-width pattern suggested by manufacturer unless boards or planks are of uniform width.

1. Install in full lengths without end joints.
2. Stagger end joints in random pattern to uniformly distribute joints on each wall.
3. Select and arrange boards on each wall to minimize noticeable variations in grain character and color between adjacent boards. Install with uniform tight joints between boards.
4. Fasten paneling by face nailing, setting nails, and filling over nail heads.
5. Fasten paneling with trim screws, set below face and filled.
6. Fasten paneling by blind nailing through tongues.

3.5 SHELVING INSTALLATION

A. Cut shelf cleats at ends of shelves about 1/2 inch less than width of shelves and sand exposed ends smooth.

B. Install shelf cleats by fastening to framing or backing with finish nails or trim screws, set below face and filled. Space fasteners not more than 16 inches o.c.

C. Install shelf brackets according to manufacturer's written instructions, spaced not more than 32 inches o.c. Fasten to framing members, blocking, or metal backing, or use toggle bolts or hollow wall anchors.

D. Cut shelves to neatly fit openings with only enough gap to allow shelves to be removed and reinstalled. Install shelves, fully seated on cleats, brackets, and supports.

3.6 RAILING INSTALLATION

A. Railings: Secure wall rails with metal brackets. Fasten freestanding railings to newel posts and to trim at walls with countersunk-head wood screws or rail bolts, and glue. Assemble railings at goosenecks, easements, and splices with rail bolts and glue.

END OF SECTION 062023
SECTION 064116 - PLASTIC-LAMINATE-FACED ARCHITECTURAL CABINETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Plastic-laminate-faced architectural cabinets.
   2. Wood furring, blocking, shims, and hanging strips for installing plastic-laminate-faced architectural cabinets unless concealed within other construction before cabinet installation.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product, including panel products, high-pressure decorative laminate, adhesive for bonding plastic laminate, fire-retardant-treated materials, and cabinet hardware and accessories.

B. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.

C. Samples:
   1. Plastic laminates, for each color, pattern, and surface finish.
   2. Thermoset decorative panels, for each color, pattern, and surface finish.

1.3 INFORMATIONAL SUBMITTALS

A. Woodwork Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.

1.4 QUALITY CONTROL

A. Fabricator Qualifications: Certified participant in AWI's Quality Certification Program or Licensee of WI's Certified Compliance Program.

B. Installer Qualifications: Certified participant in AWI's Quality Certification Program or Licensee of WI's Certified Compliance Program.

1.5 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install cabinets until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.
PART 2 - PRODUCTS

2.1 ARCHITECTURAL CABINET FABRICATORS

A. Fabricators: Subject to compliance with requirements, available fabricators offering products that may be incorporated into the Work include, but are not limited to, the following:

   1. <Insert, in separate subparagraphs, names and possibly contact information for preapproved woodworking firms>.

2.2 PLASTIC-LAMINATE-FACED ARCHITECTURAL CABINETS

A. Quality Standard: Unless otherwise indicated, comply with the "Architectural Woodwork Standards" for grades of architectural plastic-laminate cabinets indicated for construction, finishes, installation, and other requirements.

   1. Provide labels and certificates from AWI or WI certification program indicating that woodwork, including installation, complies with requirements of grades specified.

B. Grade: [Premium] [Custom].

C. Regional Materials: Plastic-laminate cabinets shall be manufactured within 500 miles of Project site.

D. Certified Wood: Plastic-laminate cabinets shall be made from wood products certified as "FSC Pure" or "FSC Mixed Credit" according to FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship," and FSC STD-40-004, "FSC Standard for Chain of Custody Certification."

E. Type of Construction: [Frameless] [Face frame].

F. Cabinet, Door, and Drawer Front Interface Style: [Flush overlay] [Reveal overlay] [Lipped] [Flush inset].

G. Reveal Dimension: [1/2 inch] [As indicated].

H. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or if not indicated, as required by woodwork quality standard.

   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

      a. Abet Laminati, Inc.
      b. Formica Corporation.
      c. Lamin-Art, Inc.
      d. Panolam Industries International, Inc.
      e. Wilsonart International; Div. of Premark International, Inc.
f. ‹Insert manufacturer's name›.

I. Laminate Cladding for Exposed Surfaces:
   1. Horizontal Surfaces: [Grade HGS] [Grade HGL].
   2. Postformed Surfaces: Grade HGP.
   3. Vertical Surfaces: [Grade HGS] [Grade VGS].
   4. Pattern Direction: Vertically for drawer fronts, doors, and fixed panels or As indicated.

J. Materials for Semiexposed Surfaces:
   1. Surfaces Other Than Drawer Bodies: [High-pressure decorative laminate, NEMA LD 3, Grade VGS] [High-pressure decorative laminate, NEMA LD 3, Grade CLS] [Thermoset decorative panels].
   2. Drawer Sides and Backs: Thermoset decorative panels with PVC or polyester edge banding.
   3. Drawer Bottoms: Thermoset decorative panels

K. Dust Panels: 1/4-inch plywood or tempered hardboard above compartments and drawers unless located directly under tops.

L. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
   1. As indicated by laminate manufacturer's designations.
   3. As selected by Architect from laminate manufacturer's full range in the following categories:
      a. Solid colors, matte finish.
      b. Solid colors with core same color as surface, matte finish.
      c. Wood grains, matte finish.
      d. Patterns, matte finish.

2.3 WOOD MATERIALS

A. Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of woodwork and quality grade specified unless otherwise indicated.
   1. Wood Moisture Content: 8 to 13 percent.

B. Composite Wood and Agrifiber Products: Provide materials that comply with requirements of referenced quality standard for each type of woodwork and quality grade specified unless otherwise indicated.
   1. Recycled Content of Medium-Density Fiberboard and Particleboard: Postconsumer recycled content plus one-half of preconsumer recycled content not less than <Insert number> percent.
2. Composite Wood and Agrifiber Products: Products shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."


4. Particleboard: ANSI A208.1, Grade M-2, made with binder containing no urea formaldehyde.

5. Softwood Plywood: DOC PS 1, medium-density overlay.


7. Thermoset Decorative Panels: Particleboard or medium-density fiberboard finished with thermally fused, melamine-impregnated decorative paper and complying with requirements of NEMA LD 3, Grade VGL, for test methods 3.3, 3.4, 3.6, 3.8, and 3.10.

2.4 FIRE-RETARDANT-TREATED MATERIALS

A. Fire-Retardant-Treated Materials, General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article that are acceptable to authorities having jurisdiction and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

1. Identify fire-retardant-treated materials with appropriate classification marking of qualified testing agency in the form of removable paper label or imprint on surfaces that will be concealed from view after installation.

B. Fire-Retardant-Treated Lumber and Plywood: Products with a flame-spread index of 25 or less when tested according to ASTM E 84, with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.

1. Kiln dry lumber and plywood after treatment to a maximum moisture content of 19 and 15 percent, respectively.

2.5 CABINET HARDWARE AND ACCESSORIES

A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets except for items specified in Section 087111 "Door Hardware (Descriptive Specification)."

B. Butt Hinges: 2-3/4-inch, five-knuckle steel hinges made from 0.095-inch-thick metal, and as follows:

1. Semiconcealed Hinges for Flush Doors: BHMA A156.9, B01361.
2. Semiconcealed Hinges for Overlay Doors: BHMA A156.9, B01521.
C. Frameless Concealed Hinges (European Type): BHMA A156.9, B01602, [135] [170] degrees of opening, self-closing.

D. Back-Mounted Pulls: BHMA A156.9, B02011.

E. Wire Pulls: Back mounted, solid [metal] [plastic], [4 inches long, 5/16 inch in diameter] [5 inches long, 2-1/2 inches deep, and 5/16 inch in diameter].

F. Catches: [Magnetic catches, BHMA A156.9, B03141] [Push-in magnetic catches, BHMA A156.9, B03131] [Roller catches, BHMA A156.9, B03071] [Ball friction catches, BHMA A156.9, B03013].

G. Adjustable Shelf Standards and Supports: [BHMA A156.9, B04071; with shelf rests, B04081] [BHMA A156.9, B04102; with shelf brackets, B04112].

H. Shelf Rests: BHMA A156.9, B04013; [metal] [plastic] [metal, two-pin type with shelf hold-down clip].

I. Drawer Slides: BHMA A156.9.

1. Grade 1 and Grade 2: Side mounted and extending under bottom edge of drawer; partial-extension type; epoxy-coated steel with polymer rollers.
2. Grade 1HD-100 and Grade 1HD-200: Side mounted; [full-extension] [full-overtravel-extension] type; zinc-plated-steel ball-bearing slides.
3. For drawers not more than 3 inches high and not more than 24 inches wide, provide Grade 1.
4. For drawers more than 3 inches high but not more than 6 inches high and not more than 24 inches wide, provide [Grade 1] [Grade 1HD-100].
5. For drawers more than 6 inches high or more than 24 inches wide, provide [Grade 1HD-100] [Grade 1HD-200].
6. For computer keyboard shelves, provide [Grade 1] [Grade 1HD-100].
7. For trash bins not more than 20 inches high and 16 inches wide, provide [Grade 1HD-100] [Grade 1HD-200].

J. [Plastic] [Aluminum] Slides for Sliding Glass Doors: BHMA A156.9, B07063.

K. Door Locks: BHMA A156.11, E07121.

L. Drawer Locks: BHMA A156.11, E07041.

M. Door and Drawer Silencers: BHMA A156.16, L03011.

N. Float Glass for Cabinet Doors: ASTM C 1036, Type I, [Class 1 (clear)] [Class 2 or 3 (tinted)], Quality-Q3, [3.0 mm] [4.0 mm] [5.0 mm] [6.0 mm] thick.

1. Tint Color: [Blue-green] [Bronze] [Green] [Gray] <Insert color>.

O. Tempered Float Glass for Cabinet Doors: ASTM C 1048, Kind FT, Condition A, Type I, [Class 1 (clear)] [Class 2 or 3 (tinted)], Quality-Q3, with exposed edges seamed before tempering, 6 mm thick unless otherwise indicated.
1. Tint Color: [Blue-green] [Bronze] [Green] [Gray] <Insert color>.

P. Tempered Float Glass for Cabinet Shelves: ASTM C 1048, Kind FT, Condition A, Type I, [Class 1 (clear)] [Class 2 or 3 (tinted)], Quality-Q3; with exposed edges seamed before tempering, 6 mm thick.

1. Tint Color: [Blue-green] [Bronze] [Green] [Gray] <Insert color>.

Q. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA A156.18 for BHMA finish number indicated.

1. Dark, Oxidized, Satin Bronze, Oil Rubbed: BHMA 613 for bronze base; BHMA 640 for steel base; match Architect's sample.
2. Bright Brass, Clear Coated: BHMA 605 for brass base; BHMA 632 for steel base.
5. Satin Chromium Plated: BHMA 626 for brass or bronze base; BHMA 652 for steel base.
6. Bright Chromium Plated: BHMA 625 for brass or bronze base; BHMA 651 for steel base.
7. Satin Stainless Steel: BHMA 630.

2.6 MISCELLANEOUS MATERIALS

A. Furring, Blocking, Shims, and Hanging Strips: [Softwood or hardwood lumber] [Fire-retardant-treated softwood lumber], kiln dried to less than 15 percent moisture content.

B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.

C. Adhesives: Do not use adhesives that contain urea formaldehyde.

D. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. Adhesive for Bonding Plastic Laminate: [Unpigmented contact cement] [Contact cement] [PVA] [Urea formaldehyde] [Resorcinol].

1. Adhesive for Bonding Edges: Hot-melt adhesive[ or adhesive specified above for faces].
2.7 FABRICATION

A. Complete fabrication, including assembly and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.

B. Shop-cut openings to maximum extent possible to receive hardware, appliances, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

C. Install glass to comply with applicable requirements in Section 088000 "Glazing" and in GANA's "Glazing Manual." For glass in wood frames, secure glass with removable stops.

PART 3 - EXECUTION

3.1 PREPARATION

A. Before installation, condition cabinets to average prevailing humidity conditions in installation areas.

3.2 INSTALLATION

A. Grade: Install cabinets to comply with same grade as item to be installed.

B. Install cabinets level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb to a tolerance of \( \frac{1}{8} \) inch in 96 inches.

C. Scribe and cut cabinets to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.

D. Anchor cabinets to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with woodwork.

E. Cabinets: Install without distortion so doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.

1. Install cabinets with no more than \( \frac{1}{8} \) inch in 96-inch sag, bow, or other variation from a straight line.

2. Fasten wall cabinets through back, near top and bottom, and at ends not more than 16 inches o.c. with [No. 10 wafer-head screws sized for not less than 1-1/2-inch penetration into wood framing, blocking, or hanging strips] [No. 10 wafer-head sheet metal screws through metal backing or metal framing]
behind wall finish] [toggle bolts through metal backing or metal framing behind wall finish].

END OF SECTION 064116
SECTION 072100 - THERMAL INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Foam-plastic board insulation.
2. Glass-fiber board insulation.
4. Loose-fill insulation.
5. Spray polyurethane foam insulation.
6. Vapor retarders.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.
B. LEED Submittals:

1.3 INFORMATIONAL SUBMITTALS

A. Product test reports.
B. Research/evaluation reports.

PART 2 - PRODUCTS

2.1 FOAM-PLASTIC BOARD INSULATION

A. Extruded-Polystyrene Board Insulation: ASTM C 578, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. DiversiFoam Products.
   b. Dow Chemical Company (The).
   c. Owens Corning.
   d. Pactiv Building Products.
   e. <Insert manufacturer's name>.

2. Type X, 15 psi.
3. Type IV, 25 psi.
4. Type VI, 40 psi.
5. Type VII, 60 psi.
6. Type V, 100 psi.

B. Molded-Polystyrene Board Insulation: ASTM C 578, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. DiversiFoam Products.
   b. Plymouth Foam, Inc.
   c. <Insert manufacturer's name>.

2. Type I, 10 psi.
3. Type II, 15 psi.
4. Type VIII, 20 psi.

2.2 GLASS-FIBER BOARD INSULATION

A. Manufacturers: Subject to compliance with requirements, [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

1. CertainTeed Corporation.
2. Johns Manville.
4. Owens Corning.
5. <Insert manufacturer's name>.

B. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than <Insert number> percent.

C. Glass-Fiber Board Insulation: ASTM C 612, Type IA; [unfaced,] [foil faced,] with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics.

1. Nominal density of 2.25 lb/cu. ft., thermal resistivity of 4.3 deg F x h x sq. ft./Btu x in. at 75 deg F.
2. Nominal density of 3 lb/cu. ft., thermal resistivity of 4.3 deg F x h x sq. ft./Btu x in. at 75 deg F.
3. Nominal density of 4.25 lb/cu. ft., thermal resistivity of 4.3 deg F x h x sq. ft./Btu x in. at 75 deg F.
4. Nominal density of 6 lb/cu. ft., thermal resistivity of 4.4 deg F x h x sq. ft./Btu x in. at 75 deg F.
2.3 GLASS-FIBER BLANKET INSULATION

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. CertainTeed Corporation.
2. Guardian Building Products, Inc.
5. Owens Corning.
6. <Insert manufacturer's name>.

B. Unfaced, Glass-Fiber Blanket Insulation: ASTM C 665, Type I; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics.

C. Polypropylene-Scrim-Kraft-Faced, Glass-Fiber Blanket Insulation: ASTM C 665, Type II (non-reflective faced), Class A (faced surface with a flame-spread index of 25 or less); Category 1 (membrane is a vapor barrier).

D. Kraft-Faced, Glass-Fiber Blanket Insulation: ASTM C 665, Type II (non-reflective faced), Class C (faced surface not rated for flame propagation); Category 1 (membrane is a vapor barrier).

E. Reinforced-Foil-Faced, Glass-Fiber Blanket Insulation: ASTM C 665, Type III (reflective faced), Class A (faced surface with a flame-spread index of 25 or less); Category 1 (membrane is a vapor barrier), faced with foil scrim, foil-scrim kraft, or foil-scrim polyethylene.

F. Foil-Faced, Glass-Fiber Blanket Insulation: ASTM C 665, Type III (reflective faced), Class B (faced surface with a flame-propagation resistance of 0.12 W/sq. cm); Category 1 (membrane is a vapor barrier), faced with foil scrim, foil-scrim kraft, or foil-scrim polyethylene.

G. Eave Ventilation Troughs: Preformed, rigid fiberboard or plastic sheets designed and sized to fit between roof framing members and to provide cross ventilation between insulated attic spaces and vented eaves.

2.4 LOOSE-FILL INSULATION

A. Cellulosic-Fiber Loose-Fill Insulation: ASTM C 739, chemically treated for flame-resistance, processing, and handling characteristics.

B. Glass-Fiber Loose-Fill Insulation: ASTM C 764, Type I for pneumatic application with maximum flame-spread and smoke-developed indexes of 5, per ASTM E 84.
2.5 SPRAY POLYURETHANE FOAM INSULATION

A. Closed-Cell Polyurethane Foam Insulation: ASTM C 1029, Type II, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. BASF Corporation.
   b. BaySystems NorthAmerica, LLC.
   c. Dow Chemical Company (The).
   d. ERSystems, Inc.
   e. Gaco Western Inc.
   f. Henry Company.
   g. NCFI; Division of Barnhardt Mfg. Co.
   h. SWD Urethane Company.
   i. Volatile Free, Inc.
   j. <Insert manufacturer's name>.

2. Minimum density of 1.5 lb/cu. ft., thermal resistivity of 6.2 deg F x h x sq. ft./Btu x in. at 75 deg F.

B. Open-Cell Polyurethane Foam Insulation: Spray-applied polyurethane foam using water as a blowing agent, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84.

1. Manufacturers: Subject to compliance with requirements, [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
   a. BaySystems NorthAmerica, LLC.
   b. Demilec (USA) LLC.
   c. Gaco Western Inc.
   d. Icynene Inc.
   e. SWD Urethane Company.
   f. <Insert manufacturer's name>.

2. Minimum density of 0.4 lb/cu. ft., thermal resistivity of 3.4 deg F x h x sq. ft./Btu x in. at 75 deg F.

2.6 VAPOR RETARDERS

A. Polyethylene Vapor Retarders: ASTM D 4397, 6 mils thick, with maximum permeance rating of 0.13 perm.

B. Vapor-Retarder Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.
PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and applications indicated.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.

C. Extend insulation to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

D. Provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

3.2 INSTALLATION OF BELOW-GRADE INSULATION

A. On vertical surfaces, set insulation units using manufacturer's recommended adhesive according to manufacturer's written instructions.
   1. If not otherwise indicated, extend insulation a minimum of 24 inches below exterior grade line.

B. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.
   1. If not otherwise indicated, extend insulation a minimum of 24 inches from exterior walls.

3.3 INSTALLATION OF CAVITY-WALL INSULATION

A. Foam-Plastic Board Insulation: Install pads of adhesive spaced approximately 24 inches o.c. both ways on inside face, and as recommended by manufacturer. Fit courses of insulation between wall ties and other obstructions, with edges butted tightly in both directions. Press units firmly against inside substrates.
   1. Supplement adhesive attachment of insulation by securing boards with two-piece wall ties designed for this purpose and specified in Section 042000 "Unit Masonry."

3.4 INSTALLATION OF INSULATION FOR FRAMED CONSTRUCTION

A. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions. If no specific method is indicated, bond units to substrate with
adhesive or use mechanical anchorage to provide permanent placement and support of units.

B. Foam-Plastic Board Insulation: Seal joints between units by applying adhesive, mastic, or sealant to edges of each unit to form a tight seal as units are shoved into place. Fill voids in completed installation with adhesive, mastic, or sealant as recommended by insulation manufacturer.

C. Glass-Fiber Insulation: Install in cavities formed by framing members according to the following requirements:

1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
3. Maintain 2-inch clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
4. Install eave ventilation troughs between roof framing members in insulated attic spaces at vented eaves.
5. For metal-framed wall cavities where cavity heights exceed 96 inches, support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.
6. For wood-framed construction, install blankets according to ASTM C 1320 and as follows:
   a. With faced blankets having stapling flanges, secure insulation by inset, stapling flanges to sides of framing members.
   b. With faced blankets having stapling flanges, lap blanket flange over flange of adjacent blanket to maintain continuity of vapor retarder once finish material is installed over it.
7. Vapor-Retarder-Faced Blankets: Tape joints and ruptures in vapor-retarder facings, and seal each continuous area of insulation to ensure airtight installation.
   a. Exterior Walls: Set units with facing placed toward as indicated on Drawings.
   b. Interior Walls: Set units with facing placed as indicated on Drawings.

D. Loose-Fill Insulation: Apply according to ASTM C 1015 and manufacturer's written instructions. Level horizontal applications to uniform thickness as indicated, lightly settle to uniform density, but do not compact excessively.

1. For cellulosic-fiber loose-fill insulation, comply with CIMA's Bulletin #2, "Standard Practice for Installing Cellulose Insulation."

E. Spray-Applied Insulation: Apply spray-applied insulation according to manufacturer's written instructions. Do not apply insulation until installation of pipes, ducts, conduits, wiring, and electrical outlets in walls is completed and windows, electrical boxes, and other items not indicated to receive insulation are masked. After insulation is applied,
make flush with face of studs by using method recommended by insulation manufacturer.

F. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:

1. Loose-Fill Insulation: Compact to approximately 40 percent of normal maximum volume equaling a density of approximately 2.5 lb/cu. ft.
2. Spray Polyurethane Insulation: Apply according to manufacturer's written instructions.

3.5 INSTALLATION OF INSULATION FOR CONCRETE SUBSTRATES

A. Install board insulation on concrete substrates by adhesively attached, spindle-type insulation anchors as follows:

1. Fasten insulation anchors to concrete substrates with insulation anchor adhesive according to anchor manufacturer's written instructions. Space anchors according to insulation manufacturer's written instructions for insulation type, thickness, and application indicated.
2. Apply insulation standoffs to each spindle to create cavity width indicated between concrete substrate and insulation.
3. After adhesive has dried, install board insulation by pressing insulation into position over spindles and securing it tightly in place with insulation-retaining washers, taking care not to compress insulation below indicated thickness.
4. Where insulation will not be covered by other building materials, apply capped washers to tips of spindles.

3.6 INSTALLATION OF CURTAIN-WALL INSULATION

A. Install board insulation in curtain-wall construction where indicated on Drawings according to curtain-wall manufacturer's written instructions.

1. Hold insulation in place by securing metal clips and straps or integral pockets within window frames, spaced at intervals recommended in writing by insulation manufacturer to hold insulation securely in place without touching spandrel glass. Maintain cavity width of dimension indicated between insulation and glass.
2. Install insulation where it contacts perimeter fire-containment system to prevent insulation from bowing under pressure from perimeter fire-containment system.

3.7 INSTALLATION OF VAPOR RETARDERS

A. Place vapor retarders on side of construction indicated on Drawings. Extend vapor retarders to extremities of areas to protect from vapor transmission. Secure vapor retarders in place with adhesives or other anchorage system as indicated. Extend vapor retarders to cover miscellaneous voids in insulated substrates, including those filled with loose-fiber insulation.
B. Seal vertical joints in vapor retarders over framing by lapping no fewer than two studs.
   1. Fasten vapor retarders to wood framing at top, end, and bottom edges; at perimeter of wall openings; and at lap joints. Space fasteners 16 inches o.c.
   2. Before installing vapor retarders, apply urethane sealant to flanges of metal framing including runner tracks, metal studs, and framing around door and window openings. Seal overlapping joints in vapor retarders with vapor-retarder tape according to vapor-retarder manufacturer's written instructions. Seal butt joints with vapor-retarder tape. Locate all joints over framing members or other solid substrates.
   3. Firmly attach vapor retarders to metal framing and solid substrates with vapor-retarder fasteners as recommended by vapor-retarder manufacturer.

C. Seal joints caused by pipes, conduits, electrical boxes, and similar items penetrating vapor retarders with vapor-retarder tape to create an airtight seal between penetrating objects and vapor retarders.

D. Repair tears or punctures in vapor retarders immediately before concealment by other work. Cover with vapor-retarder tape or another layer of vapor retarders.

END OF SECTION 072100
PART 1 GENERAL

1.01 WORK SPECIFIED HEREIN
A. This Specification shall cover the furnishing of all labor, equipment, materials, accessories and services necessary to furnish and install new asphalt-fiberglass roof shingles and flashings, complete with preformed ridge caps, valley gutters and accessory trim as indicated, specified and required for a complete installation.
B. Provision of temporary roof seals as required to maintain watertight conditions and protect roofing system during installation.

1.02 REFERENCE STANDARDS
A. Reference to standards and/or specifications herein shall be interpreted to mean the latest revision unless noted otherwise. The following abbreviations appear in the specification:
   - ASTM American Society for Testing and Materials
   - OSHA Occupational Safety and Health Administration
   - UL Underwriters Laboratory
B. The following standards shall be made a part of this Specification:
   - ASTM D3018 Standard Specification for Class A Asphalt Shingles Surfaced with Mineral Granules
   - ASTM D3161 Wind-Resistance of Asphalt Shingles, Test Method For
   - FS SS-C-153 Plastic Cement
   - UBC Uniform Building Code, International Conference of Building Officials
   - UL 790 Tests for Fire Resistance of Roof Covering Materials
C. Permission for deviation from these standards and/or specifications must be approved, in writing, by the Engineer in advance of Bid Proposal submittal.

1.03 QUALITY ASSURANCE
A. Manufacturer shall be an Associate Member, in good standing, of the National Roofing Contractors Association and Western States Roofing Contractors Association.
B. Manufacturer shall be nationally recognized in the roofing, waterproofing industry for fifty years.
C. Contractor shall be the roofing material manufacturer's approved qualified applicator.
D. Upon request by the Engineer, the Contractor shall provide the names of at least ten jobs from the greater Phoenix area, available for inspection by the Engineer, that are similar or identical to the system specified in this Specification.
E. Contractor's designated foreman shall have a minimum of five years experience in the Installation of asphalt-fiberglass roof shingles similar to the system specified in this Specification.
F. The completed roofing system assembly shall meet or exceed UL 790, Class B requirements.

1.04 GUARANTEE
A. The manufacturer of the asphalt-fiberglass roof shingles shall provide a twenty-year non-prorated guarantee covering all materials and workmanship comprising the Contract Work against any leaks, defects or other deterioration of the system. Any leaks, defects or deterioration shall be repaired at no cost to Purchaser.
B. In conjunction with manufacturer's guarantee, the Contractor shall provide a two-year guarantee covering repair/replacement of any materials and workmanship comprising the Contract Work resulting in leaks, defects or other deterioration of the system. Any leaks, defects or deterioration shall be repaired at no cost to Purchaser.
C. Unless otherwise expressly noted within this Specification, the roofing system installed shall comply with the applicable roofing material manufacturer's written recommendations.

1.05 DELIVERY, STORAGE, AND HANDLING
A. Materials shall be stored on pallets or equivalent wood blocking.
B. All materials shall be covered with waterproof covering top to bottom. Covering shall be secured with twine or rope.
C. Roofing materials shall be handled so as to avoid bending, tearing or other damage during transportation and installation.
D. Roofing felts, asphalt and other materials shall be stored in a place protected from water and extreme temperatures.
E. Rolls of roofing felt shall be stored on ends only. Rolls which have been flattened or otherwise damaged shall be discarded.
F. Material handling equipment shall conform to, and be operated in conformance with, OSHA and local building code requirements.
G. Material handling equipment shall be selected and operated so as not to damage newly applied roofing, the existing roof system or the building. Do not load materials or operate equipment on any roof area in a manner that could endanger or disturb occupants of the building; the Engineer will determine locations available to the Contractor at the pre-bid conference.

1.06 SITE CONDITIONS
A. Access to roof shall be from the exterior. Coordinate access and work with the Engineer.
B. Installation work shall not be performed during rainy or inclement weather. Maintain building weather tight during inclement weather. Engineer may stop project if, in his/her opinion, the work should not be continued due to adverse weather conditions.
C. Contractor shall assume that the building space directly under the roof areas included by this specification will be occupied and utilized for ongoing operations. Contractor shall not interrupt Purchaser’s operations unless written approval is received from the Engineer.

1.07 SUBMITTALS
Submit manufacturer’s literature at least two weeks prior to installation of asphalt-fiberglass roof shingles. Literature shall indicate materials to be provided and manufacturer’s recommended installation procedures.

PART 2 PRODUCT

2.01 LUMBER
Lumber shall be Douglas fir-hemlock, construction grade with West Coast lumber inspection bureau grade stamp. Size as required to match existing or as shown on drawings.

2.02 PLYWOOD SHEATHING
Plywood sheathing shall be Structural II, A-D, exterior or standard sheathing with exterior glue, as identified by stamp of American Plywood Association, a minimum 3/4-inch thickness or match existing as appropriate for span.

2.03 NAILS
Use galvanized common nails for framing and sheathing. Size as required by UBC. For roofing, use galvanized steel 10-gauge, screw-threaded shank, 3/8 inch head, with length as required to penetrate 3/4 inch into plywood sheathing.

2.04 ROOFING FELT
Roofing felt shall be 28-pound asphalt saturated unperforated felt.

2.05 PLASTIC CEMENT
Plastic cement shall be as recommended and supplied by shingle manufacturer, complying with FS SS-C-153, Type 1.

2.06 SHINGLES
A. Shingles shall be asphalt saturated, fiberglass base, ceramic granule coated, Class A and wind resistant label shingles, in compliance with ASTM D3018, Type 1 and D3161.
B. Shingles shall be "Sentinel" grade as manufactured by GAF Building Materials Corp., and have a 20-year warranty from the manufacturer. Similar shingles as manufactured by Certainteed, Bird and Son, Flintkote, or Owens-Corning Fiberglas are also acceptable.

C. Color of Shingles shall be as selected by the Engineer from manufacturer's standard colors.

2.07 METAL DRIP EDGE
Metal drip edge shall be minimum 24-gauge galvanized steel with minimum three-inch nailing flange. Fascia width shall be minimum of one inch with 1/4 inch concealed hem drip edge. Maximum length for individual piece is 10 feet.

2.08 ROOF JACK
Roof jack shall be minimum 24-gauge galvanized steel with minimum three-inch wide flange around conical base. Shop fabricate vertical flashing cone and base sheet to match slope of roof deck. Where required by existing conditions at deck penetration, provide two-piece "split" jack.

PART 3 EXECUTION

3.01 INSPECTION
A. Roofing system shall not be installed until all unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions by Contractor.

B. Verify that any work of other trades requiring penetration of roof surface or requiring men and/or equipment to traverse roof has been completed or has been approved by the Engineer and material manufacturer's representative.

C. Check projections, curbs, walls and deck for inadequate anchorage, foreign material, moisture or unevenness preventing execution or adversely affecting quality of new roofing system. Assure that surfaces to receive shingles are uniform, smooth, sound, clean, dry, and free of irregularities. Replace existing defective plywood roof deck surface with new similar to adjacent existing deck. Correct any deficiencies.

3.02 PROTECTION
A. Contractor shall be responsible for protection of property, including all areas around buildings, during course of work. All damage caused by this Contractor shall be repaired by this Contractor, at his expense, to its original condition to the complete satisfaction of the Engineer.

B. Roofing system and flashings shall be fully installed and sealed in a watertight manner on the day of installation and before arrival of inclement weather. Night seals shall be closely examined by job foreman after each working day to ensure watertightness. Prior to removal of temporary and daily waterstops/tie-ins, all ponded water shall be removed in such a manner as not to create any water penetration into the building. Contractor shall be responsible for any water damage to the building and/or contents.

3.03 CONSTRUCTION PREPARATION
A. Work sequence shall be scheduled to avoid use of newly constructed roofing for storage, walking surface, or equipment movement. Equipment and ground storage areas shall be moved to designated locations as work progresses.

B. Standing pipes and roof-mounted conduit shall be lifted, disconnected and saved for later reinstallation. If the Contractor is not qualified to plug plumbing or disconnect electrical connections, the Contractor will, at his expense, subcontract this work.

3.04 FELT UNDERLAYMENT
A. Roofs with 3 in 12 slope or greater: Lay one layer of felt underlayment horizontally over entire roof, lap each course over lower course. Lap two-inch minimum on horizontal joints, four-inch minimum at end joints and six inch minimum both sides over hips and ridges. Secure underlayment to deck with sufficient fasteners to hold in place until shingles are installed.

B. Roofs with slope from 2 to 3 in 12: Apply two layers of felt underlayment parallel with eaves; lay 19-inch strip as starter course, overlap with second layer. Cover roof with 36-inch wide sheets of felt, overlap preceding layer by 19 inches, exposing 17 inches of underlying sheet.
Secure underlayment to deck with sufficient fasteners to hold in place until shingles are installed.

C. Install 36-inch wide felt underlayment centered in valley and nail in position. Horizontal underlayment courses shall overlap valley underlayment six inches minimum.

D. Eave flashings, slope 4 in 12 or greater: Apply course of smooth roll roofing to project 3/8 inch beyond felt underlayment and metal drip edge. Extend roll roofing up roof deck to a minimum of 12 inches inside perimeter wall line of building.

E. Eave flashings, slope less than 4 in 12: Apply bituminous plastic cement at rate of two gallons per 100 square feet to surface of felt underlayment. Apply second course of underlayment to extend up roof deck to a minimum of 30 inches inside perimeter wall line of building.

3.05 CLOSED VALLEY FLASHING
Center 36-inch wide smooth surface roll roofing, placed over felt underlayment, within valley.

3.06 SHINGLES
A. Starter Strip: Install row of inverted shingles along lower eave edge, with tabs facing up roof. Nail three inches in from eave edge, with nail heads not exposed to first course cutouts.

B. Random Spaced Joints: Start first course with full shingles. Start second course with full shingle with starting tab cut to three-inch minimum width. Locate cutout centerline of succeeding courses at least three inches laterally from cutout centerline of course below. Vary starting tab widths to avoid pattern cutout alignment. Install shingles with five-inch exposure.

C. Install shingles in straight horizontal single courses, following the eave and ridge lines of the building. Observe spacing and layout of shingles during installation to prevent occurrence of diagonal lines and other non-uniform appearing patterns.

3.07 HIPS AND RIDGES
Install manufacturer's standard preformed hip and ridge shingles.

3.08 CLOSED VALLEYS
Lay shingles along eaves of roof crossing valley, extending over adjoining roof deck 12 inches minimum. Lay first course along eaves of adjoining roof and extend 12 inches minimum across valley on top of previously applied shingle. Lay succeeding courses alternately. Nail no closer than five inches to valley center line and place two nails at end of each terminal strip.

3.09 ROOF JACKS
Install prefabricated sheet metal jacks at all roof deck penetrations. Base sheet of jack shall be set in plastic cement (before new shingles are installed) and nailed securely in place. Opening at top of jack cone shall be 1/2 to 3/4 inch larger than penetrating item. Seal open joint with gun-grade liquid polysulfide polymer, Thiokol, or similar as approved by Engineer. Paint (primer and finish coat) sheet metal to blend with adjacent roof shingle color.

3.10 FIELD QUALITY CONTROL
Manufacturer's representative, along with the Engineer, shall provide a final inspection of the completed work. Contractor's job foreman shall attend installation inspection and shall provide repair materials to repair areas of new roofing system found unsatisfactory by the Engineer and/or material manufacturer's representative.

3.11 ADJUSTING AND CLEANING
A. Any deficiencies found during final inspection will be corrected within five working days and will be re-inspected by the manufacturer's representative and the Engineer.

B. Remove any debris from roof.

C. Clean gutters and downspouts of all debris so they are free flowing.

D. Leave premises clean to the complete satisfaction of the Engineer.

END SECTION

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Asphalt-Fiberglass Roof Shingles
PART 1 GENERAL

1.01 WORK SPECIFIED HEREIN
A. This Specification shall cover the furnishing of all labor, equipment, materials, accessories and services necessary to furnish and install roof insulation and roofing system as indicated and specified.
B. Installation of new asphalt built-up, gravel surfaced roofing system and flashings, complete with new wood nailers and new sheet metal as specified.
C. Provision of temporary roof membrane seals as required to maintain watertight conditions and protect roofing system during installation.

1.02 REFERENCE STANDARDS
A. Reference to standards and/or specifications herein shall be interpreted to mean the latest revision unless noted otherwise. The following abbreviations appear in the specification:
   - ASTM: American Society for Testing and Materials
   - AWPI: American Wood Preservers Institute
   - FM: Factory Mutual Engineering Corporation
   - FS: Federal Specification
   - NRCA: National Roofing Contractors Association
   - OSHA: Occupational Safety and Health Administration
   - UL: Underwriters Laboratory
B. The following standards shall be made a part of this Specification:
   - ASTM C208: Standard Specification for Insulating Board (Cellulosic Fiber), Structural and Decorative
   - ASTM D312-84: Standard Specification for Asphalt Used in Roofing, Type IV
   - ASTM D2178-89: Standard Specification for Asphalt Glass Felt Used in Roofing and Waterproofing
   - ASTM D4586-86: Standard Spec. for Asphalt Roof Cement, Asbestos Free, Type I
   - ASTM D4601-86: Specification for Asphalt Coated Base Sheet Used in Roofing Type II.
   - AWPI LP-2: Wood Preservative
   - FS LL-L-535A: Insulation Board, Thermal
   - FS SS-CC-153: Roof Cement
   - FF SS-R-620b: Roofing Felt, Roll, Asphalt-Prepared
   - NCRA: Deck Dryness Test
   - UL 790: Tests for Fire Resistance of Roof Covering Materials, Class A Rated
C. Permission for deviation from these standards and/or specifications must be approved, in writing, by the Roofing Program Coordinator in advance of Bid Proposal submittal.

1.03 QUALITY ASSURANCE
A. Manufacturer shall be an Associate Member, in good standing, of the National Roofing Contractors Association and Western States Roofing Contractors Association.
B. Manufacturer shall be nationally recognized in the roofing, waterproofing industry for fifty years.
C. Contractor shall be the roofing material manufacturer's approved qualified applicator.
D. Upon request by the Engineer, the Contractor shall provide the names of at least ten jobs from the greater Phoenix area, available for inspection by the Roofing Program Coordinator, that are similar or identical to the system specified in this Specification.
E. Contractor's designated foreman shall have a minimum of five years experience in the installation of asphalt built-up roofing systems similar to the system specified in this Specification.
F. The completed roofing system assembly shall meet or exceed the UL Assembly #790, Class B requirements.

G. Materials shall be typically installed in compliance with the "NRCA Construction Details" as published by the National Roofing Contractors Association, unless otherwise expressly noted within this specification. Any deviations from these details and this specification, required by the roofing material manufacturer for its compliance with paragraph 1.4 Guarantee, shall be submitted in writing with the contractor's Form of Proposal.

1.04 GUARANTEE

A. The manufacturer/supplier of the materials for the roofing system shall provide a ten-year non-prorated guarantee covering materials and workmanship against any leaks, defects, or other deterioration of the system occurring from material performance failure or workmanship. Any such leaks, defects, or deterioration shall be repaired at no cost to purchaser. The purchaser will periodically inspect the roofing system and have a contractor approved by the material manufacturer perform annual maintenance items as necessary.

B. In conjunction with manufacturer's guarantee, the Contractor shall provide a two-year guarantee covering repair/replacement of any materials and workmanship comprising the Contract Work resulting in leaks, defects or other deterioration of the system. Any leaks, defects or deterioration shall be repaired at no cost to Purchaser.

C. Unless otherwise expressly noted within this Specification, the roofing system installed shall comply with the applicable roofing material manufacturer's written recommendations.

D. Upon completion of project and payment by Purchaser, Manufacturer shall deliver to purchaser a ten year manufacturer Roof System Quality Assurance Warranty and Owner's manual. Manufacturer will, during the second and fifth year of the warranty, inspect the roofing and provide a written executive summary regarding condition and serviceability of roof.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Materials shall be stored on pallets or equivalent wood blocking.

B. All materials shall be covered with waterproof covering top to bottom. Covering shall be secured with twine or rope.

C. Roofing materials shall be handled so as to avoid bending, tearing or other damage during transportation and installation.

D. Roofing felts, asphalt and other materials shall be stored in a place protected from water and extreme temperatures.

E. Rolls of roofing felt shall be stored on ends only. Rolls which have been flattened or otherwise damaged shall be discarded.

F. Material handling equipment shall conform to, and be operated in conformance with, OSHA and local building code requirements.

G. Material handling equipment shall be selected and operated so as not to damage newly applied roofing, the existing roof system or the building. Do not load materials or operate equipment on any roof area in a manner that could endanger or disturb occupants of the building. The Engineer will determine lay down and storage area locations available to the Contractor at the pre-bid conference.

H. Asphalt shall be delivered to project site with manufacturer's label intact, showing characteristics and EVT of product. No bulk shipment or tanker supplied asphalt will be permitted.

1.06 SITE CONDITIONS

A. Access to roof shall be from the exterior. Coordinate access and work with the Engineer.

B. Installation work shall not be performed during rainy or inclement weather. Maintain building weather tight during inclement weather. Engineer may stop project if, in his/her opinion, the work should not be continued due to adverse weather conditions.

C. Contractor shall assume that the building space directly under the roof areas included by this specification will be occupied and utilized for ongoing operations. Contractor shall not interrupt Purchaser's operations unless written approval is received from the Engineer.

1.07 SUBMITTALS
Submit manufacturer's literature indicating roofing system and roof insulation to be provided. Literature/catalog cut sheets submitted shall be for same product and manufacturer as listed by the Contractor on its Form of Proposal for the respective project. Minimum aged "R" value for one inch of insulation board shall be 4.17.

PART 2 PRODUCT

2.01 INSULATION
A. Insulation shall be fiberglass insulation board as manufactured by Owens-Corning Fiberglas or similar, as approved by Roofing Program Coordinator, installed in two layers of minimum 3/4 inch board with total thickness of insulation to be equal to insulation removed or as shown on the plans.
B. Insulation shall conform to FS HH-I-526 and ASTM C726. Insulation to be supplied in nominal 24 by 48 inch boards with asphalt adhered kraft paper cover.
C. Insulation shall be compatible with roofing system and be approved by roofing material manufacturer.
D. Insulation shall remain dimensionally stable for the life of the roof system.
E. Insulation tape, if desired by manufacturer, shall be fiberglass roof tape as supplied by Owens-Corning Fiberglas Corporation.

2.02 BASE SHEET
Base sheet shall be roofing material manufacturer's standard asphalt coated fiberglass base sheet minimum weight of 25 pounds per square, Conglas W-1 or Perma Ply No. 28, conforming to specification requirements.

2.03 ASPHALT BUILT UP SYSTEM
Asphalt built-up roofing system shall be as listed below or similar system meeting this specification as approved by Roofing Program Coordinator:
A. Fiberglass Felt: Type V1 fiberglass felts by Tremco, Conglas, or Owens-Corning Fiberglas in accordance with ASTM D2178.
B. Special Steep Asphalt: Steep Roofing Asphalt, Tremco Premium Type IV. conforming with requirements of ASTM D312, Type IV, provided by Tremco.
C. Roofing aggregate: Roofing aggregate shall meet requirements of ASTM D1863 and shall be hard, durable, opaque, washed free of clay, loam, sand or other foreign substances. No.5 granite, or clean/washed river aggregate sieve graded 3/16 inch to 3/8 inch is acceptable.
D. Weathering Surface Bitumen: Flood coat for embedment of aggregate shall be Tremco thermastic adhesive conforming to ASTM D36, and ASTM D92. (Softening point 195 degrees to 205 degrees Fahrenheit.)

2.04 PLASTIC CEMENT
A. In all exposed locations plastic cement shall be Tremco standard product, Tremco Polyroof, (conforming to FS SS-CC-153, Type 1, and ASTM D4586).
B. In concealed applications, not exposed to weather, plastic cement may be Tremco ELS, (conforming to FS SS-CC-153, Type I), or similar product approved by Roofing Program Coordinator.

2.05 STACK FLASHING
Stack flashing shall be four-pound lead with four inch flange. For pipes three inches or less in diameter, provide preformed lead counterflashing collar.

2.06 NAILERS
B. Nails shall be sized for adequate penetration and anchorage. Case hardened nails shall be used for concrete.
2.07 MEMBRANE FLASHING
Membrane flashing shall be SBS modified bitumen sheet MB3G25 mineral surfaced, as supplied by Tremco, or similar asphalt modified bitumen having a core of spunbound polyester mat coated with durable modified asphalt as approved by Roofing Program Coordinator. Membrane shall be formulated for hot asphalt mopping application. Ply sheet shall be Poly-Therm as supplied by Tremco.

2.08 WALKWAY PADS
Walkway pads shall be APOC "Dek-Top," Carey "Careytred," or W. R. Meadows "Seal-tight Protection Course," granular surfaced asphaltic boards not less than 1/2-inch thickness. Walkway pads must be of a material compatible with roofing system.

2.09 INSULATION FASTENERS (STEELDECK)
A. From Fabco Fastening Systems, West Newton, PA:
   a. Insul-Fixx (plastic disc or metal plate).
   b. Plate-Fixx (plastic disc).
B. From Buildex Div. of ITW, Itasca, IL:
   a. Roofgrip (plastic disc or metal plate).
   b. Climasealed Roofgrip (plastic disc or metal plate).
C. From B.F. Goodrich, Akron, OH:
   a. Lexsuco Insulation Clips with universal metal plate discs.
   b. Lexsuco Insulation Screw Fasteners (R*ustop plastic discs).
D. Screw/clip length: Sufficient to engage steel deck.

2.10 BASE SHEET FASTENERS (LIGHTWEIGHT CONCRETE)
A. Tube-Lock Self Locking Tube Nail by Simplex
B. Zonolite Base Ply Fasteners by W. R. Grace
C. Capped E/S Nails by E S Products

PART 3 EXECUTION

3.01 INSPECTION
A. Roofing system shall not be installed until all unsatisfactory conditions affecting roof installation and durability are corrected. Beginning work constitutes acceptance of conditions by Contractor.
B. Verify that any remaining work of other trades requiring men and/or equipment to traverse roof deck has been approved by the Engineer and material manufacturer's representative.
C. Check projections, curbs, walls and deck for inadequate anchorage, foreign material, moisture or unevenness preventing execution or adversely affecting quality of new roofing system. Correct any deficiencies.
D. Examine the underside of metal roof deck for any piping, conduit or other equipment that could be damaged by penetration of metal deck by insulation mechanical fasteners. If any such items exist, determine with the Engineer proper protective procedures to follow to ensure no damage occurs due to installation of mechanical fasteners.

3.02 PROTECTION
A. Contractor shall be responsible for protection of property, including all areas around buildings, during course of work. All damage caused by this Contractor shall be repaired by this Contractor, at his expense, to its original condition to the complete satisfaction of the Engineer.
B. Protect building surface at laydown area with tarpaulins, secured in place. Provide dumpster or approved container for receiving debris. Spilled or scattered debris shall be cleaned up immediately. Removal material to be disposed of from roof as it accumulates and in a manner that will not allow accidental damage to adjacent critical equipment.
C. Asphalt built-up roofing system and flashings shall be fully installed and sealed in a watertight manner on the day of installation and before arrival of inclement weather. Night seals will be closely examined by job foreman after each working day to ensure watertightness. Prior to removal of temporary and daily waterstops/tie-ins, all ponded water shall be removed in such a
manner as not to create any water penetration into the building. Contractor shall be responsible for any water damage to the building and/or contents.

D. Contractor shall instruct and supervise his workmen to ensure that aggregate, asphalt and/or debris is not tracked into new work areas or into areas adjacent to the work site.

3.03 CONSTRUCTION PREPARATION
A. Work sequence shall be scheduled to avoid use of newly constructed roofing for storage, walking surface, or equipment movement. Equipment and ground storage areas shall be moved to designated locations as work progresses.

B. Drains shall be plugged with rags to prevent debris entry. Plugs shall be removed at end of each workday and before arrival of inclement weather. Coordinate with the Engineer the closing of all air intakes to the building. Air intakes are to be reset to original condition as soon as practical, or at completion of roofing work.

C. Standing pipes and roof-mounted conduit shall be lifted, disconnected and saved for later reinstallation. Reinstall at completion of roofing membrane installation. If the Contractor is not qualified to plug plumbing or disconnect electrical connections, the Contractor will, at his expense, subcontract this work.

D. Prior to application of roofing base sheet and/or insulation, the roof deck must be clean and dry, and concrete roof deck must pass the NCRA "Deck Dryness Test."

3.04 BASE SHEET INSTALLATION: WOOD, GYPSUM AND LIGHTWEIGHT CONCRETE ROOF DECKS
Install base sheet to deck with mechanical fasteners six inches on center down laps and 18 inches on center down sheet, staggered, 12 inches in from laps. Lap edges four inches and ends six inches.

3.05 BASE SHEET INSTALLATION, CONCRETE DECKS
A. Coat bare concrete deck surfaces with asphalt primer at a rate of one gallon per 100 square feet of roof area; allow to dry to the touch.

B. Install base sheet to primed concrete deck in a full mopping of hot special steep asphalt, Type IV, at a rate of not less than 25 pounds per square. Lap edges two inches and ends six inches.

3.06 INSULATION INSTALLATION: METAL DECK
A. Thoroughly clean deck and remove all debris from Purchaser's property.

B. Mechanically attach first layer of insulation to metal deck. Install fasteners as required to ensure insulation is firm under foot and in compliance with FM I-90, Class 1. Drive mechanical fasteners flush to top surface of insulation. Minimum number of fasteners shall be one fastener for each two square feet of area, and two fasteners for each piece of board. First layer of insulation shall be of sufficient thickness to span the flutes of the metal deck without damage from construction activities.

C. Form continuous insulation joints over deck flange. Do not cantilever insulation edges over deck ribs. Minimum edge bearing to be one inch. Filler insulation shall be a minimum of 18 inches square and shall have a minimum of two fasteners per piece.

3.07 INSULATION PLACEMENT
A. Closely butt edges of insulation units without forcing into place. Lay insulation with long dimension of insulation board perpendicular to roof slope. Exercise care in placement of bottom layer of insulation over metal deck to ensure tight joints and to prevent asphalt dropping to areas below deck.

B. Cut and fit insulation where roof deck intersects vertical surfaces, but keep 1/4 inch from all vertical flashings.

C. Miter insulation edges at ridges and elsewhere to prevent open joints and irregular surfaces. Maximum elevation variation between boards at joints shall be 1/8 inch.

D. At roof scuppers and drains, taper insulation from flush with opening to full thickness at 18 inches away from drains and scuppers on all sides.

E. Do not install insulation or vapor retarder to bridge across expansion joints or other similar devices.

F. Embed first layer of insulation board placed over a base sheet and second layer of roof insulation in a solid, uniform 30 pounds per 100 square feet mopping of hot special steep asphalt. Asphalt must be hot enough at the time of application to attain positive securement.
Hot asphalt mopping shall not proceed ahead of insulation installation by more than two boards. Insulation boards shall be placed in hot asphalt within 30 seconds of asphalt mopping application. "Walking-in" of the individual insulation boards is required to ensure maximum adhesive contact. Second layer of roof insulation shall be laid with joints staggered a minimum of 12 inches in both directions from joints of the first layer.

3.08 CARPENTRY
A. Mechanically attach wood blocking to structural deck. Blocking is to be a nominal six inches wide by insulation thickness.
B. Fasteners are to be in two rows, staggered, with a maximum of 24 inches spacing in either row. Maximum spacing within eight feet of corners is 12 inches.
C. Offset blocking layers 12 inches and weave corners.
D. For additional requirements, see specification section for Sheet Metal Flashing.

3.09 CANT ATTACHMENT
Set fiberboard cants into Type IV hot asphalt.

3.10 MEMBRANE BASE SHEET
A. Over insulation board, install fiberglass base sheet in solid, uniform mopping of hot steep asphalt applied at the rate of 30 lbs. per 100 square feet.
B. Lay sheet smooth and free of wrinkles, buckles, or fishmouths. Lay so water flows over or parallel to, but never against the laps. Lap 2 inches on sides and 6 inches on ends. Lightly broom installed base sheet to insure full adhesion with substrate.
C. At perimeter and interior curb penetrations, extend sheet a minimum of 2 inches above the top of the cant strip, solidly adhered in hot asphalt without bridging and buckling.

3.11 ROOF MEMBRANE APPLICATION
A. Starting at a low point of the roof, install three plies of fiberglass felt, shingle fashion (starter sheets required), lapping each sheet nominal 25 inches over preceding sheet. Solidly mop each ply to underlying roofing with mini-mum 25 pounds per 100 square feet of hot asphalt. Lap ply sheet ends six inches. Stagger end laps a minimum of 18 inches. Each ply shall be completely and firmly embedded in hot asphalt and be free of wrinkles, buckles, blisters, fishmouths and voids.
B. Apply bitumen no more than ten feet ahead of each roll being embedded. Embed felt in hot bitumen, within 20 seconds of time bitumen is mopped. From unmopped side, broom each ply before bitumen cools. Ensure complete and continuous seal and contact between bitumen and ply sheets, including ends, edges, and laps. Avoid walking on plies until bitumen has set.
C. Extend roofing plies into roof drain trim. Lay four-pound lead, set in flashing cement, around drain and one inch inside drain. (The lead is three feet square in size.) Prime the top surface of the lead flashing and allow to dry. Install layer of membrane flashing over lead in a full coating of hot asphalt and extending four inches beyond edge of lead. Install two plies of fiberglass felt set in minimum 25 pounds per 100 square feet of hot steep asphalt. Each layer to extend a minimum of four inches beyond previous layer and be installed so water will flow freely to drain.
D. On curb details, plies shall extend two inches above cants and be set in hot asphalt. Cover with one layer membrane flashing, each piece shall not be more than six feet long; width shall extend from four inches beyond toe of cant to four inches above bottom edge of sheet metal flashing and be adhered to substrate wall with full continuous mopping of hot asphalt.

3.12 FLASHINGS
A. Prime vertical substrate with asphaltic primer at rate of one gallon per 100 square feet.
B. Install new roofing plies not less than two inches beyond top edge of cant, fully adhered in hot asphalt.
C. Set one ply of Poly-Therm flashing to substrate in uniform continuous mopping of hot asphalt, from four inches beyond toe of cant to two inches above bottom of metal counterflashing. Overlap plies four inches. Remove wrinkles and voids.
D. Cut modified bitumen flashing sheet in lengths not to exceed ten feet. Coat back surface of flashing sheet and Poly-Therm flashing surface with uniform and continuous (1/16 inch thick) mopping of hot asphalt. Extend flashing sheet six inches beyond toe and four inches above...
bottom edge of metal counterflashing. Press sheet firmly in place; ensure complete bond and continuity without wrinkles or voids.

E. Mechanically fasten top of modified bitumen flashing sheet to substrate with one inch cap nails eight inches on center. Nails to be located a minimum of 1-1/2 inches above bottom edge of metal counterflashing.

3.13 METAL STACK FLASHINGS
A. Slide new four-pound lead flashing over pipe. Set in plastic cement on completed plies prior to application of protective finish. Coat top surface of flange with asphalt primer and allow to dry.
B. Only on nailable decks, fasten flange through roof membrane with large-head, case-hardened nails three inches on center. Seal flange with two layers of fiberglass membrane in hot asphalt. Each layer extending a minimum of four inches beyond previous layer.
C. Install modified bitumen membrane flashing, set in hot asphalt, between metal flange and roof surface over metal flange. Membrane flashing shall extend four inches beyond metal flange.
D. If outside diameter of pipe is three inches or less, cut off lead at top of pipe and install preformed lead counterflashing collar.
E. If outside diameter of pipe is greater than three inches, bend lead inside pipe (minimum one inch) with pliers or rubber/plastic mallet. Do not use roofing hammer, since blows from hammer may crack lead. Any lead that is cracked shall be replaced with new four-pound lead at Contractor's Expense.

3.14 TEMPORARY TIE-INS
A. Extend new roofing plies onto existing cleaned roof a minimum of 12 inches in a full mopping of hot asphalt.
B. Seal outside edges with a layer of plastic cement, "feathered" to a smooth finish.
C. On curb and wall details, plies shall extend a minimum of two inches above cants and a layer of plastic cement shall be applied to top edge and "feathered" to a smooth finish.
D. Projections shall have a layer of plastic cement applied to base. Ensure mastic is beveled and "feathered" to a smooth finish.

3.15 PROTECTIVE FINISH
Over the entire asphalt and fiberglass felt roofing membrane apply a uniform and continuous flood coat of hot Tremco Thermastic at the minimum rate of 3 1/2 gallons per 100 square feet. Immediately broadcast a minimum of 300 pounds aggregate per 100 square feet into the hot bitumen to achieve a uniform, securely embedded surface coating. Cover bitumen completely with no bleed-through. After bitumen has set, sweep aggregate surface and remove loose aggregate from roof surface and drain sumps.

3.16 WALKWAY PAD INSTALLATION
Install walkway pads after completion of membrane installation and prior to aggregate surface application. Walkway pads shall be set in adhesive recommended by pad manufacturer and acceptable to roofing manufacturer and shall be installed to insure complete contact and prevent curling. Pads shall be placed in locations as shown on drawings and as indicated by the Engineer with a maximum four-inch space between pads. Unless otherwise noted, long dimension of pad shall be placed perpendicular to direction of travel.

3.17 FIELD QUALITY CONTROL
A. Manufacturer's representative shall make daily inspections of work in progress in conjunction with the Contractor's Quality Control personnel.
B. Contractor's superintendent shall provide weekly reports to the Engineer describing the amount of work completed, any job slowdowns and how they were solved, and other pertinent data.
C. Manufacturer's representative, concurrently with the Engineer and Roofing Program Coordinator, shall provide a final inspection of the work before protective finish has been applied over completed plies. Contractor's job foreman shall attend installation inspection and shall provide repair materials to repair areas of new roofing system found unsatisfactory by the Engineer, Roofing Program Coordinator and/or material manufacturer's representative.
3.18 ADJUSTING AND CLEANING
A. Any deficiencies found during final inspection will be corrected within five working days and will be re-inspected by the manufacturer's representative and the Engineer.
B. Lightly broom sweep entire roofing area and remove any debris or excess aggregate.
C. Unplug drains and set drain screens or baskets in position. Provide new drain screens and baskets in locations where screens or baskets are broken or missing.
D. Clean gutters and downspouts of all debris so they are free flowing.
E. Leave premises clean to the complete satisfaction of the Engineer.

END SECTION
SECTION 075416 - MEMBRANE (KEE) ROOFING

PART 1 - GENERAL

1.1 SUMMARY
   A. Section Includes:
      1. Adhered KEE membrane roofing system.
      2. Mechanically fastened KEE membrane roofing system.

1.2 PERFORMANCE REQUIREMENTS
   A. Solar Reflectance Index: Not less than 78 when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.
   B. Energy Performance: Provide roofing system that is listed on the DOE's ENERGY STAR "Roof Products Qualified Product List" for low-slope roof products.
   C. Energy Performance: Provide roofing system with initial solar reflectance not less than 0.70 and emissivity not less than 0.75 when tested according to CRRC-1.

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of product indicated.
   B. LEED Submittals:
      1. Product Data for Credit SS 7.2: For roof materials, indicating that roof materials comply with Solar Reflectance Index requirement.
      2. Product Data for Credit IEQ 4.1: For adhesives and sealants used inside the weatherproofing system, documentation including printed statement of VOC content.
      3. Laboratory Test Reports for Credit IEQ 4: For adhesives and sealants used inside the weatherproofing system, documentation indicating that they comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
   C. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other work.
   D. Samples for Verification: For the following products:
      1. Sheet roofing, of color specified.
      2. Roof paver in each color and texture required.
1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer Certificates: Signed by roofing manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.

1. Submit evidence of compliance with performance requirements.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A firm that is authorized by membrane roofing system manufacturer to install manufacturer's product.

B. Source Limitations: Obtain components including roof insulation fasteners for membrane roofing system from source approved by membrane roofing manufacturer.

C. Exterior Fire-Test Exposure: ASTM E 108, \[Class A\] \[Class B\] \[Class C\]; for application and roof slopes indicated, as determined by testing identical membrane roofing materials by a qualified testing agency. Identify materials with markings of applicable testing agency.

D. Preinstallation Roofing Conference: Conduct conference at Project site or other location as coordinated by SRP PM.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard or customized form, without monetary limitation, in which manufacturer agrees to repair or replace components of membrane roofing system that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Include cost for 5-year warranty in base bid. Provide alternate pricing for 10, 15, and 20-year warranties from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 KEE MEMBRANE ROOFING


1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Thickness: 45 mils nominal or 60 mils, nominal

2.2 AUXILIARY MEMBRANE ROOFING MATERIALS

A. General: Auxiliary membrane roofing materials recommended by roofing system manufacturer for intended use, and compatible with membrane roofing.

1. Liquid-type auxiliary materials shall comply with VOC limits of AHJ.
2. Adhesives and sealants that are not on the exterior side of weather barrier shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

   a. Plastic Foam Adhesives: 50 g/L.
   b. Gypsum Board and Panel Adhesives: 50 g/L.
   c. Multipurpose Construction Adhesives: 70 g/L.
   d. Fiberglass Adhesives: 80 g/L.
   e. Single-Ply Roof Membrane Adhesives: 250 g/L.
   f. Other Adhesives: 250 g/L.
   g. PVC Welding Compounds: 510 g/L.
   h. Adhesive Primer for Plastic: 650 g/L.
   i. Single-Ply Roof Membrane Sealants: 450 g/L.
   j. Nonmembrane Roof Sealants: 300 g/L.
   k. Sealant Primers for Nonporous Substrates: 250 g/L.
   l. Sealant Primers for Porous Substrates: 775 g/L.

3. Adhesives and sealants that are not on the exterior side of weather barrier shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Sheet Flashing: Manufacturer's standard sheet flashing of same material, type, reinforcement, thickness, and color as KEE sheet membrane.

C. Bonding Adhesive: Manufacturer's standard.

D. Slip Sheet: Manufacturer's standard, of thickness required for application.

E. Metal Termination Bars: Manufacturer's standard, predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch thick; with anchors.

F. Metal Battens: Manufacturer's standard, aluminum hot-zinc-alloy-coated or hot-zinc-coated steel sheet, approximately 1 inch wide by 0.05 inch thick prepunched.
G. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening membrane to substrate, and acceptable to membrane roofing system manufacturer.

H. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, lap sealants, termination reglets, and other accessories.

2.3 SUBSTRATE BOARDS

A. Substrate Board: ASTM C 1278/C 1278M, cellulosic-fiber-reinforced, water-resistant fiberglass/foam substrate, 1/2 inch, or 5/8 inch thick.

B. Substrate Board: ASTM C 728, perlite board, 3/4 inch or 1 inch thick, seal coated.

C. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed to fasten substrate board to roof deck.

2.4 ROOF INSULATION

A. Polyisocyanurate Board Insulation: ASTM C 1289, [Type II, Class 1, Grade 2] [Type II, Class I, Grade 3], felt or glass-fiber mat facer on both major surfaces.

B. Composite Polyisocyanurate Board Insulation: ASTM C 1289, with factory-applied facing board on one major surface, as indicated below by type, and felt or glass-fiber mat facer on the other.

1. Type IV, cellulosic-fiber-insulating-board facer, Grade 2, 1/2 inch thick.
2. Type V, OSB facer, 7/16 inch (11 mm) thick.
3. Type VII, glass mat faced gypsum board facer, 1/4 inch thick.

C. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

2.5 INSULATION ACCESSORIES

A. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation to substrate, and acceptable to roofing system manufacturer.

1. Insulation Adhesive: Insulation manufacturer's recommended cold-applied adhesive formulated to attach roof insulation to substrate or to another insulation layer.
2.6 WALKWAYS

A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured walkway pads, approximately 3/16 inch thick, and acceptable to membrane roofing system manufacturer.

PART 3 - EXECUTION

3.1 SUBSTRATE BOARD

A. Install substrate board with long joints in continuous straight lines, perpendicular to roof slopes with end joints staggered between rows. Tightly butt substrate boards together.

1. Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof according to membrane roofing system manufacturers' written instructions.

3.2 INSULATION INSTALLATION

A. Coordinate installing membrane roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.

B. Comply with membrane roofing system and insulation manufacturer's written instructions for installing roof insulation.

C. Install tapered insulation under area of roofing to conform to slopes indicated.

D. Install insulation under area of roofing to achieve required thickness. When multiple layers are installed, each layer’s should be offset from previous layer joints a minimum of 6 inches in each direction.

E. Adhered Insulation: Install each layer of insulation and adhere to substrate as follows:

1. Prime surface of concrete deck with asphalt primer at rate of 3/4 gal./100 sq. ft. and allow primer to dry.
2. Set each layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
3. Set each layer of insulation in adhesive, firmly pressing and maintaining insulation in place.

F. Mechanically Fastened Insulation: Install each layer of insulation and secure to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.

1. Fasten insulation to resist uplift pressure at corners, perimeter, and field of roof.
G. Mechanically Fastened and Adhered Insulation: Install each layer of insulation and secure first layer of insulation to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.

1. Fasten first layer of insulation to resist uplift pressure at corners, perimeter, and field of roof.
2. Set each subsequent layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F of equiviscous temperature.
3. Set each subsequent layer of insulation in adhesive, firmly pressing and maintaining insulation in place.

H. Loosely Laid Insulation: Loosely lay insulation units over substrate.

I. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches (in each direction). Loosely butt cover boards together and fasten to roof deck.

1. Fasten cover boards to resist uplift pressure at corners, perimeter, and field of roof.

J. Install slip sheet over [insulation] and immediately beneath membrane roofing.

3.3 ADHERED MEMBRANE ROOFING INSTALLATION

A. Adhere membrane roofing over area to receive roofing and install according to membrane roofing system manufacturer's written instructions.

B. Accurately align membrane roofing and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.

C. Bonding Adhesive: Apply to substrate and underside of membrane roofing at rate required by manufacturer and allow to partially dry before installing membrane roofing. Do not apply to splice area of membrane roofing.

D. In addition to adhering, mechanically fasten membrane roofing securely at terminations, penetrations, and perimeter of roofing.

E. Apply membrane roofing with side laps shingled with slope of roof deck where possible.

F. Seams: Clean seam areas, overlap membrane roofing, and hot-air weld side and end laps of membrane roofing and sheet flashings according to manufacturer's written instructions to ensure a watertight seam installation.

1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of sheet membrane.
2. Verify field strength of seams a minimum of twice daily and repair seam sample areas.
3. Repair tears, voids, and lapped seams in roofing that does not comply with requirements.
3.4 MECHANICALLY FASTENED MEMBRANE ROOFING INSTALLATION

A. Mechanically fasten membrane roofing over area to receive roofing and install according to roofing system manufacturer's written instructions.

B. Accurately align membrane roofing and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.

C. Mechanically fasten or adhere membrane roofing securely at terminations, penetrations, and perimeter of roofing.

D. Apply membrane roofing with side laps shingled with slope of roof deck where possible.

E. In-Seam Attachment: Secure one edge of KEE sheet using fastening plates or metal battens centered within membrane seam and mechanically fasten KEE sheet to roof deck.

F. Seams: Clean seam areas, overlap membrane roofing, and hot-air weld side and end laps of membrane roofing and sheet flashings according to manufacturer's written instructions to ensure a watertight seam installation.
   1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of sheet membrane.
   2. Verify field strength of seams a minimum of twice daily and repair seam sample areas.
   3. Repair tears, voids, and lapped seams in roofing that does not comply with requirements.

3.5 BASE FLASHING INSTALLATION

A. Install sheet flashings and preformed flashing accessories and adhere to substrates according to membrane roofing system manufacturer's written instructions.

B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate and allow to partially dry. Do not apply to seam area of flashing.

C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.

D. Clean seam areas, overlap, and firmly roll sheet flashings into the adhesive. Hot-air weld side and end laps to ensure a watertight seam installation.

E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.
3.6 WALKWAY INSTALLATION

A. Flexible Walkways: Install walkway products in locations indicated. Heat weld to substrate or adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion.

C. Repair or remove and replace components of membrane roofing system where inspections indicate that they do not comply with specified requirements.

END OF SECTION 075416
SECTION 077200 - ROOF ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

   1. Roof curbs.
   2. Equipment supports.
   3. Roof hatches.
   4. Hatch-type heat and smoke vents.
   5. Dropout-type heat and smoke vents.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of roof accessory indicated.
B. Shop Drawings: For roof accessories.
C. Samples: For each exposed product and for each color and texture specified.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Roof plans, drawn to scale, and coordinating penetrations and roof-mounted items.
B. Warranty: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 WARRANTY

A. Special Warranty on Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair finishes or replace roof accessories that show evidence of deterioration of factory-applied finishes within 10 years from date of Substantial Completion.
PART 2 - PRODUCTS

2.1 METAL MATERIALS

A. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 coating designation.
   1. Mill-Phosphatized Finish: Manufacturer's standard for field painting.
   2. Factory Prime Coating: Where field painting is indicated, apply pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat, with a minimum dry film thickness of 0.2 mil.
   3. Exposed Coil-Coated Finish: Two-coat fluoropolymer finish; AAMA 621; system consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight.
   4. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil for topcoat.

B. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, AZ50 coated.
   1. Factory Prime Coating: Where field painting is indicated, apply pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat, with a minimum dry film thickness of 0.2 mil.
   2. Exposed Coil-Coated Finish: Two-coat fluoropolymer finish; AAMA 621; system consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight.
   3. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil for topcoat.

C. Aluminum Sheet: ASTM B 209, manufacturer's standard alloy for finish required, with temper to suit forming operations and performance required.
   1. Mill Finish: As manufactured.
   2. Factory Prime Coating: Where field painting is indicated, apply pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat, with a minimum dry film thickness of 0.2 mil.
   3. Clear Anodic Finish: AAMA 611, Class II, 0.010 mm or thicker.
   4. Color Anodic Finish: AAMA 611, Class II, 0.010 mm or thicker.
   5. Exposed Coil-Coated Finish: Two-coat fluoropolymer finish; AAMA 620; system consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight.
   6. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils.

D. Aluminum Extrusions and Tubes: ASTM B 221, manufacturer's standard alloy and temper for type of use, finished to match assembly where used, otherwise mill finished.

E. Stainless-Steel Sheet and Shapes: ASTM A 240/A 240M or ASTM A 666, Type 304.
F. Steel Shapes: ASTM A36/A36M, hot-dip galvanized according to ASTM A123/A123M unless otherwise indicated.

2.2 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.

B. Acrylic Glazing: ASTM D4802, thermoformable, monolithic sheet, manufacturer's standard, Type UVA (formulated with UV absorber), Finish 1 (smooth or polished).

C. Polycarbonate Glazing: Thermoformable, monolithic polycarbonate sheets manufactured by extrusion process, burglar-resistance rated according to UL 972 with an average impact strength of 12 to 16 ft-lbf/in. of width when tested according to ASTM D256, Method A (Izod).

D. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for aboveground use, acceptable to authorities having jurisdiction, containing no arsenic or chromium, and complying with AWPA C2; not less than 1-1/2 inches thick.

E. Security Grilles: 3/4-inch diameter, ASTM A1011/A1011M steel bars spaced 6 inches o.c. in one direction and 12 inches o.c. in the other; factory finished with manufacturer's or fabricator's standard, universal shop primer compatible with substrate and field-applied finish paint system indicated.

F. Fasteners: Roof accessory manufacturer's recommended fasteners suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners.

G. Sealants: As recommended by roof accessory manufacturer for installation indicated.

2.3 ROOF CURBS

A. Roof Curbs: Internally reinforced roof-curb units capable of supporting superimposed live and dead loads, including equipment loads and other construction indicated on Drawings; with welded or mechanically fastened and sealed corner joints and integrally formed deck-mounting flange at perimeter bottom.

   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following

   2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

      a. AES Industries, Inc.
b. Curbs Plus, Inc.
c. Custom Solution Roof and Metal Products.
d. Greenheck Fan Corporation.
e. LM Curbs.
f. Metallic Products Corp.
g. Milcor Inc.; Commercial Products Group of Hart & Cooley, Inc.
h. Pate Company (The).
i. Roof Products, Inc.
j. Safe Air of Illinois.
k. Thybar Corporation.
l. Vent Products Co., Inc.
m. <Insert manufacturer's name>.

B. Material: Zinc-coated (galvanized) or Aluminum-zinc alloy-coated steel sheet, 0.052 inch thick.
   1. Finish: Mill phosphatized or baked enamel or powder coat.
   2. Color: As selected by Architect from manufacturer's full range of color.

C. Material: Stainless-steel sheet, 0.078 inch thick.
   1. Finish: Manufacturer's standard.

D. Construction:
   1. Insulation: Factory insulated with 1-1/2-inch- thick glass-fiber board insulation.
   2. Liner: Same material as curb, of manufacturer's standard thickness and finish.
   3. Factory-installed wood nailer at top of curb, continuous around curb perimeter.
   4. On ribbed or fluted metal roofs, form deck-mounting flange at perimeter bottom to conform to roof profile.
   5. Fabricate curbs to minimum height of 12 inches unless otherwise indicated.
   6. Top Surface: Level around perimeter with roof slope accommodated by sloping the deck-mounting flange.
   7. Sloping Roofs: Where roof slope exceeds 1:48, fabricate curb with perimeter curb height tapered to accommodate roof slope so that top surface of perimeter curb is level. Equip unit with water diverter or cricket on side that obstructs water flow.
2.4 EQUIPMENT SUPPORTS

A. Equipment Supports: Internally reinforced metal equipment supports capable of supporting superimposed live and dead loads, including equipment loads and other construction indicated on Drawings; with welded or mechanically fastened and sealed corner joints and integrally formed deck-mounting flange at perimeter bottom.

1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

   a. AES Industries, Inc.
   b. Curbs Plus, Inc.
   c. Custom Solution Roof and Metal Products.
   d. Greenheck Fan Corporation.
   e. LM Curbs.
   f. Milcor Inc.; Commercial Products Group of Hart & Cooley, Inc.
   g. Pate Company (The).
   h. Roof Products, Inc.
   i. Thybar Corporation.
   j. Vent Products Co., Inc.
   k. <Insert manufacturer's name>.

B. Material: Zinc-coated (galvanized) or Aluminum-zinc alloy-coated steel sheet, 0.052 inch thick.

   1. Finish: Mill phosphatized, Baked enamel, or powder coat.
   2. Color: As selected by Architect from manufacturer's full range of color.

C. Material: Stainless-steel sheet, 0.078 inch thick.

   1. Finish: Manufacturer's standard or No. 2D, directional polish finish >.

D. Construction:

   1. Insulation: Factory insulated with 1-1/2-inch thick glass-fiber board insulation.
   2. Liner: Same material as equipment support, of manufacturer's standard thickness and finish.
   3. Factory-installed continuous wood nailers 5-1/2 inches wide at tops of equipment supports.
4. **Metal Counterflashing:** Manufacturer's standard, removable, fabricated of same metal and finish as equipment support.

5. On ribbed or fluted metal roofs, form deck-mounting flange at perimeter bottom to conform to roof profile.

6. Fabricate equipment supports to minimum height of 12 inches unless otherwise indicated.

7. **Sloping Roofs:** Where roof slope exceeds 1:48, fabricate each support with height to accommodate roof slope so that tops of supports are level with each other. Equip supports with water diverters or crickets on sides that obstruct water flow.

8. **Security Grille:** Provide where indicated.

### 2.5 ROOF HATCH

**A.** Roof Hatches: Metal roof-hatch units with lids and insulated single or double-walled curbs, welded or mechanically fastened and sealed corner joints, continuous lid-to-curb counterflashing and weatherlight perimeter gasketing and integrally formed deck-mounting flange at perimeter bottom.

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2. **Basis-of-Design Product:** Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   a. AES Industries, Inc.
   b. Babcock-Davis.
   c. Bilco Company (The).
   d. Bristolite Skylights.
   e. Custom Solution Roof and Metal Products.
   f. Dur-Red Products.
   g. Hi Pro International, Inc.
   h. J. L. Industries, Inc.
   i. Metallic Products Corp.
   j. Milcor Inc.; Commercial Products Group of Hart & Cooley, Inc.
   k. Naturalite Skylight Systems; Vistawall Group (The).
   l. Nystrom.
m. O'Keeffe's Inc.

n. Pate Company (The).

o. Precision Ladders, LLC.

p. <Insert manufacturer's name>.

B. Type and Size: Single-leaf lid, 30 by 54 inches.

C. Type and Size: Double-leaf lid, 72 by 96 inches.

D. Loads: Minimum 40-lbf/sq. ft external live load and 20-lbf/sq. ft. internal uplift load.

E. Hatch Material: Zinc-coated (galvanized) or Aluminum-zinc alloy-coated steel sheet, 0.079 inch thick.
   1. Finish: Mill phosphatized, baked enamel, or powder coat.
   2. Color: As selected by Architect.

F. Hatch Material: Aluminum sheet, 0.090 inch thick.
   1. Finish: Mill, Clear anodic, baked enamel or powder coat.
   2. Color: As selected by Architect.

G. Hatch Material: Stainless-steel sheet, 0.078 inch thick.
   1. Finish: Manufacturer's standard or No. 2D, directional polish finish.

H. Construction:
   1. Insulation: Glass-fiber or Polyisocyanurate board.
   2. Hatch Lid: Opaque, insulated, and double walled, with manufacturer's standard metal liner of same material and finish as outer metal lid.
   3. Hatch Lid: Glazed, insulated, and double walled, with manufacturer's standard metal liner of same material and finish as outer metal lid.
   4. Curb Liner: Manufacturer's standard, of same material and finish as metal curb.
   5. On ribbed or fluted metal roofs, form flange at perimeter bottom to conform to roof profile.
   6. Fabricate curbs to minimum height of 12 inches unless otherwise indicated.
   7. Sloping Roofs: Where slope or roof deck exceeds 1:48, fabricate curb with perimeter curb height that is tapered to accommodate roof slope so that top surfaces of perimeter curb are level. Equip hatch with water diverter or cricket on side that obstructs water flow.

I. Hardware: Galvanized-steel spring latch with turn handles, butt- or pintle-type hinge system, and padlock hasps inside and outside.
   1. Provide two-point latch on lids larger than 84 inches.
   2. Provide remote-control operation.
J. Safety Railing System: Roof-hatch manufacturer's standard system including rails, clamps, fasteners, safety barrier at railing opening, and accessories required for a complete installation; attached to roof hatch and complying with 29 CFR 1910.23 requirements and authorities having jurisdiction.

K. Ladder-Assist Post: Roof-hatch manufacturer's standard device for attachment to roof-access ladder. Post locks in place on full extension; release mechanism returns post to closed position.

2.6 HEAT AND SMOKE VENTS

A. Hatch-Type Heat and Smoke Vents: Manufacturer's standard, with single-walled insulated curbs, welded or mechanically fastened and sealed corner joints, integral condensation gutter, and cap flashing. Fabricate with insulated double-walled lid and continuous weathertight perimeter lid gaskets, and equip with automatic self-lifting mechanisms and UL-listed fusible links rated at 165 deg F.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

   a. Babcock-Davis.
   b. Bilco Company (The).
   c. Bristolite Skylights.
   d. Dur-Red Products.
   e. Hi Pro International, Inc.
   f. J. L. Industries, Inc.
   g. Milcor Inc.; Commercial Products Group of Hart & Cooley, Inc.
   h. Naturalite Skylight Systems; Vistawall Group (The).
   i. Nystrom.
   j. O'Keeffe's Inc.
   k. Pate Company (The).
   l. Western Canwell.
   m. <Insert manufacturer's name>.
3. Type and Size: Single-leaf lid, 30 by 54 inches.
4. Type and Size: Double-leaf lid, 72 by 96 inches.
   a. When release is actuated, lid shall open against 10-lbf/sq. ft wind load and lock in position.
6. Heat and Smoke Vent Standard: Provide units that have been tested and listed to comply with UL 793.
7. Curb, Framing, and Lid Material: Zinc-coated (galvanized) or Aluminum-zinc alloy-coated steel sheet, 0.079 inch thick.
   a. Finish: Mill phosphatized, baked enamel or powder coat.
   b. Color: As selected by Architect.
8. Curb, Framing, and Lid Material: Aluminum sheet, 0.090 inch thick.
   a. Finish: Mill phosphatized, baked enamel or powder coat.
   a. Color: As selected by Architect.
9. Curb, Framing, and Lid Material: Stainless-steel sheet, 0.078 inch thick.
   a. Finish: Manufacturer's standard or No. 2D, directional polish finish.
10. Construction:
    a. Insulation: Glass-fiber or Polyisocyanurate] board.
    b. Hatch Lid: Opaque, insulated, and double walled, with manufacturer's standard metal liner of same material and finish as outer metal lid.
    c. Hatch Lid: Glazed, insulated, and double walled, with manufacturer's standard metal liner of same material and finish as outer metal lid.
    d. Exterior Curb Liner: Manufacturer's standard, of same material and finish as metal curb.
    e. Fabricate curbs to minimum height of 12 inches unless otherwise indicated.
    f. Sloping Roofs: Where slope or roof deck exceeds 1:48, fabricate curb with perimeter curb height that is tapered to accommodate roof slope so that top surfaces of perimeter curb are level. Equip hatch with water diverter or cricket on side that obstructs water flow.
    g. Security Grille: Provide where indicated.
11. Hardware: Manufacturer's standard, corrosion resistant or hot-dip galvanized; with hinges, hold-open devices, and independent manual-release devices for inside and outside operation of lids.
B. Dropout-Type Heat and Smoke Vents: Manufacturer's standard, gravity operated and automatic; with single-walled insulated curbs and frame, welded or mechanically fastened and sealed corner joints, integral condensation gutter, cap flashing, and heat-sensitive dome glazing that will deform and drop out of vent opening according to heat and smoke vent standard indicated.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   a. Construction Specialties, Inc.
   b. Naturalite Skylight Systems; Vistawall Group (The).
   c. Pate Company (The).
   d. Plasteco, Inc.
   e. <Insert manufacturer's name>.


4. Heat and Smoke Vent Standard: Provide units that have been tested and listed to comply with UL 793 and are FM Approved.

5. Curb and Framing Material: Zinc-coated (galvanized) or Aluminum-zinc alloy-coated steel sheet, 0.079 inch thick.
   a. Finish: Mill phosphatized, baked enamel or powder coat.
   b. Color: As selected by Architect.

6. Curb and Framing Material: Aluminum sheet, 0.090 inch thick.
   a. Finish: Mill, Clear anodic, baked enamel or powder coat.
   b. Color: As selected by Architect from manufacturer's full range.

7. Curb and Framing Material: Stainless-steel sheet, 0.078 inch thick.
   a. Finish: Manufacturer's standard or No. 2D, directional polish finish.

8. Construction:
   a. Insulation: Glass-fiber or Polyisocyanurate board.
   b. Exterior Curb Liner: Manufacturer's standard, of same material and finish as metal curb.
   c. Fabricate curbs to minimum height of 12 inches unless otherwise indicated.
   d. Sloping Roofs: Where slope of roof deck exceeds 1:48, fabricate curb with perimeter curb height that is tapered to accommodate roof slope so that top surfaces of perimeter curb are level. Equip unit with water diverter or cricket on side that obstructs water flow.

9. Hardware: Manufacturer's standard, corrosion resistant or hot-dip galvanized; with hinges, hold-open devices, and independent manual-release devices for inside and outside operation of lids.
PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Verify dimensions of roof openings for roof accessories. Install roof accessories according to manufacturer's written instructions.

1. Install roof accessories level, plumb, true to line and elevation, and without warping, jogs in alignment, excessive oil canning, buckling, or tool marks.
2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.

B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.

1. Coat concealed side of uncoated aluminum and stainless-steel roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
2. Underlayment: Where installing roof accessories directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet, or install a course of polyethylene sheet.

C. Security Grilles: Weld bar intersections and, using tamper-resistant bolts, attach the ends of bars to structural frame or primary curb walls.

D. Seal joints with sealant as required by roof accessory manufacturer.

3.2 REPAIR AND CLEANING

A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing according to ASTM A 780.

B. Touch up factory-primed surfaces with compatible primer ready for field painting according to Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

C. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION 077200
SECTION 078413 – PENETRATION FIRESTOPPING

PART 1 GENERAL

1.01 SECTION INCLUDES:
   A. Work, in general includes furnishing and installation of those fire and smoke penetration seals for openings in floors, walls and other elements of construction that are in accordance with ASTM E-814, E-119 and/or UL-1479, UL-263.

1.02 RELATED WORK:
   A. Coordination of the sections listed below with this section includes, but is not limited to:
      1. Division 3, Concrete
      2. Division 4, Masonry
      3. Division 7, Thermal and Moisture Protection
      4. Section 09220 - Plaster and Stucco Finishes
      5. Section 09620 - Gypsum Drywall
      6. Division 15 & 16, Mechanical, Plumbing and Electrical

1.03 RELATED DOCUMENTS:
   A. Drawings and general provisions of contract including supplementary conditions that apply to any work specified in this section.
   B. The extent of work is shown and shall include, but not be limited to:
      1. Firestop sealants
      2. Firestop mortar
      3. Firestop pillows
      4. Firestop devices and wrap strip
      5. Firestop silicone foam
      6. Firestop safing with elastomeric smoke seal

1.04 QUALITY ASSURANCE:
   A. Applicator Qualifications: Minimum two years experience installing UL classified firestopping or manufacturer certification.
   B. Standards: All firestop systems shall have an F (flame) rating and T (temperature) rating conforming to applicable building codes and in accordance with project drawings and specifications
   C. Single Source Responsibility for Firestopping: Obtain firestopping materials from a single manufacturer for each different product required.

1.05 SUBMITTALS:
   A. Shop Drawings: Submit shop drawings or manufacturer’s detail sheets showing each condition that requires a penetration or joint seal. These details must be in accordance with the proposed approved system. Details must include materials to be used, anchorage, methods of installation and relationship to all adjacent construction.
   B. Manufacturer’s Data: Submit copies of all manufacturer’s specification data, recommendations and installation instructions for each type of material required.

1.06 DELIVERY, STORAGE AND HANDLING:
   A. General:
      1. All materials shall be delivered and stored in original, unopened and clearly labeled containers. Containers shall list the name of the manufacturer and bear proper UL label.
      2. Materials shall be stored and protected from environmental conditions as required by manufacturer.

1.07 PROJECT CONDITIONS:
A. **Existing Conditions:** Installer shall verify that existing conditions and substrates conform to manufacturer’s requirements before starting work. Unsatisfactory conditions must be corrected before proceeding.

**PART 2 PRODUCTS**

**2.01 MATERIALS:**
A. **General:** Provide firestop and accessory materials with fire resistance rating indicated which are identical to those assemblies whose fire endurance has been determined by testing per ASTM E814 or E119, by Underwriters Laboratory, Inc., or other testing and inspecting agency acceptable to authorities having jurisdiction.

**2.02 FIRESTOP SEALANTS:**
A. **General:**
1. All materials shall comply with ASTM E814 or E119 (UL 1479) and shall be manufactured of non-toxic, non-hazardous, asbestos-free materials and unaffected by water or moisture when cured.
2. **Primers:** Conform to manufacturer’s recommendations for primers required for various substrates and conditions.
3. **Back-up Materials:** Back-up materials, supports and anchoring devices shall be provided as required by UL testing.
B. **Silicone Sealant:** One-part, low modulus, moisture curing silicone capable of withstanding movement of 50% in extension and 50% in compression in service.
C. **Ceramic Fiber Sealant:** One-part, moisture curing, water-based ceramic fiber sealant, unaffected by moisture or frost when cured, with a melting point not less than 3000 degrees F.
D. **Intumescent Sealant:** One-part, water-based graphite intumescent sealant, unaffected by moisture or frost when cured.
E. **Intumescent Wrap Strips:** Solvent-free, graphite-based intumescent wrap strip unaffected by water, frost or UV.
F. **Intumescent Putty:** Water-based graphite, water-resistant intumescent putty.
G. **Fire Prevention Mortar:** Hydraulic, fire-resistant, cementitious mortar.
H. **Firestop Pillows:** Semi-intumescent, dust-free fiberglass pillows, impervious to water, humidity, frost and light.
I. **Fire-Resistive Joint Sealant and Safing:** Ceramic fiber or mineral wool joint filler strips or blankets of sizes and shapes recommended by manufacturer, specifically for increasing fire resistance or endurance of joint systems with elastomeric smoke seal consisting of a polyurethane, silicone or acrylic meeting ASTM C-920, Class 25 and capable of withstanding movement of 25% in extension and compression in service.

**PART 3 EXECUTION**

**3.01 EXAMINATION:**
A. **General:** Examine joints and openings indicated to receive firestop sealers, with installer present, for compliance with requirements for proper configuration, installation tolerances and other conditions affecting firestop performance. Do not proceed with installation of firestop sealers until unsatisfactory conditions have been corrected.

**3.02 PREPARATION:**
A. **Surface Cleaning of Openings:** Clean out openings and joints immediately before installing firestop sealers to comply with recommendations of firestop manufacturer.

**3.03 INSTALLATION:**
A. **General:**
1. Apply in strict accordance with manufacturer’s recommendations to provide F and T rated seal as required.
2. Apply firestops with sufficient pressure to properly fill and seal openings, then tool or trowel exposed surfaces.

3.04 FIELD QUALITY CONTROL:
A. All sealed areas should be inspected by an appointed code official and the General Contractor to ensure proper installation. All sealed areas should remain accessible until inspection by applicable authorities has been completed.

3.05 CLEAN-UP:
A. General:
1. Clean adjacent surfaces immediately and leave work neat and clean.
2. Remove excess materials using recommended procedures as work progresses.
3. Remove dams after initial set of firestops as required.

3.06 SYSTEM TYPES:
A. Use system listed below that best matches the wall and floor construction.
1. Single metal pipe or conduit penetrations:
   - ULC designations: SP-143, SP-144, SP-169, SP-173, SP-178, SP-236, SP-237, SP-254, SP-255, SP-256, SP-257
2. Multiple metal pipe or conduit penetration:
   - UL designations: C-AJ-1047, W-L-1020, W-J-1012
   - ULC designations: SP-179, SP-180, SP-231, SP-232, SP-233, SP-234, SP-236, SP-237, SP-256
3. Multiple mixed metal and plastic pipe or conduit penetrations:
   - UL designations: C-AJ-8034
4. Insulated metal pipe penetrations:
   - ULC designations: SP-145, SP-146, SP-179, SP-180, SP-236, SP-237
5. Plastic pipe or conduit penetrations:
6. Cable penetrations:
   - ULJ designations: SP-170, SP-171, SP-172, SP-207, SP-231, SP-232, SP-234, SP-235, SP-238, SP-254, SP-255
7. Cable tray penetrations:
   - UL designations: C-AJ-4018, W-J-4005, C-AJ-4007
8. Busways:
   - UL designations: C-AJ-6007
9. Metal duct:
   - UL designations: C-AJ-7005
10. Blank openings:
    - UL designations: C-AJ-0026, C-AJ-0011
    - ULC designations: SP-147, JF-18, JF-19, JF-20, JF-21, JF-22
11. Fire-rated joints:
    - Omega Point: Report #95172
    - ULC designations: JF-19, JF-20, JF-21, JF-22, JF-18, JF-4, JF-5, JF-6, JF-32, JF-33, JF-34

END SECTION
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Penetration Firestopping
SECTION 07920 - JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Silicone joint sealants.
2. Urethane joint sealants.
3. Latex joint sealants.
4. Preformed joint sealants.
5. Acoustical joint sealants.

1.2 PRECONSTRUCTION TESTING

A. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers samples of materials that will contact or affect joint sealants. Use manufacturer's standard test method to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.


1.3 ACTION SUBMITTALS

A. Product Data: For each joint-sealant product indicated.

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For sealants and sealant primers used inside the weatherproofing system, documentation including printed statement of VOC content.
2. Laboratory Test Reports for Credit IEQ 4: For sealants and sealant primers used inside the weatherproofing system, documentation indicating that they comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Samples: For each kind and color of joint sealant required.

D. Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.

1.4 INFORMATIONAL SUBMITTALS

A. Product test reports.
B. Preconstruction compatibility and adhesion test reports.
C. Preconstruction field-adhesion test reports.
D. Field-adhesion test reports.
E. Warranties.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM C 1021 to conduct the testing indicated.
B. Preinstallation Conference: Conduct conference at Project site with SRP PM present.

1.6 WARRANTY

A. Special Installer's Warranty: Manufacturer's standard form in which Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer's standard form in which joint-sealant manufacturer agrees to furnish joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. VOC Content of Interior Sealants: Sealants and sealant primers used inside the weatherproofing system shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

1. Architectural Sealants: 250 g/L.
2. Sealant Primers for Nonporous Substrates: 250 g/L.
3. Sealant Primers for Porous Substrates: 775 g/L.

B. Low-Emitting Interior Sealants: Sealants and sealant primers used inside the weatherproofing system shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Liquid-Applied Joint Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied joint sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.

1. Suitability for Immersion in Liquids. Where sealants are indicated for Use I for joints that will be continuously immersed in liquids, provide products that have undergone testing according to ASTM C 1247. Liquid used for testing sealants is deionized water, unless otherwise indicated.

D. Stain-Test-Response Characteristics: Where sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.

E. Suitability for Contact with Food: Where sealants are indicated for joints that will come in repeated contact with food, provide products that comply with 21 CFR 177.2600.

2.2 SILICONE JOINT SEALANTS

A. Mildew-Resistant, Neutral-Curing Silicone Joint Sealant: ASTM C 920.
   a. Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      b. BASF Building Systems.
      c. Dow Corning Corporation.
      d. GE Advanced Materials - Silicons.
      e. May National Associates, Inc.
      f. Pecora Corporation.
      g. Polymeric Systems, Inc.
      h. Schnee-Morehead, Inc.
      i. Sika Corporation; Construction Products Division.
      j. Tremco Incorporated.

2. Type: Single component (S) or multicomponent (M).
3. Grade: [Pourable (P)] or [nonsag (NS)].
4. Class: [100/50] [50] [25].
5. Uses Related to Exposure: Traffic (T) Nontraffic (NT).
2.3  URETHANE JOINT SEALANTS

A. Urethane Joint Sealant: ASTM C 920.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      a. BASF Building Systems.
      b. Bostik, Inc.
      d. May National Associates, Inc.
      e. Pacific Polymers International, Inc.
      f. Pecora Corporation.
      g. Polymeric Systems, Inc.
      h. Schnee-Morehead, Inc.
      i. Sika Corporation; Construction Products Division.
      j. Tremco Incorporated.

2. Type: Single component (S) or multicomponent (M).
3. Grade: [Pourable (P)] or [nonsag (NS)].
4. Class: [100/50] [50] [25].
5. Uses Related to Exposure: Traffic (T) Nontraffic (NT).

2.4  LATEX JOINT SEALANTS

A. Latex Joint Sealant: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      a. BASF Building Systems.
      b. Bostik, Inc.
      c. May National Associates, Inc.
      d. Pecora Corporation.
      e. Schnee-Morehead, Inc.
      f. Tremco Incorporated.

2.5  PREFORMED JOINT SEALANTS

A. Preformed Foam Joint Sealant: Manufacturer's standard preformed, precompressed, open-cell foam sealant manufactured from urethane foam with minimum density of 10 lb/cu. ft. and impregnated with a nondrying, water-repellent agent. Factory produce in precompressed sizes in roll or stick form to fit joint widths indicated; coated on one side with a pressure-sensitive adhesive and covered with protective wrapping.
1. **Basis-of-Design Product**: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   
   a. Dayton Superior Specialty Chemicals.
   b. EMSEAL Joint Systems, Ltd.
   c. Sandell Manufacturing Co.
   d. Schul International, Inc.
   e. Willseal USA, LLC.

2.6 **ACOUSTICAL JOINT SEALANTS**

   A. Acoustical Joint Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

   1. **Basis-of-Design Product**: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      
      a. Pecora Corporation.
      b. USG Corporation.
      c. <Insert manufacturer's name>.

2.7 **JOINT SEALANT BACKING**

   A. Cylindrical Sealant Backings: ASTM C 1330, **Type C (closed-cell material with a surface skin), Type O (open-cell material), Type B (bicellular material with a surface skin),** or any of the preceding types, when approved in writing by joint-sealant manufacturer for joint application indicated and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

   B. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer.

2.8 **MISCELLANEOUS MATERIALS**

   A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

   B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials.

   C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.
PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions.
   1. Remove laitance and form-release agents from concrete.
   2. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants.

B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.2 INSTALLATION

A. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

B. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
   1. Do not leave gaps between ends of sealant backings.
   2. Do not stretch, twist, puncture, or tear sealant backings.
   3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

C. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

D. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
   1. Place sealants so they directly contact and fully wet joint substrates.
   2. Completely fill recesses in each joint configuration.
   3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
E. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Remove excess sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
3. Provide concave joint profile per Figure 8A in ASTM C 1193, unless otherwise indicated.

F. Acoustical Sealant Installation: Comply with ASTM C 919 and with manufacturer's written recommendations.

G. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.3 FIELD QUALITY CONTROL

A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:

1. Extent of Testing: Test completed and cured sealant joints as follows:
   a. Perform two tests for the first 1000 feet of joint length for each kind of sealant and joint substrate.
   b. Perform 1 test for each 1000 feet of joint length thereafter or 1 test per each floor per elevation.


B. Evaluation of Field-Adhesion Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.4 JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application: Exterior joints in horizontal traffic surfaces.

1. Joint Locations:
   a. Control and expansion joints in brick pavers.
   b. Isolation and contraction joints in cast-in-place concrete slabs.
   c. Joints between plant-precast architectural concrete paving units.
   d. Joints in stone paving units, including steps.
e. Tile control and expansion joints.
f. Joints between different materials listed above.
g. Other joints as indicated.

5. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.


1. Joint Locations:
   b. Joints between plant-precast architectural concrete units.
   c. Control and expansion joints in unit masonry.
   d. Joints in dimension stone cladding.
   e. Joints in glass unit masonry assemblies.
   f. Joints in exterior insulation and finish systems.
   g. Joints between metal panels.
   h. Joints between different materials listed above.
   i. Perimeter joints between materials listed above and frames of doors, windows, and louvers.
   j. Control and expansion joints in ceilings and other overhead surfaces.
   k. Other joints as indicated.

5. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

C. Joint-Sealant Application: Interior joints in horizontal traffic surfaces.

1. Joint Locations:
   b. Control and expansion joints in stone flooring.
   c. Control and expansion joints in brick flooring.
   d. Control and expansion joints in tile flooring.
   e. Other joints as indicated.

5. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
D. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces

1. Joint Locations:
   a. Control and expansion joints on exposed interior surfaces of exterior walls.
   b. Perimeter joints of exterior openings where indicated.
   c. Tile control and expansion joints.
   d. Vertical joints on exposed surfaces of interior unit masonry or concrete walls and partitions.
   e. Joints on underside of plant-precast structural concrete beams and planks.
   f. Perimeter joints between interior wall surfaces and frames of interior doors windows and elevator entrances.
   g. Other joints as indicated.

4. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

E. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces.

1. Joint Sealant Location:
   a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
   b. Tile control and expansion joints where indicated.
   c. Other joints as indicated.

4. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

F. Joint-Sealant Application: Interior acoustical joints in vertical surfaces and horizontal nontraffic surfaces.

1. Joint Location:
   a. Acoustical joints where indicated.
   b. Other joints as indicated.

4. Joint-Sealant Color: As selected by Architect from manufacturer's full range.

END OF SECTION 079200
SECTION 081113 - HOLLOW METAL DOORS

PART 1 GENERAL

1.01 SECTION INCLUDES:
A. The work of this section shall include all labor, materials, equipment and services required and necessary to furnish and install all hollow metal doors as indicated and specified.
B. Hollow metal doors and hollow metal frames shall be by the same manufacturer/supplier.

1.02 APPLICABLE REQUIREMENTS
A. All materials and services provided shall comply with provisions of the following specifications and standards:
   3. Steel Door Institute (SDI).
   5. Underwriter's Laboratories, Inc. (UL).
   Where provisions of pertinent codes, specifications, or standards conflict with this Section, the more stringent provisions shall govern.

1.03 SUBMITTALS
A. Submit Product Data Sheets, shop drawings, and directions for installation of hardware.
B. Provide the following information on all doors and other related materials specified in the construction documents:
   1. Elevation of all doors, and door frames.
   2. Hardware reinforcing details of doors.
   3. Door location schedule.
   4. Complete door descriptive nomenclature.
   5. Material description and gauges.
   6. Hardware preparation locations.
   7. Louver and vision panel details (if applicable).
C. Contractor shall use same door, frame and opening designations on shop drawings as indicated on contract documents, with provision for Cross-reference of Shop Drawings to Construction Documents.

1.04 QUALITY ASSURANCE
A. Regulatory Requirements
   1. OSHA Compliance - All articles and services covered by this specification shall meet or exceed the safety standards established under the Federal Occupational Safety and Health Act, latest edition, together with all amendments in effect as of the date of this specification.
   2. ADA Compliance - All layouts covered by this section shall meet or exceed the requirements of the Uniform Federal Accessibility Standards and the Arizonans With Disabilities Act.
B. Certification
   1. Fire Rated Assemblies - Submit manufacturer's written statement that construction of doors is in accordance with requirements for label rating indicated on drawings and/or as required by code.
   2. Product Data - Submit, for approval, manufacturer's literature for prime paint, and description of shop painting method and system.

1.05 DELIVERY, STORAGE AND HANDLING
A. Package, deliver, store and handle doors and frames in a manner to prevent damage and deterioration.

B. Store doors upright in a protected dry area, above ground, with each unit separated at least 1/4" for air circulation.

PART 2 PRODUCTS

2.01 COMPONENTS

A. Hollow Metal Doors

1. Hollow metal doors shall be flush type, 1-3/4" thick.

2. Hollow metal door face sheets shall be 18 gauge on all doors. Sheet steel shall be cold or hot rolled conforming to ASTM A366 or A569.

3. Door stiffeners (or cores) - Doors shall be stiffened by one of the following:
   a. Vertical stiffeners, 20 gauge steel; 6" on center, full height of doors. Weld to face sheets 4" on center. Sound deadening insulation between ribs, consisting of noncombustible fiberglass, rock wool or equivalent.
   b. Water-resistant resin-impregnated kraft honeycomb core stiffener, laminated to both face sheets with water-resistant adhesive.
   c. Expanded foam core, self-extinguishing; resistant to vermin, mildew and rot. Bonded to face panels with thermosetting adhesive.

4. End channels - 16 gauge steel.

5. Reinforcements
   a. For mortise hardware - 3/16" thick steel.
   b. For surface hardware - 3/16" thick steel.
   c. For strikes - 12 gauge steel or equal thread depth metal reinforcement.

6. Noise insulated doors - Doors noted as NC in door schedules shall be completely filled with self-extinguishing rigid urethane core formed in place and chemically bonded to all interior door faces.

7. Provide louver, grille and vision panel openings with loose 20 gauge formed steel channel stops having recessed screws for flush countersunk installation.

8. Vision panels, in non-fire-rated doors, shall be 8 inches wide and 28 inches high; with a 6 inch side stile and head rail at edge of door.

9. Exterior doors and doors noted as NC shall have automatic door bottom seals, surface mounted, number 365 as manufactured by Zero International, Inc.

2.02 FABRICATION

A. Provide doors of size and design indicated. Doors shall be "full flush" type.

B. Fabrication shall conform to NAAMM or SDI standards and/or modifications contained in Construction Documents.

C. Accurately form metal to required sizes and profiles, including astragals where required.

D. Form and weld with sharp arises, edges and corners; surfaces shall be free from warp, waves, buckles, dents or other defects.

E. Close top and bottom edges by flush welding channels at exterior doors. Door bottom channels shall have the channel legs down. Provide "breather" holes in door bottoms.

F. Return face sheets on vertical edges of doors.

G. Cutouts
   1. Provide cutouts where indicated for louvers and vision panels. Provide removable channel frame type stops on interior side, with recessed head screw anchors. Stops on exterior or outside face shall be formed integrally with door face.
   2. Stops shall be sized to receive louvers and/or vision panels as indicated by the contract documents.

H. Welding
   1. All welding shall conform to applicable AWS standards for hollow metal work.
   2. Weld all connections between component metal parts.
   3. Weld exposed joints and seams continuously full and grind smooth. No visible joints or seams on face or vertical edges.
I. Labeled doors - Conform with UL requirements for all labeled door construction. Doors shall bear label for fire-resistive rating indicated in schedules. Locate label on hinge edge of door.

J. Preparation for Hardware
   1. Reinforce and prepare doors for specified hardware.
   2. Make cutouts and mortises for mortise hardware. Drilling and tapping for mortise hardware shall be done in the factory to approved hardware templates.
   3. Provide 3/16" thick steel reinforcement for hinges.
   4. Provide 14 gauge reinforcement for surface applied hardware.
   5. Reinforce all doors for door closers.
   6. Bevel lock stiles 1/8" in 2" unless otherwise noted.
   7. Drilling and tapping for surface applied hardware will be done in field by door installer.

K. Clearances
   1. Head - 1/8"
   2. Stiles - 3/32"
   3. Meeting stiles (pair doors) - 1/8"
   4. Over threshold - 3/16" or as detailed
   5. Over finish floor material - 3/8"

2.03 FINISHES
   A. Door pieces shall be processed through a power spray washer to clean and phosphatize the steel.
   B. After the power wash, the door pieces shall be dried in a forced hot air dry-off oven and then painted with a primer in a dip priming tank. The pieces shall be completely immersed in the paint, then withdrawn, allowed to drain and then oven baked. The minimum dry film thickness for one coat of prime paint shall be 0.7 mil.
   C. The primer shall be lead-free and contain rust inhibiting pigments and exhibit excellent adhesion to the base metal. The purpose of the primer coat is to provide a preparatory base for finish painting and to protect the metal surface until the top coat is applied.
   D. The baked primer shall meet ANSI Standard A224.1-1980 for salt spray test of 120 hours, humidity test of 240 hours with 20 inch lbs direct impact (1/2" ball).

PART 3 EXECUTION

3.01 EXAMINATION
   A. Examine the areas and conditions under which work of this Section will be installed. Verify that work of other trades is sufficiently complete and in the proper condition to receive the work of this Section.
   B. Coordinate with other trades as required to assure proper and adequate provision in the work of those trades for interface with the work of this Section.

3.02 INSTALLATION
   A. Install standard steel doors and accessories in accordance with final Shop Drawings and manufacturer's data and as herein specified.
   B. Fit hollow metal doors accurately in frames, within clearances specified in SDI-100 and in this specification. Fitting by reducing metal thickness shall not be acceptable.
   C. Place fire-rated doors with clearances as specified in NFPA Standard No. 80 and UL requirements.
   D. Install hardware in accordance with drawings and hardware manufacturer's templates and instructions.
   E. Adjust operable parts for correct function.
   F. Remove hardware, except prime-coated items, tag, box and reinstall after finish painting has been completed.

3.03 ADJUSTING
   Check and readjust operating finish hardware items, leaving steel doors and frames undamaged and in complete and proper operating condition.

3.04 CLEANING
A. Prime Coat Touch-up - Immediately after erection, sand smooth any rusted or damaged areas of prime coat and apply touch-up of compatible air-drying primer. Remove all rust before above specified touch-up is applied.

B. When work of this Section has been completed, and at such other times as may be directed, remove all trash, debris, surplus materials, tools and equipment from site.

END SECTION
SECTION 081416 - WOOD DOORS

PART 1 GENERAL

1.01 SECTION INCLUDES:
A. The work of this section shall include all labor, material equipment and services required and necessary to furnish and install all wood doors as indicated or specified.

1.02 REFERENCES
A. The materials, products and installation of items provided as part of this section work shall be in conformance with the following referenced standards and specifications as applicable:
1. ANSI - American National Standards Institute
2. AWI - American Woodwork Institute
3. NWMA - National Woodwork Manufacturers Association
4. WDHS - Wood Door Hardware Standards

1.03 SUBMITTALS
A. Submit manufacturer's product, data sheets, installation, instructions and maintenance procedures for each type of door.
B. Submit samples of each color, finish and pattern indicated by the Contract Documents.
C. Submit details of core and edge construction, trim for openings and louvers and similar components.
D. Submit certifications to show compliance with specifications and plans.
E. Submit product data on required preservative treatment.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING
A. Delivery of Materials:
1. Door shall not be delivered to the Site until the entire building is weather tight and has been free from dampness due to the plastering, gypsum wall board finishing or other moisture producing work for at least ten days.
2. Protect doors during transit by enveloping each unit in an individual cover. Pallet-loads of doors shall be provided with covers and skids to protect materials from transit damage.
3. Doors and protective covers shall be individually marked in accordance with approved Shop Drawing designations.
B. Storage of Materials, Equipment and Fixtures:
1. Comply with the "On-Site Care" recommendations of NWMA pamphlet, "Care and Finishing of Wood Doors," and with the manufacturers instructions.

1.05 GUARANTEE
A. Furnish wood doors with the door manufacturer's warranty covering defects in materials and workmanship. Duration of warranty shall be as follows: solid core doors, interior - lifetime.

PART 2 PRODUCTS

2.01 MATERIALS
A. Wood doors shall be custom grade in accordance with the Architectural Woodwork Institute brochure, "Flush Doors," and the National Woodwork Manufacturers Association Publication I.S.1, "Wood Flush Doors." Face veneer of doors shall be birch. Doors shall be manufactured by Eggers Hardwood Products Corp., Algoma Hardwoods, Graham Manufacturing, Weyerhauser Company, or Glen-Mar. All of the doors furnished on the Project shall be by one manufacturer.
B. Solid core flush doors. All doors, other than fire-rated doors, sound insulating doors and hollow core doors shall be solid core flush doors, 1-3/4 inches (45 mm) thick as follows:
1. Core shall be Type SLC (glued block core).
2. Face veneers shall be sound grade.
C. Fire rated doors shall be Underwriters’ Laboratories labeled fire doors as follows for the label scheduled on the Drawings: (Except pairs of 1/3 hour labeled doors shall have Warnock Hersey Fire Laboratories’ Labels.)
   1. Fore "B" label (1 hour rating) - Use FD 1.
   3. For "20 Minute" label (1/3 hour rating) - Use FD 1/3.
      a. Pairs of doors shall have fire retardant treated wood edges to meet Warnock Hersey label requirements.
   4. Sixty and ninety minute fire rated doors in corresponding fire rated frames shall have producer's standard UL stiles for flush type, full mortise hinges and shall be installed in accordance with the requirements of NFPA Publication NO. 80, "Standard for Fire Doors and Windows."

D. Sound insulating doors shall be SR with face veneer to match that of solid core flush doors.
   1. Thickness shall be 1-3/4 inches (45 mm) with a sound transmission class of 36.

E. Dutch doors shall be of the same construction as solid core flush doors specified hereinbefore. Form counter shelf of 1-1/8 inch (30 mm) thick hardwood to match face veneer of doors, with proper jamb clearances and substantial supports. Shelf to project 8 inches (200 mm) unless otherwise indicated by Contract Documents.

2.02 ACCESSORIES
   A. Provide 18-gauge steel moldings for all doors with vision panels. Assembly shall be two-piece construction. Moldings shall be field installed. Moldings shall be finished to match the color of the door. Vision panels shall not in any way diminish the required fire rating of the doors.
   B. Cutouts shall be provided for louvers where indicated by Contract Documents. Provide fire rated louvers in fire rated doors to maintain rating required for door.

2.04 FINISHES
   Provide finish and color for each door as indicated by Contract Documents.

PART 3 EXECUTION

3.01 INSPECTION
   A. Examine door frames and verify that frames are of the correct type and have been installed as required for proper hanging of corresponding doors. Contractor shall notify Designated Representative in writing of conditions detrimental to the installation of wood doors. Hanging of doors shall not proceed until unsatisfactory conditions have been corrected as required for proper hanging of door.

3.02 PREPARATION
   A. Carefully prepare doors as required for all finish hardware. Obtain templates for use during machining. Verify hardware location and core type of door prior to machining.
   B. Acclimatize doors to the average prevailing humidity in the installation area prior to hanging wood doors.

3.03 INSTALLATION/APPLICATION/PERFORMANCE/ERECTION
   A. Condition doors to average prevailing humidity in installation area prior to hanging. Relative humidity should not be less than 30 percent or more than 60 percent.
   B. Install wood doors in accordance with manufacturer's instructions, finish hardware requirements and as indicated by Contract Documents.
   C. Align doors to frame for proper fit and uniform clearance at each edge. Fitting clearance shall not exceed 1/8 inch at sides and top. Coordinate door bottom fit with threshold requirements and adjacent flooring material heights.

3.04 ADJUSTING
   A. Rehang or replace doors which do not swing or operate freely as determined by the Designated Representative.

3.05 PROTECTION
A. Comply with door manufacturer's recommended procedures to protect installed wood doors from damage or deterioration until acceptance of work. Remove protection at completion of project work.

END SECTION
SECTION 083323 - OVERHEAD COILING DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. Service doors.
   2. Insulated service doors.
   3. Counter doors.
   4. Fire-rated service doors.
   5. Fire-rated, insulated service doors.
   6. Fire-rated counter doors.

B. Related Section:
   1. Section 055000 "Metal Fabrications" for miscellaneous steel supports.

1.2 PERFORMANCE REQUIREMENTS

A. Structural Performance, Exterior Doors: Exterior overhead coiling doors shall withstand the wind loads, the effects of gravity loads, and loads and stresses within limits and under conditions indicated according to SEI/ASCE 7.


B. Windborne-Debris-Impact-Resistance Performance: Provide glazed and impact-protective overhead coiling doors that pass missile-impact and cyclic-pressure tests when tested according to ASTM E 1886 and ASTM E 1996.

C. Seismic Performance: Overhead coiling doors shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

1.3 ACTION SUBMITTALS

A. Product Data: For each type and size of overhead coiling door and accessory.

B. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data. Include plans, elevations, sections, details, and attachments to other work.

C. Samples: For each exposed product and for each color and texture specified.
1.4 INFORMATIONAL SUBMITTALS
A. Oversize Construction Certification: For door assemblies required to be fire-rated and that exceed size limitations of labeled assemblies.

1.5 CLOSEOUT SUBMITTALS
A. Maintenance Data.

1.6 QUALITY CONTROL
A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for both installation and maintenance of units required for this Project.
B. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at as close to neutral pressure as possible according to NFPA 252.

PART 2 - PRODUCTS

2.1 DOOR CURTAIN MATERIALS AND CONSTRUCTION
A. Door Curtains: Fabricate overhead coiling-door curtain of interlocking metal slats, designed to withstand wind loading indicated, in a continuous length for width of door without splices. Unless otherwise indicated, provide slats of thickness and mechanical properties recommended by door manufacturer for performance, size, and type of door indicated, and as follows:
B. Bottom Bar for Service Doors: Consisting of two angles, each not less than 1-1/2 by 1-1/2 by 1/8 inch thick; fabricated from metal to match curtain slats and finish.
C. Bottom Bar for Counter Doors: Manufacturer's standard continuous channel or tubular shape, fabricated from metal to match curtain slats and finish.
D. Astragal for Interior Doors: Equip each door bottom bar with a replaceable, adjustable, continuous, compressible gasket of flexible vinyl, rubber, or neoprene as a cushion bumper.
E. Curtain Jamb Guides: Manufacturer's standard angles or channels and angles of same material and finish as curtain slats unless otherwise indicated, with sufficient depth and strength to retain curtain, to allow curtain to operate smoothly, and to withstand loading. Slot bolt holes for guide adjustment. Provide removable stops on guides to prevent overtravel of curtain.
1. Removable Posts and Jamb Guides for Counter Doors: Manufacturer's standard.
2.2 HOOD

A. General: Form sheet metal hood to entirely enclose coiled curtain and operating mechanism at opening head. Contour to fit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Form closed ends for surface-mounted hoods and fascia for any portion of between-jamb mounting that projects beyond wall face. Equip hood with intermediate support brackets as required to prevent sagging.

1. Include automatic drop baffle on fire-rated doors to guard against passage of smoke or flame.
2. Exterior-Mounted Doors: Fabricate hood to act as weather protection and with a perimeter sealant-joint-bead profile for applying joint sealant.

2.3 LOCKING DEVICES

A. Slide Bolt: Fabricate with side-locking bolts to engage through slots in tracks for locking by padlock, located on both left and right jamb sides, operable from coil side.

B. Locking Device Assembly: Fabricate with 5 pin tumbler single unit mechanism.

C. Chain Lock Keeper: Suitable for padlock.

D. Safety Interlock Switch: Equip power-operated doors with safety interlock switch to disengage power supply when door is locked.

2.4 CURTAIN ACCESSORIES

A. Smoke Seals: Equip each fire-rated door with smoke-seal perimeter gaskets for smoke and draft control as required for door listing and labeling by a qualified testing agency.

B. Weatherseals: Equip each exterior door with weather-stripping gaskets fitted to entire perimeter of door for a weathertight installation, unless otherwise indicated.

C. Push/Pull Handles: Equip each push-up-operated or emergency-operated door with lifting handles on each side of door, finished to match door. Provide pull-down straps or pole hooks for doors more than 84 inches high.

D. Automatic-Closing Device for Fire-Rated Doors: Equip each fire-rated door with an automatic-closing device that is inoperative during normal door operations and that has a governor unit complying with NFPA 80 and an easily tested and reset release mechanism designed to be activated by the following:

1. Replaceable fusible links with temperature rise and melting point of 165 deg F interconnected and mounted on both sides of door opening.
2. Manufacturer's standard UL-labeled smoke detector and door-holder-release devices.
3. Manufacturer's standard UL-labeled heat detector and door-holder-release devices.

2.5 COUNTERBALANCING MECHANISM

A. General: Counterbalance doors by means of manufacturer's standard mechanism with an adjustable-tension, steel helical torsion spring mounted around a steel shaft and contained in a spring barrel connected to top of curtain with barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.

B. Brackets: Manufacturer's standard mounting brackets of either cast iron or cold-rolled steel plate.

2.6 MANUAL DOOR OPERATORS

A. Equip door with manufacturer's recommended manual door operator unless another type of door operator is indicated.

B. Chain-Hoist Operator: Consisting of endless steel hand chain, chain-pocket wheel and guard, and gear-reduction unit with a maximum 25 lbf force for door operation. Provide alloy-steel hand chain with chain holder secured to operator guide.

2.7 ELECTRIC DOOR OPERATORS

A. General: Electric door operator assembly of size and capacity recommended and provided by door manufacturer for door specified, with electric motor and factory-prewired motor controls, starter, gear-reduction unit, solenoid-operated brake, clutch, remote-control stations, control devices, integral gearing for locking door, and accessories required for proper operation.

1. Comply with NFPA 70.
2. Provide control equipment complying with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6, with NFPA 70 Class 2 control circuit, maximum 24 V, ac or dc.

B. Usage Classification: Electric operator and components capable of operating for not less than number of cycles per hour indicated for each door.

C. Electric Motors: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 110513 "Common Motor Requirements for Equipment" unless otherwise indicated.

1. Electrical Characteristics:
   a. Phase: Single phase [Polyphase].
   b. Volts: 208 [480] V.
   c. Hertz: 60.
2. Motor Type and Controller: Reversible motor and controller (disconnect switch) for motor exposure indicated.
3. Motor Size: Minimum size as indicated. If not indicated, large enough to start, accelerate, and operate door in either direction from any position, at a speed not less than 8 in./sec. and not more than 12 in./sec., without exceeding nameplate ratings or service factor.
4. Operating Controls, Controllers (Disconnect Switches), Wiring Devices, and Wiring: Manufacturer's standard unless otherwise indicated.

D. Obstruction Detection Device: Equip motorized door with indicated external automatic safety sensor capable of protecting full width of door opening
   1. Photoelectric Sensor: Manufacturer's standard system designed to detect an obstruction in door opening without contact between door and obstruction.
   2. Sensor Edge: Automatic safety sensor edge, located within astragal or weather stripping mounted to bottom bar. Contact with sensor activates device. Connect to control circuit using manufacturer's standard take-up reel or self-coiling cable.

E. Remote-Control Station: Momentary-contact, three-button control station with push-button controls labeled "Open," "Close," and "Stop."
   1. Interior units, full-guarded, surface-mounted, heavy-duty type, with general-purpose NEMA ICS 6, Type 1 enclosure.
   2. Exterior units, full-guarded, standard-duty, surface-mounted, weatherproof type, NEMA ICS 6, Type 4 enclosure, key operated.


G. Emergency Operation Disconnect Device: Equip operator with hand-operated disconnect mechanism for automatically engaging manual operator and releasing brake for emergency manual operation while disconnecting motor without affecting timing of limit switch. Mount mechanism so it is accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.

H. Motor Removal: Design operator so motor may be removed without disturbing limit-switch adjustment and without affecting emergency manual operation.

I. Audible and Visual Signals: Audible alarm and visual indicator lights in compliance with regulatory requirements for accessibility.

2.8 DOOR ASSEMBLY

A. [Service] [Insulated Service] [Counter] Door: Overhead coiling door formed with curtain of interlocking metal slats.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
a. Cookson Company.
b. Kinnear Corporation.
c. Overhead Door Corporation.
d. Pacific Rolling Door Company

e. Raynor.
f. Windsor Door.
g. <Insert manufacturer's name>.

B. Fire Rating: [3/4 hour] [1 hour] [1-1/2 hours] [3 hours] [4 hours] [with temperature-rise limit] [and] [with smoke control].

C. Curtain R-Value: 4.5 deg F x h x sq. ft./Btu.

D. Door Curtain Material: Aluminum.

E. Door Curtain Slats: Flat profile slats of [1-1/4-inch] [1-1/2-inch] [1-7/8-inch] [2-5/8-inch] [3-1/4-inch] center-to-center height.

3. Vision Panels: Approximately 10- by 1-5/8-inch openings spaced approximately 2 inches apart and beginning 12 inches from end guides; in [two] [three] <Insert number> rows of slats at height indicated on Drawings; installed with [insulated] [fire-rated] vision-panel glazing.
4. Insulated-Slat Interior Facing: [Metal] [Plastic].

F. Curtain Jamb Guides: [Galvanized steel] [Stainless steel] [Aluminum] with exposed finish matching curtain slats. [Provide continuous integral wear strips to prevent metal-to-metal contact and to minimize operational noise.] Provide removable post(s) and jamb guides where shown on Drawings.

G. Hood: Match curtain material and finish.

1. Shape: As shown on Drawings.
2. Mounting: [Face of wall] [Between jambs] [As shown on Drawings].

H. Integral Frame, Hood, and Fascia for Counter Door: [Galvanized steel].

1. Mounting: [Face of wall] [Between jambs] [As shown on Drawings].

I. Sill Configuration for Counter Door: [No sill] [Integral metal sill] [Fire-rated, laminate counter].

J. Locking Devices: Equip door with [slide bolt for padlock] [locking device assembly] [and] [chain lock keeper].

1. Locking Device Assembly: [Single-jamb side] [Cremone type, both jamb sides] locking bars, operable from [inside with thumb turn] [outside with
cylinder] [outside only, with cylinder] [inside and outside with cylinders] 
<Insert requirement>.

K. Manual Door Operator: [Push-up operation] [Chain-hoist operator] [Manufacturer's standard crank operator] [Awning-crank operator] [Wall-crank operator].

L. Electric Door Operator:
1. Usage Classification: Standard duty, up to 60 cycles per hour
4. Obstruction-Detection Device: Automatic photoelectric sensor or electric sensor edge on bottom bar.
5. Remote-Control Station: Where shown on Drawings.

M. Door Finish:
1. Aluminum Finish: Mill Clear, or Anodized color as selected by Architect.
2. Baked-Enamel or Powder-Coated Finish: Color as selected by Architect from manufacturer's full range.
4. Stainless-Steel Finish: No. 2B (bright), cold rolled.
5. Interior Curtain-Slat Facing: Match exterior finish or <Insert finish>.

PART 3 - EXECUTION

3.1 INSTALLATION
A. Install overhead coiling doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions and as specified.

B. Fire-Rated Doors: Install according to NFPA 80.

C. Smoke-Control Doors: Install according to NFPA 80 and NFPA 105.

D. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion. Lubricate bearings and sliding parts as recommended by manufacturer. [Adjust seals to provide weathertight fit around entire perimeter.]

3.2 DEMONSTRATION
A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain overhead coiling doors.

END OF SECTION
SECTION 087100 - DOOR HARDWARE

PART 1 GENERAL

1.01 SECTION INCLUDES:

A. The work of this section shall include all labor, materials, equipment and services necessary to furnish and install all finish hardware as indicated and specified. All finish hardware component parts required for a complete, functioning building, whether specifically specified or not, shall be provided.

B. Finish hardware noted elsewhere in the contract documents as being a component part of an assembly or item furnished as part of that work is not included with the work of this section.

C. SRP uses a proprietary key system. SRP will provide all permanent cores. No alternates will be accepted.

1.02 REFERENCES

Reference to standards and/or specifications herein shall be interpreted to mean the latest revision unless noted otherwise. The following abbreviations appear in the specifications:

A. BHMA - Builders Hardware Manufacturers Association
B. NBHA - National Builders Hardware Association
C. DHI - Door & Hardware Institute

1.03 SUBMITTALS

A. Submit Product Data Sheets, shop drawings, material manufacturer's installation instructions, and cleaning and maintenance procedures.

1. Include a report that the product supplied meets the requirements of this specification, OSHA, and ADA.

2. The shop drawings shall show the direction of swing or hand of each door leaf. Furnish each item of hardware for proper installation and operation of the door movement as shown.

3. Furnish hardware templates with machine screws for use on all doors and frames. Supply all necessary template information to the Contractor for the various manufacturers in a timely manner.

B. Finish Hardware Schedule

1. The Hardware Supplier shall prepare and submit to the SRP Project Manager a complete schedule of all finish hardware required.

2. Based on finish hardware specified or indicated on the drawings, organize the hardware schedule into hardware sets indicating complete designations of every item required for each door opening. Include the following information:

   a. Type, style, function and finish of each hardware item.

   b. Name and manufacturer of each item.

   c. Fastenings and other pertinent information.

   d. Location of hardware set cross-referenced to door and frame schedule.

   e. Explanation of abbreviations, symbols, codes, etc. contained in schedule.

   f. Mounting locations for hardware.

   g. Door and frame sizes and materials.

3. Hardware Schedule to be in vertical written type format with Groups indicated by name and number.

C. Provide copies of cutsheets for each product or schedule.

D. Contractor shall use same door, frame and opening designations on Shop Drawings, to indicate hardware locations, as is indicated on the Contract Documents, with provision for cross-reference of Shop Drawings to Construction Documents.
E. Items of hardware not specified but required for completion of work - Furnish such items of type and quality suitable to the service required and comparable to adjacent hardware.

F. Provide the Basis of Design or pre-approved equal for each hardware component. Any deviations from this requirement is considered a Substitution and the Contractor must follow the procedures prescribed in Section 012500 Substitution Procedures.

1.04 QUALITY ASSURANCE

A. Obtain all closures from only one manufacturer.

B. Hardware Supplier shall be a recognized builders’ hardware supplier who has been furnishing specified hardware in the project’s immediate vicinity for a minimum of five years, and who is, or employs on a full time basis, a registered member of the American Society of Architectural Hardware Consultants to properly detail work, order materials, and supervise installation.

C. The firm proposing to supply Finish Hardware for this project must be a regular stocking distributor of the hardware it proposes to furnish.

D. The Hardware Supplier shall make periodic inspections of project (upon receipt of hardware at project, during installation and at completion of installation) so that at completion of the installation, he can certify to the SRP Project Manager that said hardware is properly installed according to manufacturer's printed instructions. Hardware Supplier is to provide two copies of certification to the SRP Project Manager within two weeks after installation of all hardware.

E. Provide hardware for fire-rated openings in compliance with NFPA Standard No. 80. Provide only hardware which has been tested and listed by UL for types and sizes of doors required and complies with requirements of door and door frame labels.

F. Where emergency exit devices are required on fire-rated doors (with supplementary marking on doors' UL label for each door indicating "Fire Door to be Equipped with Fire Exit Hardware") provide UL label on exit devices indicating "Fire Exit Hardware."

1.05 DELIVERY, STORAGE AND HANDLING

A. Package each item of hardware and each lock separately in individual containers, complete with necessary screws, keys, instructions and installation templates for spotting mortising tools. Mark each container with heading number and number corresponding to Finish Hardware Schedule.

B. Inventory hardware jointly with representatives of the Hardware Supplier and the Hardware Installer until each is satisfied that the count is correct.

C. Store finish hardware in a suitable, secure (lockable) storage space.

PART 2 PRODUCTS

2.01 MATERIALS

Produce hardware units of the basic metal and forming method indicated, using the manufacturer's standard metal alloy, composition, temper and hardness, but in no case of lesser (commercially recognized) quality than specified for the applicable hardware units by FS FF-H-106, FS FG-G-111, FS FF-H-116, and FS FF-H-121. Do not furnish "optional" materials or forming methods for those indicated, except as otherwise specified.

2.02 MANUFACTURED UNITS

A. Locksets
   1. Cylindrical Series. Base Manufacturer is to be Schlage Lock Company. "ND" Series (heavy duty), trim design shall be Rhodes. All locks to be equipped with "Figure 8" removable core, 6-pin tumblers. Backset to be 2-3/4" unless otherwise
noted. Furnish all strike plates with wrought boxes, WBX. Furnish the following functions:

**Schlage**

- **a.** Passage doors Latchset D10S
- **b.** Unisex Toilet doors Privacy D0S
- **c.** Office doors Locking D53RD
- **d.** Storage, Custodial, Classroom doors Locking D80RD
- **e.** Interior Mechanical/Electrical doors Locking D80RD

2. Mortise Series. Base Manufacturer shall be Schlage Lock Company. "L" Series (extra heavy duty) lever design to be 06 to match Rhodes, Roses to be "B" (2-9/16”) size. All locksets to be equipped with 30-016 housing, temporary brass construction cores "Figure 8" removable core, 6-pin tumblers. Furnish WBX for all locksets. Spec-Rite series not approved.

- **a.** Mechanical/Electrical doors Locking L9080R

3. Tubular Deadlocks. Base Manufacturer shall be Schlage Lock Company. "L400" Series (heavy duty), furnish 2-3/4" backset. All locks to be equipped with "Figure 8" removable core, 6-pin tumblers. Furnish WBX for all locksets.

- **a.** Single Cylinder B60R
- **b.** Double Cylinder B62R

4. Deadbolts. Base manufacturer shall be Schlage Lock Company. B600 Series in full size interchangeable core. Restroom door deadbolts shall have occupied (red)/unoccupied (green) indicator.

B. Rim Cylinders and Padlocks. Base Manufacturer shall be Schlage Lock Company. All cylinders to be equipped with "Figure 8" removable core, 6-pin tumblers.

1. Rim Cylinder 20-079
2. Padlock 5-101

C. Exit Devices - To be rim type with lever and cylinder for outside operation. Exit devices to be listed with UL under Life Safety Section. Acceptable Manufacturer: Von Duprin 99L. All exit devices to comply with ADA. Von Duprin-99L-F-2 series rim Exit Devices in fire rated openings with 996L Break away levers. (*Note- Preferred double door openings to be rim devices with KR9954 key removable mullion or option 9949 Concealed Vertical Cable device and no mullion. Electric latch retraction units to be 99 or 9949 "QEL"-quiet electric latch retraction.)

D. Door Closures - All to have a cast iron body with finish and equipped with three operation valves. All closures sized by the Installing Contractor. All wood doors to be equipped with sex nuts and bolts.

Acceptable Manufacturers:

- Manual Closers: LCN 4040XP heavy duty surface mounted with proper arm function. No hold open, CUSH arm, or fusible link without prior approval.

Color to match specified hardware. Wireless transmitter/receiver unless otherwise indicated. Push/pull installation as indicated.

E. Kickplates - All kickplates to be 16 inches high by 1-1/2 inches L.D.W. for single doors, 16 inches high by one inch L.D.W. on all pairs of doors. Materials to be S.S., .050 thick, beveled 4 sides. Ives 8400 series.
F. Push/Pull Plates – Ives 8200 or 8300 Series, 4 inches by 16 inches; 0.050 inches thick, bevel edge.


H. Stops:
   1. Interior:
      a. Wall – Ives 406 or 407, concave or convex, forged aluminum, concealed screw with wall plate.
      b. Floor – Ives 400 Series, 1/2 dome type, 1 5/8 overall height, cast. Ives R435 or R437 risers as needed.
      c. Overhead - Glynn-Johnson- 900 or 450 series surface mounted overhead stops or holders.

   2. Exterior: Floor - Ives FS444 heavy duty.

   3. Overhead: Glynn-Johnson 900 or 450 Series surface mounted.

I. Thresholds:
   1. Architectural Aluminum Doors - Reese Enterprises Model No. S39D, finish to match finish of architectural aluminum. Other acceptable manufacturers are Pemko or National Guard Products.

   2. All Other Doors - RE1, Reese Enterprises, Model S39A, brushed aluminum finish, or Pemko.

   3. Provide vinyl reducer where threshold is installed at VCT.

J. Door Sweeps shall be Pemko 315 or 321.

K. Weather stripping shall be provided at head and jambs.

L. Silencers – Ives SR64 for hollow metal doors, Ives SR65 for wood jambs. All frames to receive three each silencers for single door frames and two each for pairs of doors.

M. Hinges shall to be ball bearing, Ives 5BB1 HW heavy weight or standard weight as required, with non-removable pin (NRP) at locking doors, full mortise at rated doors and at all exterior main entry and other high use areas. Provide 1-1/2 pairs for all doors, sized per manufacturer's recommendations or as follows. Manufacturers: Stanley FBB179 Series; Ives, Pemko, or Hager Series.

   1. Doors 1-3/4" thick and up to 36" wide to have 4-1/2" butts.
   2. Doors 1-3/4" thick, 42" to 48" wide to have 5" butts.
   3. All butts finish sized in width to clear all trim.
   4. Provide Ives- 224HD geared continuous hinge-UL type. Acceptable alternate Reese and Select geared hinges when required and approved by owner.

N. Automatic Door Bottom - To be fully mortised, commercial medium duty series, minimum 3/4 inch drop with neoprene insert and satin aluminum body. Sized for door in accordance with manufacturer's recommendations. Acceptable Manufacturer. Surface mounted to be Reese series 521 or Pemko series 4301 plk.

O. Flush Bolt - Manual, with spring loaded snap action lever for bolt retraction, with 1/2 inch rod; recessed, or Ives 454 surface mounted when needed or Glynn-Johnson FB7/FB8 and Ives FB31.

P. Latch Guard – Ives LG10.

Q. Astragal – Reese 183SP or Hager 835S, steel

R. Door Holder - Ives, Model FS452 or FS452155, 5 inches, brass.

S. Touch Sensor Bar - Securetron Model TSB-1

T. Pivots - Ives- 7226 heavy duty pivots with 7226 INT intermediate pivot when required.

U. Coordinators – Ives COR7G gravity type

V. Smoke Seals: Pemko S88 Pemko S44

W. Floor Strike: Ives DP2, dustproof.

X. Meeting Stile Brush/Sweeps: Pemko 18061 or 18062

Y. Meeting Stile Brush/Sweeps: Pemko 18061 or 18062

**2.03 FINISHES**
A. All hardware shall be US26D, 626, or required to match existing.
B. Provide matching finishes for hardware units at each door or opening, to the greatest extent possible, and except as otherwise indicated.
   1. Reduce differences in color and textures as much as commercially possible where the basic metal or metal forming process is different for individual units of hardware exposed at the same door or opening.
   2. In general, match items to the manufacturer’s standard finish for the latch and locket (or push-pull units if no latch locksets) for color and texture.
C. Provide finishes which match those established by the BHMA.
D. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer’s standard, but in no case less than specified for the applicable units of hardware by referenced standards.
E. The designations used in schedules and elsewhere to indicate hardware finishes are those listed in “Materials and Finishes Standard 1301” by the BHMA, including coordination with the traditional U.S. finishes shown by certain manufacturers for their products.

2.04 KEYING
A. Contractor will provide cylinders of function as indicated on by the Contract Documents. Key all locks to IIIIII bitted keyed to site using 6, 7, or 8 keyways. Contact SRP Project Manager for proper keyway information.
B. All locks are to be provided with two original factory change keys (nickel silver), unless noted otherwise. All keying requirements will be provided by the SRP Project Manager to the Contractor. All cylinders are to be construction keyed, furnish six each construction keys to the Contractor for his use. Construction key is to be voided by use of a permanent change key, Master key or extractor. All cut change keys, Master keys, or Grandmaster keys are to be delivered to the SRP Project Manager via UPS, USPS with signed receipt request, or hand-delivered for personal signature. The keys and cylinder faces (cylinder barrel) to have key symbol (change key) embossed on them for ease of identification.

2.05 COMPONENTS
A. Hardware to conform to the published templates, generally prepared for machine screw installation. Do not provide hardware which has been prepared for self-tapping sheet metal screws, except as specifically indicated.
B. Furnish screws for installation with each hardware item. Provide Phillips flat-head screws except as otherwise indicated. Finish exposed (under any condition) screws to match the hardware finish, or if exposed in surfaces of other work, to match the finish of such other work as closely as possible, including “prepared for paint” in surfaces to receive painted finish.
C. Provide concealed fasteners for hardware units which are exposed when the door is closed, except to the extent no standard units of the type specified are available with concealed fasteners. Do not use through bolts for installation where the bolt head or the nut on the opposite face is exposed in other work, except where it is not feasible to adequately reinforce the work.
D. Use only manufacturer’s fasteners for installation.

2.06 MAINTENANCE TOOLS
Furnish a complete set of specialized tools as needed for Owner’s continued adjustment, maintenance and removal and replacement of builders’ hardware.

PART 3 EXECUTION

3.01 INSTALLATION
A. Mount hardware units at heights indicated in "Recommended Locations Builders Hardware for Standard Steel Doors and Frames," by the Door and Hardware Institute, except as specifically indicated or required to comply with governing regulations, and except as may be otherwise directed by the Architect/Engineer.

B. Install each hardware item in compliance with the manufacturer's instructions and recommendations.
   1. Wherever cutting and fitting is required to install hardware onto or into surfaces which are later to be painted or finished in another way, coordinate removal, storage and reapplication or reinstallation or application of surface protections with finishing work specified by the contract documents.
   2. Do not install surface mounted items until finishes have been completed on the substrate.

C. Set units level, plumb and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.

D. Drill and countersink units which are not factory-prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.

E. Install all hardware without marring or damaging hardware or other work. Replace all marred or damaged work. Adjust for easy operation.

F. Install closures, stops and other hardware as scheduled.
   1. Provide extra support blocking for all interior and exterior applied hardware.
   2. Do not install surface mounted items until finishes have been completed on the substrate.

G. Set units level, plumb and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.

H. Drill and countersink units which are not factory-prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.

I. Install all hardware without marring or damaging hardware or other work. Replace all marred or damaged work. Adjust for easy operation.

J. Install closures, stops and other hardware as scheduled.
   1. Provide extra support blocking for all interior and exterior applied hardware.
   2. All hardware shall be installed by workmen skilled in this type of work, and the installation of the hardware shall in no manner detract from the appearance of the doors. Faulty workmanship shall be cause for rejecting the doors.
   3. Where manufacturers specify certain requirements in installing doors, these requirements shall be called to the attention of, and be followed by the workmen.

3.02 ADJUSTING

A. Adjust each operating item of hardware and each door, to ensure the proper operation or function of each unit. Replace units which cannot be adjusted to operate freely and smoothly as intended for the application made.

B. Wherever hardware installation is made more than one month prior to acceptance or occupancy of a space or area, make final check and adjustment of all hardware items in such space or area.

C. Adjust door control devices to compensate for final operation of heating and ventilating equipment.

D. Instruct Owner’s personnel in proper adjustment and maintenance of hardware and hardware finishes during the final adjustment of hardware.

3.03 CLEANING

Clean operating items as necessary to restore proper function and finish of hardware and doors.

3.04 FIELD QUALITY CONTROL
A. Approximately six months after the acceptance of hardware, perform Maintenance Services. The Installer, accompanied by the Representative of the latch and lock manufacturer, shall return to the project and readjust every item of hardware.
B. Consult with and instruct Owner’s personnel in any recommended additions to the maintenance procedures.
C. Replace hardware items which have deteriorated or failed due to faulty design, materials or installation of hardware units.
D. Prepare a written report of current and predictable problems (of substantial nature) in the performance of the hardware within two weeks after the service maintenance is complete.

### 3.05 HARDWARE SCHEDULE

A. INTERIOR HARDWARE GROUPS:

#### Group 1: Office, and/or Work Room
1. 1 1/2 pr. Hinges
2. 1 Passage Set
3. 1 Stop (Wall)
4. 3 Silencers

#### Group 2: Darkroom Door
1. 1 1/2 pr. Hinges
2. 1 Lockset, single key
3. 1 Closer
4. 1 Stop (Wall)
5. 1 set Light seals
6. 1 Automatic door bottom
7. 3 Silencers

#### Group 3: Meeting, Conference, Crew and Break Rooms
1. 1 1/2 pr. Hinges
2. 1 Passage Set
3. 1 Closer
4. 1 Stop (Wall)
5. 3 Silencers

#### Group 3A: Meeting, Conference, Crew and Break Rooms
1. 1 1/2 pr. Hinges
2. 1 set Push/ Pulls
3. 1 Closer
4. 1 Stop (Wall)
5. 3 Silencers

#### Group 4: Electrical, Mechanical, Custodial, and Storage Rooms
1. 1 1/2 pr. Hinges
2. 1 Lockset, single key
3. 1 Closer
4. 1 Stop (Wall)
5. 3 Silencers
6. *Double Doors

*Provide the following additional hardware
1. 1 1/2 pr. Hinges
2. 1 Stop (Drop Arm)
3. 3 Silencers
4. 1 pr. Recessed Flush Bolts (Top and Bottom) Inactive Leaf
1 Door Hold Open, Surface, Inactive Leaf

Group 5: Typical Restroom
1. 1 1/2 pr. Hinges
2. 1 set Push/Pull
3. 1 Closer
4. 3 Silencers
5. 1 Stop (Wall)

Group 6: Unisex Toilet
1. 1 1/2 pr. Butts
2. 1 Privacy lock set
3. 1 Closer
4. 3 Silencers
5. 1 Stop (Wall)

Group 7: Corridor
1. 1 1/2 pr. Hinges
2. 1 Passage Set
3. 1 Closer
4. 3 Silencers
5. 1 Stop (Wall)
6. *Double Doors
   *Provide the following additional hardware
   1 1/2 pr. Hinges
   1 Stop (Wall)
   3 Silencers
   2 pr. Push Pulls in lieu of passage hardware

Group 7A: Corridor (Single)
1. 1 1/2 pr. Hinges
2. 1 Lock Set
3. 1 Closer
4. 3 Silencers
5. 1 Stop (Wall)
6. *Double Doors
   *Provide the following additional hardware
   1 1/2 pr. Hinges
   1 Stop (Wall)
   3 Silencers
   2 Pr. Push/Pull in lieu of lockset
   1 Pr. Recessed Flush Bolts (Top and Bottom) Inactive Leaf
   1 Dead Bolt Keyed (Active Leaf)
   1 Closer

Group 7B: Corridor (Double Door Entrance)
1. 3 pr. Hinges
2. 2 pr. Push/Pulls
3. 2 Closers
4. 2 Dead Bolts
5. 6 Silencers

Group 7C: Card Keyed Access Doors
1. 1 1/2 pr. Hinges
2. 1 Closer
3. 1 Touch Sensor Bar, Provided by SRP
4. 1 Pull
5. 1 Door Stop (Wall)
6. 3 Silencers
7. * Double Doors
   *Provide the following additional hardware
   1 1/2 pr. Hinges
   1 Door Stop (Wall)
   3 Silencers
   1 Touch Sensor Bar, Provided by SRP
   1 Pull
   1 Closer

B. EXTERIOR HARDWARE GROUPS:

Group 8: Aluminum Storefront Doors
1. 1 Cylinder for locks provided with doors.
2. All other hardware provided by storefront manufacturer.
3. 1 Sign ("This Door shall remain unlocked during business hours")

Group 9: Exit Door
1. 1 1/2 pr. Hinges
2. 1 Lockset, single key
3. 1 Closer
4. 1 Threshold
5. 1 Door Sweep
6. 1 set Weatherstrip
7. 3 Silencers
8. 1 Latch Guard

Group 9A: Exit Door/Card Key Access
1. 1 1/2 pr. Hinges
2. 1 Touch Sensor Bar, Provided by SRP
3. 1 Door Pull
4. 1 Closure
5. 1 Threshold (width of door or doors)
6. 1 Door Sweep (width of door or doors)
7. 1 set Weatherstrip
8. 3 Silencers
9. 1 Latch Guard
10. * Double Doors
    *Provide the following additional hardware:
       1 1/2 pr. Hinges
       1 Touch Sensor Bar, provided by SRP
       1 Closure
       3 Silencers
       1 Door Pull
       1 set Weatherstrip

Group 10: Mechanical, Electrical, Communications, and Storage Rooms
1. 1 1/2 pr. Hinges
2. 1 Lockset, single key
3. 1 Closer
4. 1 Stop (Wall)
5. 1 set Weatherstrip
6. 1 Threshold (Width of door or doors)
7. 1 Door Bottom (Width of door or doors)
8. 1 Silencers
9. 1 Latch Guard
10. *Double Doors
*Provide the following additional hardware
  1 1/2 pr. Hinges
  1 Door Hold Open, Surface (Inactive Leaf)
  1 pr. Recessed Flush Bolts (Inactive Leaf)
  1 Astragal

END SECTION
SECTION 088000 - GLAZING

PART 1 GENERAL
1.01 SECTION INCLUDES:
A. The work of this section shall include all labor, materials, equipment, accessories and services required and necessary to provide the glass and glazing and related items as indicated or specified.

1.02 SUBMITTALS
A. Submit Product Data Sheets, shop drawings indicating layout locations, directions for installing anchorage in other materials, and cleaning and maintenance instructions.
B. Provide letter of certification, or certified test laboratory report that all materials comply with the requirements and is intended for the applications shown.
C. Submit manufacturer's five-year guarantee on mirrors against silver spoilage.

1.03 QUALITY ASSURANCE
A. All work under this section shall conform to this specification, Chapter 54 of the UBC, OSHA, and to local code requirements. In case of conflict, the more stringent requirements shall apply.

PART 2 PRODUCTS
2.01 MATERIALS
A. Glass
1. Regular Plate Glass - Complying with FS DD-G-451, Type I, Class I. Quality Q-3, plate or float.
2. Tempered Glass - Fully tempered float and/or plate glass. Permanently etch each light with manufacturer's name and his compliance with ANSI Z-97.1. Interior - Clear unless noted otherwise. Tempered glass shall have no visible tong marks and no apparent visual distortion when installed.
3. Insulating glass - one inch thick hermetically edge sealed and metal banded insulating glass consisting of two 1/4 inch panes of tempered float glass, with LOF Eclipse Bronze reflective coating on surface #2. Panels shall be factory fabricated and have a ten year guarantee against seal failure.
4. Obscure glass
5. Glass Thickness - Determined by requirements of FS DD-6-451 and/or Chapter 54 of UBC.
B. Wire Glass - 1/4" thick polished clear wire glass; square pattern Misco as manufactured by Hordis Brothers, Inc. Provide as indicated by contract documents or required by code.
C. Mirrors shall be 1/4" #1 quality polished plate laminated glass, blue labeled, as per CS-27. Finish shall be silver coating or electrolytic copper plating and the copper protected by a coat of mineral oxide oil base paint. Mirrors shall have metal frames of stainless steel unless noted otherwise.
D. Interior Glazing Compound - Polymerized butyl rubber and inert. Fillers (pigments), solvent based with minimum 75% solids, nonsag consistency, tack-free time of 24 hours or less, paintable nonstaining.
E. Setting Blocks - Neoprene, EPDM, or other resilient blocks of 85 shore A durometer hardness, minimum length 4".
F. Other Accessories - Glazer points, clips, sealants, preformed tape, etc., in accordance with FGMA "Glazing Manual" specifications and manufacturer's recommendations.

PART 3 EXECUTION
3.01 EXAMINATION
Examine the framing or glazing channel surfaces, backing, removable stop design and the conditions under which the glazing is to be performed, and notify the Contractor in writing of any conditions detrimental to the proper and timely completion of the work. Do not proceed with glazing until unsatisfactory conditions have been corrected in an acceptable manner.

3.02 INSTALLATION

A. Glass
   1. Glass installation must withstand normal temperature changes without failure of any kind including loss or breakage of glass.
   2. Protect glass from edge damage at all times during handling, installation and operation of the building. Glass breakage during the guarantee period will be considered a form of faulty material or workmanship (resulting from edge damage) unless known to result from vandalism or other causes not related to materials and workmanship.
   3. Glazing channel dimensions are intended to provide for necessary minimum bite on the glass, minimum edge clearance and adequate sealant thicknesses, with reasonable tolerance. The glazier is responsible for correct glass size for each opening, within the tolerances and necessary dimensions established.
   4. Comply with combined recommendations of Glass Manufacturer and manufacturer of sealants and other materials used in glazing, except where more stringent requirements are shown or specified, and except where manufacturer’s technical representatives direct otherwise.
   5. Clean the glazing, channel or other framing members to receive glass, immediately before glazing. Remove coatings which are not firmly bonded to the substrate.
   6. Do not attempt to cut, seam, nip or abrade glass which is tempered or heat strengthened.
   7. Comply with "Glazing Manual" by Flat Glass Manufacturer's Association, except as shown and specified otherwise by the manufacturers of the glass and glazing materials.
   8. Inspect each piece of glass immediately before installation, and eliminate any which have observable edge damage or face imperfections.
   9. Install setting blocks of proper size at quarter points of sill rabbet. Set blocks in first course of the heel-head compound, if any.
  10. Provide spacers inside and out, and of proper size and spacing, for all glass sizes larger than 50 united inches. Provide 1/8" minimum bite of spacers on glass, and use thickness equal to sealant width.
  11. Unify appearance of each series of lights by setting each piece to match others as nearly as possible. Inspect each piece and set with pattern, draw and bow oriented in the same direction as other pieces.

B. Mirrors
   Adhesive Installation of Mirrors - Apply one additional coat of moisture-resistant paint, of type recommended by Mirror Manufacturer, to back of mirror, and allow to dry. Apply mirror mastic to cover not more than 25% of back of mirror. Set mirror in support on setting blocks or continuous gasket, and press against substrate to ensure bond of adhesive. Leave open ventilation space, 1/8" or more in thickness between mirror and substrate, over 75% of mirror area (wherever there is not adhesive). Do not seal-off ventilation space at edges of mirror.

3.03 PROTECTION

A. Protect glass from breakage immediately upon installation, by attachment of crossed streamers to framing held away from glass. Do not apply markers of any type to surfaces of glass.

B. Remove and replace glass which is broken, chipped, cracked, abraded or damaged in any other way during the construction period, including natural causes, accidents and vandalism.

END SECTION
SECTION 092216 - NON-STRUCTURAL METAL FRAMING

PART 1 GENERAL
1.01 SECTION INCLUDES:
The work of this section shall include all labor, materials, equipment, accessories, and services required and necessary to furnish and install non-load bearing framing and related items as indicated or specified.

1.02 SUBMITTALS
A. Submit Product Data Sheets, shop drawings, and directions for proper installation of anchorage for each component item of framing and accessories. Provide shop drawing for all components and installation instructions not fully detailed in manufacturer's product data.
B. Submit manufacturer's certification that material meets or exceeds specification requirements.
C. Submit Erection Drawings for framing members showing size and gauge designations, number, type, location and spacing. Indicate supplemental strapping, bracing, splices, bridging, accessories and details required for proper installation.

1.04 QUALITY ASSURANCE
A. Component Design - Compute structural properties of studs and joists in accordance with AISC "Specification for Design of Cold-Formed Steel Structural Members."
B. Fire-Rated Assemblies - Where framing units are components of assemblies indicated for a fire-resistance rating, including those required for compliance with governing regulations, provide units which have been approved by governing authorities having jurisdiction and/or the UBC.

1.05 DELIVERY, STORAGE AND HANDLING
Protect metal framing units from rusting and damage. Deliver to project site in manufacturer's unopened containers or bundles, fully identified with name, brand, type and grade. Store off ground in a dry ventilated space or protect with suitable waterproof coverings.

PART 2 PRODUCT
2.01 MATERIAL
A. General
Non-load bearing framing shall be made of light gauge materials. With each type of metal framing required, provide manufacturer's standard steel runners (tracks), blocking, lintels, clip angles, shoes, reinforcements, fasteners and accessories as recommended by manufacturer for applications indicated, as needed to provide a complete metal framing system. All metal framing components shall be galvanized complying with ASTM 525 for G60 coating.
B. Metal Studs
1. Studs shall be type "C" roll formed from galvanized steel and designed for screw attachment. Studs shall conform to ASTM C645.
2. Studs shall be at least a 25-gauge minimum, unless the manufacturer recommends a heavier gauge for the length of stud used. Use the appropriate stud size for chases and recess mounted equipment.
3. For interior studs, deflection shall not exceed 1/240 of wall height under a load of five pounds per square feet when applied perpendicular to the wall.
4. For 16-gauge and heavier units, fabricate metal framing components of structural quality steel sheet with a minimum yield strength of 50,000 psi; ASTM A446, A570 or A611.
5. For 18-gauge and lighter units, fabricate metal framing components of commercial quality steel sheet with a minimum yield strength of 33,000 psi; ASTM, A446, A570, or A611.
C. Floor and Ceiling Runners
Floor and ceiling runners shall be formed from galvanized steel in sizes to correspond with studs, complying with ASTM C645.
D. Runner Channels
Runner channels shall be 1-1/2 inches deep, cold rolled steel, weighing 475 pounds per 1,000 linear feet with black asphaltum base paint finish.

E. Furring Channels
Furring channels shall be galvanized steel, hat shaped, and 7/8 of an inch deep.

F. Backing Plates
Backering plates shall be a minimum of 14-gauge galvanized steel anchored to framing system.

PART 3 EXECUTION

3.01 INSTALLATION

A. Fabrication
1. General - Framing components may be prefabricated into panels prior to erection. Fabricate panels plumb, square, true to line and braced against racking, with joints welded. Perform lifting of prefabricated panels in a manner to prevent damage or distortion.
2. Fastenings - Attach similar components by welding. Attach dissimilar components by welding, bolting, or screw fasteners, as standard with manufacturer.
3. Wire tying of framing components is not permitted.

B. Installation of Stud System
1. Manufacturer's Instructions - Install metal framing systems in accordance with manufacturer's printed or written instructions and recommendations, unless specifically otherwise indicated.
2. Runner Tracks - Install continuous tracks sized to match studs. Align tracks accurately to layout at base and tops of studs. Secure tracks as recommended by stud manufacturer for type of construction involved, except do not exceed 24 inches on center spacing for nail or power-driven fasteners, or 16 inches on center for other types of attachment. Provide fasteners at corners and ends of tracks.
3. Stud width shall be as shown on the drawings. Spacing of studs shall not exceed 24 inches on center. Set studs plumb, except as needed for diagonal bracing or required for non-plumb walls or warped surfaces and similar requirements.
4. Where stud system abuts structural columns or walls, including masonry walls, anchor ends of stiffeners to supporting structure.
5. Install supplementary framing, backing plates and bracing in metal framing system wherever walls or partitions are to support fixtures, equipment, services, casework, heavy trim and furnishings, and similar work requiring attachment to the wall or partition. Where type of supplementary support is not indicated, comply with stud manufacturer's recommendations, considering weight or loading resulting from item supported.
6. Installation of Wall Stud System - Secure studs to top and bottom runner tracks by either welding or screw fastening, alternating sides, top and bottom of outside flanges. Track anchors shall be drive pins placed at a maximum of four feet on center unless noted otherwise. Anchors shall be placed at all jambs, corners, both sides of expansion and control joints, intersections and wall ends. All bottom tracks shall have a minimum of two anchors.
7. Use double stud at each jamb of frame where wall opening is larger than two feet square unless otherwise noted. Install runner tracks and jack studs above and below wall openings. Anchor tracks to jamb studs with stud shoes or by welding, and space jack studs same as full-height studs of wall.
8. Frame both sides of expansion and control joints with separate studs. Do not bridge the joint with components of stud system.
9. Install horizontal runner channels in stud system, spaced (vertical distance) at a maximum of four feet on center. Mechanically fasten at each intersection, providing a minimum eight inch lap.
10. At double stud partitions, such as chases, install pieces of stud to span horizontally between the vertical wall studs at a vertical spacing not to exceed four feet on center. Securely screw horizontal stud bracing to web of vertical wall studs on each side of double stud partition.

D. Installation of Metal Furring Channels
1. Attach metal furring channels, spaced vertically 24 inches on center, to masonry or concrete surfaces with hammer-set or powder-driven fasteners or concrete stub nails on opposite flanges. Nest channels eight inches at splices and anchor with two fasteners in each wing.
2. Metal furring channels shall be spaced on both sides of control joints.
3. Field Painting - Touch up shop-applied protective coatings damaged during handling and installation. Use galvanox or approved equal for repair of galvanized surfaces.
4. All welding shall be performed by welders experienced in lightgauge steel framing work.

END SECTION
SECTION 092400 – PORTLAND CEMENT PLASTERING

PART 1 GENERAL

1.01 SECTION INCLUDES:
The work of this section shall include all labor, materials, equipment, accessories and incidentals required and necessary for plaster and stucco work as indicated or specified.

1.02 SUBMITTALS
A. Submit manufacturer's Product Data Sheets, certificate that materials meet specification requirements, samples, and instructions for proper use and installation of product.
B. Samples of each material and texture indicated or specified for use shall be provided on the job site, and when approved, shall become the standard for all work. Samples shall show texture and workmanship of finished work. Sample size is 4’ x 4’ minimum.

1.04 QUALITY ASSURANCE
A. Comply with requirements of ASTM C-842 and C-926 as applicable; and Plaster, Metal Framing System Lath Manual.
B. Allowable Tolerance for Plaster Finish is a maximum deviation from true plane of 1/8 inch in ten (10) feet (non-cumulative) as measured by straight edge placed at any location on surface.
C. All finished plastering work shall be performed in a highly skilled manner with surfaces true and accurate.
D. Use Portland Cement plaster for all work indicated as stucco.

PART 2 PRODUCT

2.01 MATERIAL
A. Portland Cement - Portland Cement shall conform to ASTM C-150, Type II.
B. Hydrated Lime - Hydrated lime shall conform to ASTM C-207, Type S.
C. Sand - Sand shall be clean and sharp, free from alkali and deleterious materials such as lignite, loam, silt and conforming to ASTM C-35 gradation.
D. Water - Water shall be clean and potable.

2.02 MIXES
A. Proportion ingredients entering the several plaster mixes and measure using calibrated boxes or containers so that quantities can be readily and accurately checked. Comply with product manufacturer's recommendations and specifications for use, mixing and application.
B. Mix factory prepared plaster ingredients in accordance with the product manufacturer's written instructions. Do not mix more at one time than can be applied within one hour after mixing. Do not retemper material or use retempered material.
C. Cement Plaster - Scratch Coat - One part Portland Cement to not less than three parts sand, to which hydrated lime of not more than 10% (by weight) of the cement content may be added.
D. Cement Plaster - Brown Coat - One part Portland Cement to not less than three parts to not more than five parts sand with hydrated lime added as specified for scratch coat.
E. Cement Plaster - Finish Coat - One part Portland Cement to three parts of finishing sand with hydrated lime added as specified for scratch coat.

2.03 PLASTER COAT APPLICATIONS
A. Plaster over masonry shall be two-coat work consisting of a 3/8 inch brown and a 1/4 inch finish coat with a total thickness not less than 5/8 inch plus the thickness of the texture coat.
B. Plaster over concrete shall be two-coat work consisting of a 3/8 inch brown and a 1/8 inch finish coat with a total thickness not less than 1/2 inch plus the thickness of the texture coat.
C. Plaster over gypsum lath shall be two-coat work consisting of a 3/8 inch brown coat and a 1/8 inch finish coat with a total thickness not less than 1/2 inch plus the thickness of the texture coat.
D. Plaster over metal lath shall be three-coat work consisting of a 3/8 inch scratch coat, a 3/8 inch brown coat and a 1/4 inch finish coat for a total thickness of 1 inch, plus the thickness of the texture coat.

PART 3 EXECUTION

3.01 PREPARATION
A. Evenly dampen interior and exterior wall surfaces exhibiting high suction to provide proper suction prior to plastering. Allow sufficient time for surface suction to equalize.
B. Clean monolithic concrete surfaces receiving bond plaster of all dust, loose particles and other foreign matter. Remove laitance and efflorescence by washing with a 10/5 solution of commercial hydrochloric (muriatic) acid and water and then rinse with clean water to remove all traces of acid. Completely remove any grease or oil. Apply bonding agent over all concrete surfaces indicated to receive plaster, by brush, spray or roller in strict accordance with manufacturer's printed instructions, covering the surface completely. Apply plaster when bonding agent is dry to touch or within a one month period from application.
C. Concrete surface shall have sufficient roughness to provide a proper bond. If surfaces are not rough, hack or bushhammer, or apply suitable bonding agent in accordance with the manufacturer's instructions.

3.02 APPLICATION
A. Arrange and install all plastering, when and as required, to conceal or connect with work of other trades in a finished manner.
B. Rod and straightedge plaster to uniform surfaces in true plane, finish free from lumps, cracks, checks or other structural defects and surface imperfections and flush with grounds, corner beads, base screed, outlet boxes and similar details.
C. Do not apply plaster to concrete surfaces that have been coated with a bituminous compound or other waterproofing agents.
D. Tool finish at flush trim or frames to a slight "V". Provide scoring where indicated. Do not lap successive coats over laps in former coats. Avoid joining marks by working top and bottom of work at the same time.
E. Scratch Coat - Apply scratch coat over metal lath with sufficient pressure so that it is forced through the lath to form full keys and to embed completely the reinforcement.
F. Brown Coat - Where indicated over masonry, apply brown coat directly over masonry. Dampen masonry evenly on interior and exterior of wall to obtain uniform suction. Apply to a thickness of 3/8 inch. Bring to a true, even surface by floating or rodding, and leave rough, ready to receive finish coat.
G. Finish Coat - Finish by floating to a true, even surface. The second, or brown, coat shall be lightly and evenly sprayed with clean water before the 1/8 inch finish coat is applied. Finish cement plaster by floating to a uniform, finish texture.

3.03 CURING
A. Cure and protect plaster from too rapid or too slow drying because of weather or lack of air circulation. Both the exterior and interior wall surfaces shall be moistened to avoid excessive suction of moisture from plaster into the masonry wall.
B. Scratch and Brown coats shall each be moist cured by fog spray or a similar approved method that keeps the plaster continuously moist for 48 hours, allowing slow drying, after which the finish coat is applied.
C. Finish coat shall receive a minimum of four (4) applications of fog spray during curing. The first spray shall be applied approximately 8 hours after completion of the finishing operation. Subsequent sprayings shall take place at about 8 to 12 hour intervals. The time between fog spray applications shall be varied, as required, to compensate for prevailing conditions of wetness and dryness and to insure plaster remains moist for minimum of 48 hours.

3.04 PATCHING AND REPAIRS
Prior to the start of painting operations, repair damaged portions of plastering. Do patching and repairing neatly and accurately, and match the finish of the adjoining work in form, color and texture. Patch and repair where plaster surface is marred, discolored, stained or otherwise damaged. Remove finish coat and replace with new and acceptable work. Do patching, repairing and joining work neatly. Cut out broken or damaged portions of plaster and repair with new work. Cut out cracks not less than one (1) inch wide and plaster full and smooth. Moisten edge of patched areas before new plaster is applied.

3.03 PROTECTION AND CLEANING
A. Provide adequate protection to prevent damage to all adjacent or previously installed work which may be subject to damage or staining during plastering operations. If damage or staining occurs, repair or replace damaged or stained work in a manner acceptable to the Designated Representative. The Contractor shall be liable for repair or damage costs incurred.
B. When plastering is completed, remove all staging and tools of every sort used in the erection of the work. Remove all debris resulting from work under this section. Clean all plaster droppings and leave the work in an acceptable condition.

END SECTION
SECTION 092900 - GYPSUM WALLBOARD

PART 1 GENERAL

1.01 SECTION INCLUDES:
The work of this section shall include all labor, materials, equipment, accessories and services required and necessary to furnish and install gypsum wallboard, complete with related metal components, accessories and finish surfaces as indicated or specified.

1.02 QUALITY ASSURANCE
A. All materials and services provided shall comply with the provisions of the following manufacturers, specifications and standards:
   B. Manufacturers - Wallboard components shall be as manufactured by U.S. Gypsum Company, Domtar Gypsum, National Gypsum Company, Georgia-Pacific, or Flintkote Blue Diamond. It is intended that all materials furnished be a part of a single system, whether it be supplied by one or several manufacturers.
   C. ANSI A-97.1 and GA-216 insofar as any portions are applicable, are hereby made a part of this Specification as though repeated herein. In case of conflicts, the more stringent requirements shall govern.

1.03 SUBMITTALS
A. Submit Product Data Sheets, shop drawings, and directions for proper installation of each component item of wallboard system.
   B. Submit copies of fire test reports on fire rated wallboard assemblies. Submit copies of evidence of fire hazard classification for wallboard. Certified test reports of other acceptable testing agencies which perform testing in accordance with ASTM E-190, E-84 and E-90 are acceptable.
   C. Furnish manufacturer's certification that materials meet or exceed Specification requirements.
   D. Manufacturer's Instructions - Furnish manufacturer's printed instructions for installation of assemblies.
   E. Provide sample of texture finishes for Designated Representatives approval.

1.04 DELIVERY, STORAGE AND HANDLING
A. Deliver wallboard materials in manufacturer's unopened containers, packages or bundles identified with manufacturer's name, brand, type and grade. Store inside dry areas and protect from dampness and deterioration. Protect ready-mixed products from freezing and protect metal accessories from rusting. Remove damaged or deteriorated materials from the premises.
   B. Deliver fire-rated materials bearing testing agency label and required fire classification number.

1.05 PROTECTION AND PREPARATION
A. Temperature and Humidity Conditions - Do not install wallboard unless installation areas comply with the minimum temperature and ventilation requirements recommended by the manufacturer.
   B. Protect work installed by other trades previous to work under this Section. Replace any work damaged without added cost to the Owner. Provide closures for exterior openings, where required. Room temperature during installation of wallboard shall not be less than 50° F., with adequate ventilation maintained to eliminate excessive moisture until joint compound is completely dry. Protect wallboard from wetting. Replace any damaged material.
   C. Provide ventilation during and following adhesives and joint treatment applications. Use temporary air circulators in enclosed areas lacking natural ventilation. Under slow drying conditions, allow additional drying time between coats of joint treatment. Protect installed materials from drafts during hot, dry weather.

PART 2 PRODUCT

2.01 MATERIALS
A. Gypsum Wallboard
1. Gypsum Wall Board, Fire Rated, ASTM C-36, Type X, 5/8 inch thick, tapered edge. Install at all areas, except as otherwise noted.
2. Gypsum Wall Board, Fire Rated, Moisture Resistant, ASTM C-630, 5/8 inch thick, tapered edge. Install at toilet room walls behind and adjacent to plumbing fixtures.
5. Multi Purpose Cement board, 5/8 inch thick, 3.75 psf, U.S. Gypsum company or equal. Install as backup surface for ceramic tile walls in bathroom and shower rooms, or where specified on drawings.

B. Wallboard Accessories
1. Corner Bead Reinforcement - U.S. Gypsum Company or approved equal.
2. Metal Edge Reinforcement - U.S. Gypsum Company or approved equal.
3. Control Joint - U.S. Gypsum Company No. 093 or approved equal.
4. Provide miscellaneous beads, casings, and trim as required for a complete project.

C. Screws
Self-drilling, self-tapping bugle head for use with power driven tool. Type S for application to light gauge metal framing, minimum 1", type 9-12 for application to heavy gauge metal framing (ASTM C-646); 1-5/8" for double layer (ASTM C-694).

D. Suspended Ceiling Components
1. Furring Channels - Type DWC-25 as manufactured by U.S. Gypsum Company or approved equal, or rigid furring channel conforming to ASTM C-645.
2. Main Runner Channels - Cold rolled sections, 1-1/2", formed of No. 16 gauge steel, painted with rust-inhibiting paint.
3. Hanger Wires - Sizes specified, double annealed and galvanized conforming to FS QQ-W-461, Type 1.
5. (Alternate) Steel stud ceiling system. Refer to drawings for stud sizes and installation details.

E. Studs - ASTM C-645.
1. Gauge - Provide 25 gauge for typical partition support. Provide no less than 20 gauge at partitions for support of applied fixtures, woodwork, handrails, all toilet room partition support and as otherwise recommended or indicated on the drawings.
2. Depth of Section - As indicated or scheduled on drawings.
3. Runners - Match studs; type recommended by Stud Manufacturer for floor and ceiling support of studs and for vertical abutment of drywall work at other work.
4. Furring Members - ASTM C-645; 25-gauge, hat-shaped or prefabricated clips for attachment of gypsum drywall to support members, as shown on drawings.
5. Fasteners for Furring Members - Type and size recommended by Furring Manufacturer for the substrate and application indicate.

F. Joint Treatment System
1. Joint tape shall be perforated, conforming to ASTM C-475 or FF SS-J-570, Type II.
2. Joint compound shall be powdered or ready-mixed conforming ASTM C-475 or FS SS-J-570, Type I. Taping and topping joint compound or all purpose joint compound may be used.

G. Texture Finish
Wall texture material shall be V-1200 wall texture as manufactured by Lahabra Products, Inc., Anaheim, California.

H. Humidity Control
Humidity control shall be provided by a six mil polyethylene vapor barrier where shown on drawings.
PART 3 EXECUTION

3.01 CEILING INSTALLATION
Install suspended ceilings in accordance with the grid manufacturer's recommendations and the following procedures.

A. Except where otherwise indicated, provide 1-1/2" c.r. main runner channels spaced on four foot centers and metal furring channels spaced on four foot centers and metal furring channels spaced on not over 24" centers. Neither main runners nor cross furring shall be let into nor come in contact with abutting masonry partitions. Locate a main runner within 6" of the wall. Support the ends of the furring channels with 2"x2x20ga. continuous metal wall angles.

B. Where main runners or furring channels are spliced, overlap the ends not less than 8" and securely tie near each end of the splice with two loops or 16 gauge galvanized wire.

C. Suspend main runners from structure (at panel points where open web steel joists and/or girders are encountered) above with one No. 8 hanger wire at 3'-0" O.C. for each 12 square feet of ceiling area. All wire hangers shall be such length so that the lower ends may be saddle-tied around the main runners so as to prevent turning or twisting of the runners.

D. At steel beams, joists or other steel construction wrap hangers around, insert through, or clip or bolt to the supports, so as to develop the full strength of the hangers.

E. Securely clip metal furring channels to main runners using furring channel clips or saddletie with two strands of 18 gauge tie wire. Install furring channel clips on alternate sides of the main runner channel.

F. At lights or other openings that interrupt the main runner of furring channels, reinforce grillage with 3/4" cold-rolled channels, wire tired atop and parallel to the main runner channels.

G. Apply wallboard with long dimension at right angles to the furring channels, with all abutting ends and edges occurring over the web surface of the furring channel. Use wallboard of maximum possible length to minimize end joints. Neatly fit and stagger end joints. Install wallboard with 1 1/4" screws spaced 8" on center in the field of the board, at all bearings, and along abutting edges.

3.02 WALL INSTALLATION
Construct wall in accordance with the wall component manufacturer's recommendations and the following procedures.

A. Apply wallboard with long dimension at right angles to framing with all abutting ends and edges occurring over stud flanges. Use wallboard of the maximum practical length to minimize end joints. Neatly fit and stagger end joints. Arrange joints on opposite sides of the partitions as to occur on different studs. Cut wallboard neatly to fit around all openings. Wallboard to extend to within 1/4" of the floor.

B. Wherever wallboard terminates against dissimilar materials or where edges of wallboard are exposed, install metal edge reinforcement as specified. At all outside corners install metal corner bead reinforcement as specified.

C. At locations indicated, install control joint over face of wallboard panels. Cut end joints square, butt together and align to provide neat fit. Attach control joint to wallboard with screws spaced not over 12 inches on center in each flange.

D. At metal studs apply wallboard using screws spaced a maximum of 12" o.c. in the field of the board and 12" on center along the abutting end joints; 8" o.c. at rated walls.

E. At double layer walls install base layer as specified above except install vertically over framing members. Install face layer with fasteners as noted and stagger joints in face layer. At all vertical corners, provide "floating" corner installation per USG Drywall Construction Handbook. When a vapor barrier is required (as noted on drawings) a six mil polyethylene sheet shall be sandwiched between the two layers of wallboard with a 6" overlap all around.

G. Provide perimeter relief where nonload-bearing wallboard partitions abut structural decks or ceilings or vertical structural elements. Allow not less than 1/4", nor more than 1/2" gap between wallboard and structure. Finish edges of wallboard face layer with square-nose metal casing.
bead and caulk space between casing bead and structure with continuous sealant bead. Attach wallboard to studs not less than 1/2" below bottom edge of ceiling track flanges and to first stud adjacent to vertical tracks. Do not attach wallboard directly to tracks.

H. Where wallboard partitions intersect masonry wall, provide control joint no less than 1/4", nor more than 3/8" wide between wallboard and masonry. Finish exposed edges of wallboard with square-nose metal casing bead and caulk space between casing bead and masonry with continuous sealant bead.

I. At all external wall corners provide metal corner reinforcing. Run corner reinforcing from floor to ceiling.

J. Finishing
   1. Reinforce wall and ceiling angles and inside vertical corner angle with tape folded to conform to the adjoining surface and to form a straight, true angle. Apply a thin uniform layer of compound, approximately 3" wide, under and over the tape in the angle joint to be reinforced. Center tape over all joints to be reinforced and seal into the compound, having sufficient compound under the tape to provide proper bond. Apply a skim coat of compound immediately after embedding tape. Clean excess compound from the wallboard surface. After drying, cover embedding compounds with an additional coat of compound.
   2. Allow joints to dry thoroughly (minimum of 24 hours) between each application of compound.
   3. All joints shall have tape embedded, filled and finished using specified compound.
   4. Cover fill coat with compound spread evenly over and slightly beyond the tapered edge of the board, feathered at the edges, with a smooth uniform slight crown over the joint. All dimples at fastener heads shall receive three coats of compound in succession as used in joints.
   5. Conceal flanges of all metal corner and edge reinforcing by at least two coats of compound. When completed, the compound shall extend approximately 8" to 10" on either side of the exposed metal nosing.
   6. Sand all coats as necessary after each application of compound has dried. The final coat and subsequent sanding shall leave all wallboard and treated areas uniformly smooth and ready to receive decoration, to the extent that after painting of wallboard, there shall be no distinguishable difference in appearance between taped and untaped surfaces.
   7. Apply an orange peel wall texture to all exposed walls that are to receive a painted finish as scheduled. Surfaces shall be free of dust, dirt and oil before application. Use as heavy a mixture as practical and avoid over-thinning of the material. Apply material using spray equipment capable of developing sufficient pressure to produce a fine sand textured finish.

END SECTION
SECTION 093000 - TILING

PART 1 GENERAL

1.01 SECTION INCLUDES:
The work of this section shall include all labor, materials, equipment, accessories and services required and necessary to furnish and install all ceramic tile as indicated or specified.

1.02 QUALITY ASSURANCE
All materials, preparation, installation and services provided shall comply with provisions of the following ANSI and TCA standards and specifications:
   A. A108.5 Installation of Ceramic Tile with Dry-Set Portland Cement Mortar or Latex-Portland Cement Mortar.
   B. A118.1 Dry-Set Portland Cement Mortar.
   C. A118.4 Latex-Portland Cement Mortar.
   D. A137.1 Specifications for Ceramic Tile.
   E. Tile Council of America, Inc. (TCA) - "Handbook for Ceramic Tile Installation".

1.03 PRODUCT DELIVERY, STORAGE, AND HANDLING
   A. Supply tile cartons grade-sealed by manufacturer in accordance with TCA 137.1, with grade-seals unbroken.
   B. Manufactured mortars and grouts to contain hallmarks certifying compliance with reference standards and be types recommended by Tile Manufacturer for application.
   C. Deliver mastic grout ready for use.
   D. Deliver dry-set mortar in sealed, moisture-proof containers.
   E. Extra Stock
      Provide cartons of each type and tile. Supply extra two percent of total quantity of each tile used for Owner's future maintenance requirements. Place in clean marked cartons for Owner's emergency repair use.

1.04 SUBMITTALS
For each type, finish, and color of tile to be furnished, submit Product Data Sheets, material samples, and cleaning, protection and maintenance procedures.

PART 2 PRODUCTS

2.01 MATERIALS
   A. Ceramic Tile - See Finish Schedule for color, manufacture and size of ceramic tile.
   B. Floor Tile - Shall have a non-slip surface with a static antistatic coefficient of friction greater than .50 (ASTM D2047-75).
   C. Unglazed Ceramic Tile - Standard Grade per ANSI A137.1 Section 5.1, unglazed porcelain in 1/4 inch thickness with cushion edges. Provide all necessary shapes and trimmers of similar tile for curbs, depressions and corners. Mount tile using factory applied silicone back joint mounting system.
   D. Wall Tile
      1. Tile Trim Shapes and Bases - Provide trim units and shapes of same color, finish and type as surrounding tile. Include bases, bullnose caps, stops, beads, coves, returns, trimmers and other shapes indicated or required to produce a completely finished tile installation. Observe following general requirements:
         a. Walls - Continuous tile behind wall mounted mirrors (where applicable).
         b. Walls - Out-corners round.
         c. Walls - In-corners square.
         d. Walls - Bullnose cap on wainscot (where applicable), except provide regular flat tile where ceramic mosaic wall surface is flush with finished wall above.
         e. Floors - Cove base required.
f. Curbs - Bullnose and cove as required for smooth rounded surfaces.
g. Jambs - Bullnose where tile work projects from jamb.

F. Tile Setting Materials
1. Portland Cement - ASTM C150, Type I or II, gray or white as required.
2. Hydrated Lime - ASTM C206 or C207, Type S.
3. Sand - ASTM C144 for mortar or grout as required.
4. Water - Clean and drinkable.
5. Dry-Set Mortars - Conform to ANSI A118.1.

G. Grouting Materials
1. Tile Walls - Commercial, white Portland Cement type grout, wet or dry-cure formulation as appropriate, shall be used unless specified otherwise in finish schedule.
2. Ceramic Floors - Commercial, colored, sanded Portland Cement type.
3. Color Grout Pigment - Provide nonfading mineral oxides or carbon black emulsion of type not affected by lime or cement, and will not stain tile.
4. Sealants - Provide white, fungicidal and mildew resistant one-part silicone rubber sealant meeting Fed. Spec. TT-S-001543, Class A or B.

H. Glass Mesh Mortar Unit and Underlayment Materials shall be installed in all shower areas. Glass Mesh Mortar Unit shall be Aggregated Portland Cement board with vinyl-coated, woven glass-fiber mesh on both front and back surfaces. Thickness to be either 7/16" or 1/2". Edges to be square cut and finished smooth.

I. Joint Reinforcement - 2" wide glass-fiber, open-weave tape.

J. Fasteners - 1 1/4" Type S screws or 1 1/2" galvanized roofing nails.

K. Sealers
1. Porcelain unglazed floor tile, Cerama Seal, Silox 8, manufactured by Hydroment.
2. Floor grout, Cerama Seal, Silox 8, manufactured by Hydroment.

PART 3 EXECUTION

3.01 INSTALLATION

A. Environmental Conditions
1. Maintain temperature at 50°F minimum during tile work and for seven days after completion.
2. Provide adequate lighting for good grouting and cleanup.

B. Ceramic Tile Installation - Install tile conforming to following standards:
1. Dry-set Portland Cement mortar - ANSI A108.5.
2. Latex-Portland Cement mortar - ANSI A108.5. (Installation method is same as Dry-set Portland Cement method, ANSI A108.5.).

C. Mastic Grout - Comply with mastic Grout Manufacturer's instructions and ANSI A108.4.

D. Silicon Rubber Sealant - Comply with Sealant Manufacturer's instructions.

E. Floor Installation - Use TCA thin-set setting bed F113-85 for thin-set latex Portland Cement mortar bond coat.


G. Laying Out Work - Lay out work so no floor tile less than half size occurs. For heights stated in feet and inches, maintain full courses to produce nearest attainable heights without cutting tile, unless specifically noted otherwise on contract documents. Align joints in wall tile vertically and horizontally, except where other patterns are indicated. Align joints in floor tile at right angles to each other and straight with walls conforming to patterns selected. Obtain exact locations of expansion joints before installing tile. Grounds, anchors, plugs, hangers, bucks, electrical and mechanical work in or behind tile shall be installed prior to proceeding with tile work.

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Ceramic Tile
H. Acceptance of Surfaces to Receive Tile - Prior to installing tile, inspect sub-surfaces verifying surfaces are free from coatings, curing membranes, oil, grease, wax, dust and other contaminates. Start of tile installation implies acceptance of sub-surfaces to receive tile. Maximum variations of sub-surface shall not exceed those specified in the TCA methods.

3.02 GENERAL INSTALLATION
A. Provide joints for grouting in accordance with material manufacturer's requirements. Rub cut tile edges with a fine stone.
B. Damp cure dry-set grout in accordance with manufacturer's recommendations.
C. Mix grout to creamy consistency and thoroughly force into joints filling entire depth. Provide joint surfaces with uniform, smooth and continuously level joints. Mix only as much grout as can be used in one hour.
D. Before setting wall tile using thin-set method, apply primer sealing and leveling coat over surfaces to receive tile.
E. Do not install tile over smooth concrete backing material. Sandblast smooth concrete surfaces giving a rough mechanical key for tile setting bed. No chemical bonding agents will be permitted on exterior concrete surfaces.
F. Expansion Joints and Sealants
   1. Conform to above specified reference standards and TCA Spec. EJ711-85. Provide sealant at joints between tile and door frames and other metal accessories. provide expansion joint sealant on peripheries of walls and columns. Seal joints with silicone rubber sealant where tile butts into metal structures such as doors jambs and other materials that have different expansion co-efficients. All structural joints in building shall have expansion joints extending through tile and sealed with silicone sealant. In no case shall tile be carried over expansion joints without a joint in tile.

3.03 CLEANING AND PROTECTION
A. Cleaning - Clean tile surfaces thoroughly on completion of grouting. Remove grout haze, observing Tile Manufacturer's recommendations for use of chemical cleaners. Rinse tilework thoroughly with clean water before and after using chemical cleaners. Polish surface of tilework with soft cloth.
B. Sealing after floor tile has been cleaned, seal tile and grout in accordance with manufacturers written installation instructions. Cure grout minimum of three days if penetrating sealer is used. Cure grout a minimum of twenty one days if a surface sealer is used.
C. Protection from Construction Dirt - Apply to clean, completed tile walls and floors a protective coat of neutral cleaner solution, one part cleaner to one part water. In addition, cover tile floor with heavy duty, non-staining construction paper, masked in place. Before final acceptance of tilework, remove paper and rinse protective coat of neutral cleaner from tile surfaces and wax and seal joints.
D. Protection from Traffic - Prohibit foot and wheel traffic from using newly tiled floors for at least seven days. Place large, flat boards in walkways and wheelways for seven days, where use of newly tiled floor is unavoidable.

END SECTION
PART 1 - GENERAL

1.1 SUMMARY
A. Section includes acoustical panels and exposed suspension systems for ceilings.

1.2 ACTION SUBMITTALS
A. Product Data: For each type of product.
B. Samples: For each exposed product and for each color and texture specified.

1.3 INFORMATIONAL SUBMITTALS
A. Product test reports.
B. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS
A. Maintenance data.

1.5 QUALITY ASSURANCE
A. Testing Agency Qualifications: Qualified according to NVLAP.
B. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
   1. Build mockup of typical ceiling area as shown on Drawings.
   2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
A. Seismic Performance: Acoustical ceiling shall withstand the effects of earthquake motions determined according to ASCE/SEI 7
B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: Comply with ASTM E 1264 for Class A materials.
2. Smoke-Developed Index: 50 or less.

2.2 ACOUSTICAL PANEL CEILINGS, GENERAL

A. Low-Emitting Materials: Acoustical panel ceilings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 50 percent.

C. Glass-Fiber-Based Panels: Made with binder containing no urea formaldehyde.


E. Metal Suspension System Standard: Comply with ASTM C 635.

F. Attachment Devices: Size for five times the design load indicated in ASTM C 635, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.

2.3 ACOUSTICAL PANELS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or specific product manufactured by:

1. Armstrong World Industries, Inc; Fissured, or Fine Fissured “Second Look”
2. USG Interiors, Inc.; “F Fissured” panels

B. Classification:

C. Color: White or as indicated on Drawings

D. LR: Greater than 78.

E. NRC (Noise Reduction Coefficient): Not less than .70; type E-400 mounting according to ASTM E 795.

F. CAC (Ceiling Attenuation Class): Not less than 35.

G. AC: <Insert AC>.

H. Edge/Joint Detail: Square

I. Thickness: as indicated on Drawings.
J. Modular Size: 24 by 48 inches

2.4 METAL SUSPENSION SYSTEM

A. Basis-of-Design Product: Subject to compliance with requirements, provide product identified below:

1. Donn DX/DXL by USG Interiors, Inc.

B. Narrow-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; prepainted, according to ASTM A 653/A 653M, not less than G30 coating designation; with prefinished 9/16-inch wide metal caps on flanges.

1. Structural Classification: Heavy-duty system.
2. Face Design: Flat.

C. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install acoustical panel ceilings to comply with ASTM C 636/C 636M and seismic design requirements indicated, according to manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."

B. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders, and comply with layout shown on reflected ceiling plans.

1. Arrange directionally patterned acoustical panels as indicated on reflected ceiling plans.

END OF SECTION 095113
SECTION 096513 – RESILIENT BASE & ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES:

The work of this section shall include all labor, material, equipment and services required and necessary to furnish and install all resilient base and related items as indicated or specified.

1.02 SUBMITTALS

Submit Product Data Sheets, samples, manufacturer's installation instructions and cleaning and maintenance instructions.

1.03 DELIVERY, STORAGE AND HANDLING

Store all materials off the ground with watertight cover and away from sweating walls and other damp surfaces until ready for use. Protect materials from extreme temperatures and work and materials of other trades.

PART 2 PRODUCTS

2.01 MATERIALS

A. Base shall be molded rubber cover base as manufactured by Roppe, four inches high x 1/8 inch thick. Rubber base shall be provided in color(s) as specified and indicated by contract documents.

B. Base Adhesive shall be Roppe Rubber Cover Base Adhesive.

C. Underlayment shall be Tamm Floor Stone, manufactured by Tamms Industries; Web Patch, manufactured by Essex Chemical Corporation.

PART 3 EXECUTION

3.01 PREPARATION

A. Inspect all surfaces to receive base and report all defects that will affect the installation. The work under this section includes smoothing of walls with underlayment as required to receive cove base. Concrete surfaces to receive base shall be dry, free of paint and oil, and swept clean before work commences.

B. Contractor shall promptly repair any defects which appear in the surface after completion.

3.02 INSTALLATION

A. All rooms, subfloors, base and adhesives shall be maintained at a minimum temperature of 70°F for at least 48 hours before commencing work. A minimum of 70°F shall be maintained during installation and for at least 48 hours after completion.

B. Use matching preformed corners, cope and end-caps throughout. Use set-on cove, smooth, plain as indicated on drawings or recommended by manufacturers.

C. After preparation of wall surfaces, apply adhesive to back of base leaving top 1/4 inch free of adhesive. Press base firmly against the walls sliding horizontally into place, making sure toe is tight to the floor and against the wall. Roll the entire surface of the base with a hand roller and press the top of the base against the wall with a straight edge. Remove excess
adhesive immediately. Install preformed corners at all outside corners and reveals and cope at all internal corners. Where base terminates at projections, install end caps.

END SECTION
SECTION 096519 - RESILIENT TILE FLOORING

PART 1 GENERAL

1.01 SECTION INCLUDES:
The work of this section shall include all labor, materials, equipment, accessories and services required and necessary to furnish and install all resilient tile flooring and related items as indicated or specified.

1.02 QUALITY ASSURANCE
A. Installation of tile shall comply with the most recent RTI, Installation Specifications for VinylComposition Tile Flooring.
C. Allowable Tolerances - 1/8 inch in 10 feet from indicated plane or elevation.
D. Color and Pattern Matching - Furnish tile from the same manufacturing lot to complete each individual area and space contiguous to that area.

1.03 SUBMITTALS
A. Submit Product Data Sheets, samples, manufacturer's installation instructions and cleaning and maintenance procedures.
   1. Full size samples of each type, color and pattern of resilient tile flooring and base material.
   2. Include full color range and pattern variation.
   3. Reducer strip - 12-inch long samples.
B. Furnish one carton of additional floor covering materials for replacement and maintenance stock including each size, color, pattern and type of material required for the work.

1.04 PROJECT CONDITIONS
A. Unless otherwise directed by Designated Representative, store materials in original containers at 70°F minimum, for not less than 24 hours before installation.
B. Maintain temperature in space to receive this work between 70°F and 90°F 24 hours before, during and 48 hours after installation.
C. Maintain minimum temperature of 55°F after flooring is installed.

PART 2 PRODUCTS

2.01 MANUFACTURER
A. The resilient tile floor material shall be manufactured by Armstrong, Kentile, or Azrock, as specified or indicated by the contract documents.
B. Resilient Materials
   1. General - Uniform in thickness, size and color with variations in variegated patterns kept to a minimum. Colors and patterns shall be as indicated by the contract documents.
   2. Vinyl Composition Tile shall comply with FS SS-T-312, Type IV, 12-inch x 12-inch by 1/8-inch thick.
   3. Provide tapered rubber reducer strips as manufactured by Roppe, 1 inch wide (minimum) x 1/8 inch thickness to match adjacent tile thickness and color.
C. Applications Materials
   1. Furnish only material recommended by manufacture of covering material for the installation conditions.
   2. Tile adhesive shall be as recommended by resilient Flooring Manufacturer.
   3. Primer shall be nonstaining type recommended by Floor Covering Manufacturer.
   4. Crack Filler shall be product as recommended by Floor Covering Manufacturer.
   5. Cleaner, Wax and Other Finishing Material - Type recommended by Floor Covering Manufacturer for the particular type of flooring material.
PART 3 EXECUTION

3.01 EXAMINATION
A. Examine substrate for excessive moisture content and unevenness which would prevent execution and obtaining quality installation of resilient flooring.
B. Correct unsatisfactory conditions before proceeding with installation.

3.02 PREPARATION
A. Remove dirt, oil, grease, or other foreign matter from surfaces to receive floor coverings and bases.
B. Fill cracks with crack filler. Level and sand smooth.
C. Prime surfaces as recommended by Floor Covering Manufacturer.
D. Install materials only after finishing operations, including painting, have been completed.

3.03 APPLICATION
A. Apply adhesives in accord with manufacturer's instructions.
   1. Removal any adhesive which dries or films over.
   2. Do not soil walls, bases, or adjacent surfaces with adhesives.
   3. Promptly remove any spillage.

3.04 INSTALLATION
A. Installation of Tile
   1. Tile layout shall be centered on room or space so that tiles at perimeter of room are of equal width, with no tiles less than 1/2 width of a field tile.
   2. Match tiles for color and pattern by using tile from cartons in the same sequence as manufactured and packaged. If tile specified has a grain or directional pattern, the tile shall be installed with adjacent tile pattern perpendicular (checkerboard) unless noted otherwise by contract documents.
   3. Provide tile in a room or common space from the same run.
   4. Cut border tile neatly and accurately to fit within 1/64 inch of abutting surfaces.
   5. Fit flooring material neatly and tightly into breaks and recesses, against bases, around pipes and penetrations, under saddles or thresholds, and around permanent cabinets and equipment.
   6. Unless scheduled otherwise, lay tile parallel to room axis in straight courses with continuous cross-joints.
B. Installation of Reducer Strips
   1. Provide where floor covering terminates exposing edge of covering.
   2. Cut material to lengths and sizes required for installation.
   3. Apply adhesives and bond securely to substrates in straight true lines.
   4. Meet visible and related features of building construction with a maximum deviation of 1/8 inch in 10 feet.
   5. Center under door, where floor covering terminates at door openings.
   6. Fit end edges to door frames and abutting surfaces and other edges to adjoining materials.

3.05 CLEANING AND FINISHING
A. Clean surfaces with a neutral cleaner recommended by Floor Covering Manufacturer for type of floor covering material installed upon completion of installation of floor covering, adjacent work, and after materials have set.
B. Protect completed work from traffic and damage until accepted by Purchaser.

END SECTION
SECTION 096813 - TILE CARPETING

PART 1 GENERAL

1.01 SECTION INCLUDES:

A. The work of this section shall include all labor, materials, equipment and services required and necessary to furnish and install the carpet squares and related items as indicated or specified.

1.02 WARRANTY

A. The contractor shall guarantee all carpeting against defects of material and workmanship for two (2) years following the date of substantial completion. Carpet shall be guaranteed to remain firm and tight in place without wrinkling, creeping, seams opening or edges loosening.

B. All carpets should be guaranteed, from the date of contract completion, for a period of ten (10) years against wear of the surface pile of more than 10% in any given area. The Carpet Manufacturer shall replace the worn area with carpet of equal or better quality if such wear should occur and pay for the total cost, including labor, freight, etc., with no costs being passed onto the Purchaser.

1.03 SUBMITTALS

A. Submit Product Data Sheets, plans indicating location and layouts, shop drawings of all miscellaneous accessories, and manufacturer’s instructions for proper installation and maintenance procedures.

PART 2 PRODUCTS

2.01 MATERIALS

A. Carpet requirements shall be as follows unless noted otherwise on the Contract Documents:

1. **Project Administration Building**: Custom Color #155254 Spiced Candy and Ideas in Contrast #2404 Frosted Ming. By Interface or approved equal.

2. **Curry Road Facility**: Palace Plus Flecks 3000 #50201 Redwood Aurora and Prisms 3000 Flecks #155412 Nutmeg Rose and periodic accents with Palette Plus Flecks 3000 $50220. By Interface or approved equal.

3. **Southside Service Center, West Valley Service Center, East Valley Service Center, X-Cut Facility and Tempe Service Center**: Custom color #158537 Wolf Grey, and Synerpoint #17920000000 Cloisonne Custom Base Color #158537 Wolf Grey. By Interface or approved equal.

4. **Information Systems Building**: Customer Color Combining #50208 Cameo Aurora and #50207 Redwood Aurora Palette. Plus Flecks 3000 and Cameo Aurora Palette Plus Flecks 3000 #50208. By Interface or approved equal.

5. **All Facilities**: Carpet shall be of 100% Chromafast Nylon with Static Control Fusion Bonded Carpet, with minimum 28 oz. Weight and a minimum .250 height with a Glasbac Vinyl Backing 158 oz. and 18 x 18 in size.

6. **All Facilities**: Walk off time should be provided at all exterior entrances. A minimum of door width times 10 feet shall be provided and installed unless shown otherwise on the Contract Documents. Walk off tile should be #501 Grey. By Interface or approved equal.
B. Adhesive shall be resealable adhesive as approved by carpet manufacturer, equal.

C. Miscellaneous Materials – Provide all seam materials, edge trim, reducer strips and other miscellaneous materials as indicated or required for a complete job.

D. Spare Parts – Provide 5% extra carpet tiles of each type and color specified.

PART 3 EXECUTION

3.1 PREPARATION

A. Areas to receive carpet shall be dry, and other construction work shall have been completed. Air temperature and subfloor temperature shall be 50-70 °F minimum for 48 hours; in cold weather provide adequate heat to fulfill this requirement. Relative humidity shall be less than 60%.

B. Surfaces designated to receive carpet shall have grease and foreign matter removed by cleaning and scraping as necessary, and shall be thoroughly cleaned with a commercial vacuum cleaner. Grind any ridges and high spots in concrete surfaces smooth. Fill cracks in concrete with latex emulsion filler compatible with the adhesive.

C. Carpet shall be opened and relaxed for 24 hours prior to installation.

D. Sweep and damp mop the area to receive carpet.

3.2 INSTALLATION

A. Carpet shall be laid out to ensure perimeter squares to be maximum size. Narrow strips shall not be acceptable.

B. Apply adhesive in one direction only with one four (4) inch strip (tac line) at ten foot intervals and along the perimeter. After adhesive is tacky and will not transfer to the back of the carpet squares, squares shall be applied at center area of application and worked in quadrants using the pyramid technique.

C. Carpet squares shall be laid accurately and firmly, butting each against its neighbor. Seams shall be tight and blended with a steam roller.

D. Install carpet and adhesive per manufacturer’s recommendations.

E. The final installation shall produce a carpeted surface that is smooth, lays completely flat, without ripples, wrinkles or surface irregularities. The carpet shall be free of any rips, tears, pulled yarns, stains or discoloration.

F. Where one color carpet transitions into a different color carpet or material at the doorway, trim carpet so that it ends directly under the center of the door. Where carpet abuts another flooring material, provide proper edge trim to produce a smooth transition and finished appearance. All edge trim shall be securely attached to the floor slab in accordance with the manufacturer’s recommendations.

3.3 CLEANING

A. All carpet shall be vacuumed thoroughly immediately after installation.

END SECTION
SECTION 096816 – SHEET CARPETING

PART 1 GENERAL

3.1 SECTION INCLUDES:

   A. The work of this section shall include all labor, materials, equipment, accessories and services requires and necessary to furnish and install all direct glue down carpeting and related items as indicated or specified.

3.2 SUBMITTALS

   A. Submit Product Data Sheets, shop drawings (seam diagram), and manufacture’s recommendations for care, cleaning and maintenance.

   B. Provides a shop drawing layout for each area to receive carpet showing pattern, seam locations, color trim, strips, and any pertinent installation details and requirements.

3.3 QUALITY CONTROL

   3 By the Manufacturer

       1. Furnish roll numbers and other information which will enable identification of the certified carpet. Inspect all carpet after manufacture for manufacturing defects.


   4 By the Installer

       1. Review manufacturer’s recommendations and recommend in writing variations required to assure installation guarantee. Guarantee installation to hold carpet firmly and tightly in place without seam openings, wrinkling, creeping, edge loosening or seam revealing for two years. Guarantee shall cover full value of installation and material requiring replacement due to installation defects.

       2. Overage and scraps – Neatly package scraps and trimmings over three feet in any one dimension in small quantities and deliver to the owner at the Project. Include as overage one piece of carpet of each color but not less than 10 feet x carpet width.

PART 2 PRODUCTS

3.1 MATERIALS

   A. General – All materials shall be delivered to the Project or approved cutting shop in original packaging and labeled with reference to certificate identifying product with specification.

       1. See contract documents for identification of carpet description and areas of installation.

       2. Adhesive – As recommended by Carpet Manufacturer.

       3. Underlayment – Portland Cement/latex concrete floor filler for leveling concrete floor as recommended by Carpet Manufacturer.

       4. Termination Strips – Concealed type, as recommended by Carpet Manufacturer.
PART 3 EXECUTION

3.1 INSTALLATION

A. Install carpet in strict accordance with manufacturer’s published instructions. Installer shall be approved by Carpet Manufacturer and shall use manufacturer approved techniques, tools and accessories. In the absence of published instructions, the supplier’s recommendation as to method of installation and adhesives shall be used.

3.2 PREPARATION

A. Preparation and Surfaces – Inspect surfaces to receive carpet, make tests recommended by Carpet Manufacturer, take corrective action deemed necessary in writing of any condition which would be detrimental to carpet installation. Remove all foreign and incompatible materials and vacuum clean surfaces immediately prior to installation of carpet. Fill cracks, construction joints and other surface imperfections with latex underlayment compound troweled level with adjacent surface. Commencement of work constitutes acceptance of surfaces and responsibility for them.

B. Make installation continuous under all removable, portable and/or accordion partitions. Seam layout shall provide a minimum total seam length with minimum head seams. Head seams shall not be located in areas of heavy traffic.

END SECTION
SECTION 096900 - ACCESS FLOORING

PART 1 GENERAL

1.01 SECTION INCLUDES:
A. The work of this section shall include all labor, materials, equipment, services and accessories required and necessary to design and install the access floor system as indicated and specified.
B. Access floor system shall be a system of 24" square modular panels supported by adjustable pedestals and stringers, providing an underfloor cavity for mechanical and electrical systems, and shall be rigid, free of rocking panels, rattles, squeaks and other noises.
C. Contractor shall:
   1. Furnish and install ramps, steps, fascia and handrails where indicated on drawings and required in accordance with UBC.
   2. Provide accessories as required to complete installation, including panel lifting device(s) service outlets, and cable cutouts with trim as noted on Finish Schedule. Supports at cutouts shall comply with Section 1.02-A. Provide grommets at service outlets with cover plates colored to match the approved floor finish.
   3. Furnish eight percent of all panels as perforated air supply panels with dampers (25% 300 cfm minimum air volume at .2" static pressure).
   4. Provide ten percent extra materials not included in quantities stated above or required for complete installation.

1.02 SYSTEM DESCRIPTION
A. Static Electricity
   1. The system shall be an electrically continuous unit with a maximum resistance between panels and understructure of 10 ohm.
   2. Surface - 1kV or less at 20 percent R.H. at 70 degrees F.
   3. Ground - Coordinate electrical requirements to assure adequate ground throughout.
B. Fire Protection
   1. Access floor system shall be in accordance with National Fire Protection Association (NEPA) Standard No. 75-255 (latest revision).

1.03 SUBMITTALS
A. Submit Product Data sheets, setting drawings, parts list, shop drawings indicating layouts, and cleaning and maintenance instructions. Layouts shall indicate floor panel layout, including railing, ramp, and step locations.
B. Submit one full size floor panel representative of panel to be furnished to meet this specification. Floor panel to be permanently stamped with manufacturer's model name or number indicating the floor panel concentrated load rating.
C. Submit one full size sample of each understructure component.
D. Samples submitted to be the standard of acceptance of the final installation.
E. Submit calculations prepared and stamped by a registered civil or structural engineer in the State of Arizona indicating compliance with all specified design criteria.
F. Certificates
   1. Furnish test reports certified by an independent testing organization indicating compliance with specified panel and understructure strength criteria.
   2. Provide certification that materials and installation were furnished in accordance with this specification.

1.04 QUALITY ASSURANCE
A. Design Criteria
   1. The entire system shall be capable of supporting the most critical of the following two loading conditions:
a. Dead load and a uniformly distributed design live load of 300 pounds square foot with 0.040 inch maximum deflection.
b. Dead load and a concentrated design load of 1,000 pounds applied through a one square inch area at any point on the panel with a maximum deflection of 0.080 inch.

2. The ultimate load capacity of the entire system shall be two (2) times the design load.

3. The entire system (including pedestals, welds, base plates, concrete anchors and bonding adhesive) shall be designed for Seismic Zone 2 in accordance with UBC, 1985 Edition, Section 2312 (g) and the following:
   a. Wp (from UBC equation 12-8) shall not be less than the dead load of the access floor system plus 33 percent of the 300 pounds per square foot floor live load.
   b. The Occupancy Importance Factor I shall equal 1.5.
   c. The effective length factor K for pedestal tubes or studs shall not be less than 1.7.
   d. The bonding adhesive shall have a minimum factor of safety of 1.7 under design loads.
   e. The lateral force F shall be applied two inches above the top of the finished floor surface.
   f. Pedestal base plate assemblies shall be designed to assure that the maximum tensile stress in the concrete floor (by others) does not exceed 125 psi.
   g. The base plate thickness shall be designed on the assumption that the overhanging portion of the base plate acts as a cantilever beam with its fixed end inside the outside edge for the tube (or stud).
   h. Shimmed base plate assemblies must meet the requirements of Section 1.02-A.

4. Understructure design shall be done in accordance with the latest edition of the AISICold-Formed Steel Design Manual and this specification.

B. Allowable Tolerances
   1. Floor panel flatness - plus or minus 0.010 inches on diagonal on top of panel or underneath edge.
   2. Floor panel surface dimensions - plus or minus 0.005 inches.
   3. Floor panel squareness - plus or minus 0.005 inches.
   4. Finished access floor - level within plus or minus 0.060 inches in 10 feet and plus or minus 0.10 inches over the entire floor.
   5. Finished floor height - as indicated on drawings.

PART 2 PRODUCTS

2.01 COMPONENTS

A. Panels shall be 24" square welded steel construction assemblies, flat, square, finished inside and out and fully interchangeable after installation.

B. Pedestals
   1. Pedestal assemblies shall be galvanized steel construction, in accordance with ASTM A123 and A500, with a minimum vertical adjustment of 2 inches.
   2. Pedestal assemblies shall be capable of resisting a direct axial compressive load of 5,000 pounds without distress or failure of any part.
   3. Pedestal assemblies shall be secured to the subfloor with an adhesive and/or mechanical anchors approved by the Engineer. Pedestal adhesive, anchors and pedestal assemblies without stringers in place shall be capable of resisting the specified seismically induced overturning moment (Section 1.02-A3) without overstressing of adhesive, anchors or any part of pedestal assembly.
C. Stringers
   1. Each panel shall be supported by not less than 20 gauge galvanized steel stringers spanning from pedestal to pedestal and in accordance with ASTM A123 and A374.
   2. Stringers shall be readily removable and be sized to maintain pedestal spacing for the panel module. Stringers shall laterally contain the bottom pan section of the panel.
   3. Stringers shall support a minimum 200 pound load applied through a one square inch area at the center with elastic deflection not to exceed 0.01 inches.
   4. Interface between panel and stringer shall provide sound deadening and complete plenum sealing.
   5. Total depth of panel and stringer is not to exceed 1-1/2 inches.
   6. Each end of each stringer shall be positively fastened to pedestal head, using screws or bolts approved by Engineer with a minimum torque of 40 inch pounds. Holes for screws or bolts shall be accurately located to correspond with a panel module within ±0.10 in.

D. Flooring
   1. Nevamar 1/8" thick melamine phenolic high pressure laminate (if included in contract documents) with vinyl edge trim or approved equal. Color as selected and indicated by Purchaser.
   2. Carpet (if included in contract documents) must be factory adhered to panels with a moisture resistant bonding adhesive by access floor manufacturer. Carpet shall be installed so as to not void any carpet warranty set forth in specifications. Carpet to be as selected by Purchaser.

2.02 FINISHES
A. Metal - All components shall be painted or corrosion resistant including panel interior.

PART 3 EXECUTION

3.01 INSTALLATION
A. Install per access flooring manufacturer's recommendations and instruction and as shown on plans.
B. The installer shall avoid interference with mechanical, electrical, plumbing and other construction which will occur beneath system. If interferences cannot be avoided, installer shall provide bridging in accordance with Section 1.02-A.
C. Clean soiled or discolored surfaces after installation.
D. Remove and replace units damaged, improperly installed or soiled beyond cleaning.

3.02 FIELD QUALITY CONTROL
A. Field Testing
   1. Prior to installation, the Contractor shall install and cure a minimum of three (3) test pedestals which shall be attached to the concrete floor in an identical manner as the new access floor shall be installed. Test pedestal installation shall be witnessed by the Designated Representative.
   2. After the manufacturer's recommended cure period and prior to installation, the D. R. will conduct overturning moment tests on the test pedestals. Each test pedestal will be tested without stringers for positive and negative overturning moment resistance about each major axis.
   3. If any test pedestal fails at an overturning moment less than 1.7 times the design moment (as determined in Section 1.02-A3), the Contractor shall anchor three (3) new test pedestals with an improved method approved by the Designated Representative. The new test pedestals shall be tested in the same manner as the failed pedestals.
   4. The Access Floor Contractor will not be responsible for concrete floor failures.
   5. The Contractor shall provide all cut-outs as noted on the drawings.

END SECTION

VER:12/07  1096900 - 3 Access Flooring
SECTION 097200 – WALL COVERINGS

PART 1 GENERAL

1.01 SECTION INCLUDES:
The work of this section shall include all labor, material, equipment accessories and services required and necessary to furnish and install all wallcovering and related items as indicated or specified.

1.02 REFERENCES
All materials and services provided shall comply with the following specifications and standards:
A. American Society For Testing and Materials (ASTM)
   1. D751 - Method of Testing Coated Fabrics
B. Federal Specifications (Fed. Spec.)
   CCC-W-408B - Wallcovering, Vinyl Coated
C. Federal Standards
   1. 191/5041 - Determination of Weight of Textile Materials, Small Specimen Method
   2. 191/5100- Strength and Elongation, Breaking of Woven Cloth; Grab Method
D. General Services Administration (GSA)
   1. 4-0995 - Guide Specifications for Wallcovering

1.04 DELIVERY, STORAGE AND HANDLING
A. Deliver materials to the Project site in their original unopened packages or containers bearing label clearly identifying manufacturer, brand, color, dye lot number, pattern, weight and other pertinent information.
B. Store materials flat in original packages or containers in dry area at a temperature not more than 90 or less than 70°F at least 24 hours before start of installation.

1.05 PROJECT CONDITIONS
A. Maintain spaces to receive the work at a temperature of not more than 90 or less than 70°F at wall base level for at least 48 hours prior to, during and 48 hours after installation.
B. Install materials only when normal temperature and humidity conditions approximate the interior conditions that will exist when building is occupied.

1.06 SUBMITTAL
A. Submit Product Data Sheets, samples of fabric wallcovering and manufacturer's instructions for cleaning and maintenance procedures.
B. Samples of fabric wallcovering shall be approximately 54 by 54 inches in size, and shall be representative of the material to be provided for this Project.
C. Color samples shall be approximately 6 by 6 inches in size. Where one color and pattern is selected, sample of fabric wallcovering only will be required.

1.07 SAMPLE INSTALLATION
Install wallcovering in a room selected by the Designated Representative from the rooms scheduled to receive wallcovering. The finished wallcovering in the designated room shall be approved prior to the start of work in other areas. The approved sample wallcovering installation shall be used as the standard for all such work.

1.08 WARRANTY
A. This contract shall provide a two year warranty against faulty materials or workmanship, or both, and against failure of wallcovering, except where such failure is due to abuse or failure of related work installed by other parties.
B. During the warranty period, restore defective work to the standard of the Contract Documents, including all materials, labor, refinishing and other costs incidental to the work. Inspect the work within 24 hours.

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Wall Coverings
after receipt of notice from the Purchaser. Restore work found to be defective as defined in the Contract Documents within 10 days after receipt of notice from the Purchaser.

PART 2 PRODUCTS

A. Wallcovering
   1. Wallcovering color, type and finish shall be as specified herein and indicated by the contract documents.
   2. Vinyl wallcovering shall be pigmented vinyl plastic and plasticizers fused or laminated to dimensionally stable and mildew resistant woven poly/cotton backing, 48 inches to 54 inches in width.
   3. Fabric wall covering shall have an acrylic backing factory applied by the manufacturer.
   4. All wall coverings shall be factory treated with an antimicrobial product to inhibit the growth of deleterious and/or odor causing organisms.

B. Fabric wall covering No. 1
   Manufacturer: Knoll
   Style: Double Dash Texture
   Color: WB278/1 Graymulti
   Width: 54 inches
   Content: Wool 40%, Rayon 24%, silk 20%
   Cotton 8%. Polyester 8%
   Weight: 17.75 ounces per linear yard
   Finish: Acrylic backed for wall application
   Flame Retardant
   Flame Retardant Rating: NFPA 701 small scale-pass ASTM E-84 Class A fire Rating UBC 4202.A (delamination test - Pass)

C. Fabric wall covering No. 2
   Manufacturer: Knoll
   Style: Niji
   Colors: W350/1 Dove; W350/3 Almond
   Width: 53/54 inches
   Content: Rayon 41%, Cotton 39%, Polyester 20%
   Weight: 13 ounces per linear yard
   Finish: Acrylic backed for wall application
   Scotchgard
   Flame Retardant Rating: ASTM E84 Class A flame spread rating UBC 4202.A (delamination test - Pass)

D. Adhesive shall be fire retardant type containing an antimicrobial product to inhibit the growth of deleterious and/or odor causing organisms. Use only adhesives acceptable to fabric manufacturer.

E. Provide clear plastic corner protectors at all wall exterior corners receiving wall fabric. Corner guards shall have one inch angle legs and be anchored with screws provided. Height of corner protectors shall be similar to height of adjacent modular wall panels, and terminate at top of base.

F. Provide metal termination bars and accessories as manufactured by PICOM and Fry in all applicable locations.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine surfaces to receive materials of this section. Defects which may influence satisfactory completion and performance of this work shall be corrected in accordance with the requirements of the applicable section of work prior to commencement of the work. Commencement will be construed as work in place being acceptable for satisfying the requirements of this section.

B. Protect the work and adjacent work against damage during progress of work. If further construction work adjacent to the finished wallcovering is necessary, protect wallcovering with suitable materials as recommended by the Wallcovering Manufacturer.
C. Following completion of work in a space, thoroughly clean wallcovering surface in accordance with Wallcovering Manufacturer's instructions.

3.02 INSTALLATION

A. Surface Preparation

1. Surfaces to receive wallcovering shall meet the minimum requirements of the Wallcovering Manufacturer and shall be clean, dry, thoroughly cured and free from materials detrimental to the required bond or materials which will bleed through the wallcovering.

2. Prime or size plaster surfaces as recommended by the Wallcovering Manufacturer. Neutralize hot areas in plaster.

3. Prime gypsum wallboard with one coat of vinyl sealer.

4. Previously painted surfaces shall be in sound condition and shall not contain water-sensitive materials or pigments that bleed in water or oils. Test painted surfaces and treat as recommended by the Wallcovering Manufacturer.

5. Work shall not be started until work of other trades that passes through wallcovering has been completed. Remove hardware, plates and other accessories to allow installation and replace upon completion of the work.

B. The entire exposed wall surface shall receive wall covering, unless noted otherwise. This includes but is not limited to reveals, terminations and recesses. Wallcovering shall be tucked into a framing member when possible. The top of partial height walls shall be fully covered unless noted otherwise. Wallcovering shall be underneath all hardware plates and accessories. Trim wallcovering material within three inches of the floor.

C. Mix and apply adhesive in accordance with adhesive manufacturer's instructions.

D. Handle and apply fabric wallcovering in accordance with manufacturer's instructions and the following:

1. Use fabric panels in exact order as they are cut from rolls. Use rolls in consecutive order. Fill in spaces above and below windows, above doors and similar areas in sequence from the roll.

2. Trim deeply textured patterns or patterns on which strips must be matched, on a work table, using a metal straight edge and sharp razor blade.

E. The installed wallcovering shall be secure, smooth, clean and without wrinkles, gaps or overlaps. Vertical seams shall be plumb and at least six inches away from any corner. Horizontal seams will not be accepted.

F. Wallcovering shall be discontinuous at control joints in the wall surface.

G. Tuck wallcovering into flanges of hollow metal frame if possible. If not possible cut wallcovering tight against flanges of frame.

END SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES:
A. The work of this section shall include all labor, materials, equipment, accessories and services required and necessary to complete all painting and finishing required for surfaces as indicated or specified.
B. The type of material to be used and the number of coats to be applied are listed in the “Schedule of Finishes” in Part 3.0 of this Section.
C. The term "paint" as used herein includes enamels, paints, stains, sealers, fillers, emulsions and other coatings whether used as prime, intermediate or finish coats.
D. The work required under this section consists of all painting, finish work and related items necessary to complete the work required.

1.02 SUBMITTALS
A. Submit Product Data Sheets, material manufacturer's instructions for application, and cleaning and maintenance procedures.
B. Upon selection of the colors, prepare and deliver two identical sets of samples of the selected colors applied to 8-1/2 inch by 11 inch by 1/4 inch thick material; the material for samples shall be of a similar material to that upon which the coating will be applied in the work. Samples of paint materials to be applied to metal surfaces (such as metal partitions or furniture) shall be submitted on six inch square pieces of metal.
C. At completion of project work, additional material to be provided to Purchaser for maintenance purposes shall be limited to one gallon of each separate color of each material applied.

1.03 DELIVERY, STORAGE AND HANDLING,
A. Deliver all materials to the job site in their original, sealed, unopened containers with all labels intact and legible at the time of use.
B. Store the approved materials at the job site store only in a suitable, designated area restricted to the storage of paint materials and related equipment.
C. Ensure the safe storage and use of materials and the prompt and safe disposal of waste. Store hazardous waste materials only in approved containers in areas designated for such storage by the Designated Representative. At completion of project work, properly dispose of any accumulated hazardous wastes resulting from this project work.
D. Protect materials before, during and after application and protect the installed work and materials of all other trades.
E. In the event of damage, immediately make all repairs and replacement necessary to the approval of the Designated Representative and at no additional cost on the contract.
F. At the end of each day, remove all oily rages and unnecessary combustible materials and debris from the premises.

1.04 QUALITY ASSURANCE
A. All materials used must comply with local air pollution control district regulations and federal lead content laws.
B. Extreme caution shall be exercised during the application and curing of products that may off-gas volatile organic compounds (VOCs) to insure the health and comfort of building occupants is not affected. Adequate ventilation and the use of auxiliary fans shall be provided as necessary to maintain an acceptable environment within the building.

PART 2 PRODUCT

2.01 MATERIALS
A. Materials listed herein are the product of Pittsburg Paints.
B. All materials and equipment shall be compatible to use; finish coats shall be compatible with prime coats; prime coats shall be compatible with the surface to be coated; all tools and equipment shall be compatible with the coating to be applied, etc.
C. Thinner, when used, shall be only those thinners recommended for that purpose by the manufacturer of the material to be thinned.
D. Each base coat shall have a slight color variation from the finish color.

PART 3 EXECUTION

3.01 QUALITY ASSURANCE
A. Use only qualified craftsmen for the mixing and application of materials. In the acceptance or rejection of installed painting, no allowance will be made for lack of skill on the part of applicators.
B. In addition to complying with all pertinent codes and regulations, comply with the recommendations of the Painting and Decorating Contractors of America in their "Modern Guide to Paint Specifications", latest edition.

3.02 GENERAL
A. Furnish clean drop clothes, or other accessory materials as necessary to protect floors, equipment, fixtures and all other surfaces from splatter, droppings and spilling at all times.
B. Colors will be selected from the approved manufacturer’s standard color charts, and all tinting and mixing of finish coats shall be done with paint manufacturer’s approved equipment.
C. Job matching or job tinting to suit field conditions may be done only after approval by the Designated Representative.
D. Do not execute any work under conditions which are unsuitable for the production of satisfactory results, such as wet or windy weather, dust, storm, extreme cold or hot, or conditions determined to be not acceptable by the Designated Representative, or in compliance with the paint manufacturer’s requirements.
E. All floor and other adjacent surfaces shall be free from dust, debris, etc. before painting work is commenced. As required, make area acceptable for coating application before starting work.
F. Surface preparations shall be in accordance with standards and recommendations of the Painting and Decorating Contractors of America and the respective product manufacturer's written directions.

3.03 EXAMINATION
A. Surface Conditions
1. Prior to all work of this section, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence. In the event of discrepancy, immediately notify the Designated Representative.
2. Application of materials will be construed as acceptance of surfaces and this contractor shall be entirely responsible for the finished work.

3.04 PREPARATION
A. Preparation of Surfaces
1. Existing surfaces to receive paint, etc. shall be thoroughly cleaned and prepared in accordance with the best trade practices and the respective manufacturer's directions.
2. Prior to all surface preparation and finishing operations, completely mask, remove, or otherwise adequately protect all hardware, accessories, machined surfaces, plates, lighting fixtures, and similar items in contact with painted surfaces but not scheduled to receive paint. Paint/coatings shall be applied behind all removable trim.
3. Schedule all cleaning and materials application so that dust and other contaminants from the cleaning process will not fall on newly finished surfaces.

B. Special Preparatory Work
1. Fill all nail holes, dimples in door frames, cracks, open joints and other defects after the first or priming coat is dry. Before the second coat is applied, spot prime all repairs.
2. All patching and caulking shall be with up-to-date manufacturer specified material, compatible with the stains, primers and finishes to be used.
3. Fill all defects to match adjacent surfaces.
4. Touch up damaged shop coats on metal with rust-inhibitive primer.
5. Remove rust, mill scale, etc. on metal down to sound surface and bring forward to receive finish coats.
6. Properly clean, patch, bring forward as necessary and prepare in accordance with the manufacturer’s printed directions all damaged and existing surfaces prior to finishing.
7. Thoroughly clean all surfaces free from dirt, oil and all other foreign substances.
8. Allow surfaces to dry thoroughly before application of finish.
9. Remove all dust and loose mortar from concrete and masonry by sweeping or brushing. Remove efflorescence with a muriatic acid solution, which requires a clean water rinse, or with a phosphoric acid solution, and allow to dry.

3.05 APPLICATION
A. Paint all exposed surfaces, including tops, sides and bottom.
B. Comply with the manufacturer’s recommendations regarding environmental conditions under which the coating systems may be applied.
C. Use a moisture-meter to test plaster and gypsum wallboard surfaces, to verify compliance with manufacturer’s recommendations.

3.06 REINSTALLATION
A. Following completion of painting in each space, promptly reinstall all items removed for painting and use only workmen skilled in the particular trade.
B. Exercise care during the reinstallation of items so that finished surfaces are marred or damaged. Any areas finished paint surfaces that are marked, marred, or otherwise damaged during reinstallation will be touched-up/refinished as necessary to conceal the damage.

3.07 RESTORATION
A. For existing surfaces, verify that the specified finishes are compatible with existing surface treatments.
B. Provide prime coats, undercoats, repairs and other preparatory work on existing surfaces as necessary to make the existing surface meet the material manufacturer’s requirements for acceptable substrate for application of specified materials.

3.08 CLEAN UP
Upon completion of this work all surfaces marred by the painting or finishing operations shall be properly cleaned and left in an acceptable condition as required by the contract documents and approved by the Designated Representative.

3.09 PAINT FINISH SCHEDULE
Provide paint finishes as indicated by the contract documents in accordance with this paint finish schedule. The material manufacturer and this contractor shall review the schedules for applicable material use and be responsible for proper material selection and application for project specific conditions.

SRP INTERIOR PAINT FINISH SCHEDULE
NEW INTERIOR FINISHES
A. Metal Galvanized and Ferrous
   1. Primer OR 90-712 Series Waterborne Acrylic
   2. Finish (flat) OR 6-70 Series
   3. Finish (semi) OR 6-510 Series Latex Enamel
   4. Finish (satin) OR 90-474 Series Waterborne Acrylic
B. Wallboard Interior
   Flat
   1. 2 Coats OR 6-70 Series Flat Latex
      OR
   Semi Gloss
   1. Primer 6-2 Sealer
   2. Finish 6-510 Series Latex Enamel
      OR
   Gloss
   1. Primer 6-2 Sealer
   2. Finish 51-110 Series Waterborne Enamel
      OR
   Epoxy (extremely wet areas)
   1. Primer 6-2 Sealer
   2. Finish 16 Series PittGlaze Acrylic Epoxy
C. Masonry Interior
   Block
   1. Primer 6-7 Blockfill
   2. Finish materials Same as wallboard
   Plaster (check pH prior to application)
      Same material systems as wallboard
D. Interior Metal Ceilings
   1. Ferrous Primer 90-712 Waterborne Acrylic
      (if factory primed, spot prime only)
      OR
   1A. Galvanized Clean and prime to remove all contaminants
      2. Finish (flat) 6-715 Latex Dry Fog
      OR
      Finish (semi) 6-714 Latex Dry Fog
      OR
      Finish (gloss) 90-274 Series Acrylic

INTERIOR REPAINT FINISHES
A. Scuff sand any surface having existing gloss finish
B. Wallboard, Plaster, Stucco and Masonry
   1. First Coat 6-755 Latex undercoat
   2. Finish (flat) 6-70 Series Latex
      OR
   3. Finish (semi-gloss) 6-510 Series Latex Enamel
      OR
   4. Finish (gloss) 51-110 Waterborne Enamel
      OR
   5. Finish (epoxy) 6-755 Enamel Undercoat
      Aquapon 9-130-A
      Aquapon 9-139-B
C. Ferrous and Galvanized Metals
   1. Primer OR 6-712 Inhibitive Primer
      90-712 Acrylic Primer
      OR
   2. Finish (flat) 6-70 Series Latex Flat
      OR
   3. Finish (semi-gloss) 6-510 Series Latex Enamel
      OR
   4. Finish (gloss) 51-110 Waterborne Enamel
D. Interior Wood
   1. Primer 6-755 Enamel Undercoat
   2. Finish (flat) 6-700 Series
3. Finish (semi-gloss) | 6-510 Series Latex Enamel
   OR
4. Finish (satin) | 90-474 Series Waterborne Acrylic
   OR
5. Finish (gloss) | 90-374 Series Waterborne Acrylic

E. Interior Wood Stain
1. 1 coat Quality Stain
2. 1 coat Compatible Sealer
3. 2 coats Designated Type Finish

**SRP EXTERIOR PAINT FINISH SCHEDULE**

**NEW EXTERIOR FINISHES**

A. Galvanized Metal
1. Clean and Solvent Wash to remove all contaminants
2. Primer | 6-712 or 90-712 Primer
3. Finish (flat) | 6-610 Series Acrylic Latex
   OR
4. Finish (gloss) | 90-374 Series Gloss

B. Ferrous Metals
1. Primer | 6-712 Waterborne Primer
   (omit primer and spot prime only if factory primed)
2. Finish (flat) | 6-610 Series Acrylic Latex
   OR
3. Finish (gloss) | 90-374 Series Gloss

C. Wallboard Exterior
1. 2 coats | 6-610 Series Acrylic Latex Flat

D. Wood Exterior (paint)
1. Primer | 6-609 Alkyd Modified Acrylic Latex
2. Finish (flat) | 6-610 Series Latex
   OR
3. Finish (semi-gloss) | 6-901 Series Acrylic Latex

E. Wood Exterior Stain
1. 2 Coats (solid Color) | 77-400 Series
2. 2 Coats (transparent) | 77-460 Series

F. Masonry with Stucco, Cement Plaster
   Check PH on surface prior to application
1. Primer | 2099 Acrylic Primer
2. Finish (flat) | 6-610 Series Acrylic Latex
   OR
3. Finish (eggshell) | 76 Series Acrylic

G. Masonry Block
1. First Coat | 6-7 Block Fill
2. Finish (flat) | 6-610 Series
   OR
3. Finish (eggshell) | 76 Series eggshell

H. Exterior Acrylic - Elastomeric
1. Finish | 4-110 Pitt Flex

**EXTERIOR REPAINT FINISHES**

A. Scuff sand any surface have existing gloss finish

B. Metals; Ferrous, Galvanized, Aluminum
   Clean as per material manufactures requirements
1. Prime Coat | 90-712 Waterborne Acrylic Primer
2. Finish (flat) | 6-610 Series Acrylic
   OR
3. Finish (satin) | 90-474 Waterborne Acrylic
4. Finish (gloss) 90-374 Waterborne Acrylic

C. Masonry
1. After cleaning, if chalking is still present, prime with 2009 Acrylic Primer
2. Finish (flat) 6-610 Series Latex
   OR
3. Finish (eggshell) 76 Series Acrylic

D. Wallboard
1. Spot prime with finish coat
2. Finish (flat) 6-610 Series Acrylic Latex
   OR
3. Finish (semi-gloss) 6-900 Series Acrylic

E. Wood
1. Spot Prime 6-609 Acrylic Latex Primer
2. Finish (flat) 6-610 Series Acrylic Latex
   OR
3. Finish (semi-gloss) 6-900 Series Acrylic

F. Factory Finished Metal Buildings
1 or 2 coats 71 Series Metal Siding Refinish

END SECTION
SECTION 102113 - TOILET COMPARTMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel toilet compartments configured as toilet enclosures and urinal screens.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For toilet compartments. Include plans, elevations, sections, details, and attachments to other work.

C. Samples for each exposed product and for each color and texture specified.

1.3 INFORMATIONAL SUBMITTALS

A. Product certificates.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.5 QUALITY ASSURANCE

A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84, or another standard acceptable to authorities having jurisdiction, by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 75 or less.

2. Smoke-Developed Index: 450 or less.

B. Regulatory Requirements: Comply with applicable provisions in the revised regulations for Titles II and III of the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA)" and 28 CFR 35.151; 28 CFR part 36, Subpart D; and the 2004 ADAAG ("the 2010 ADA Standards") for toilet compartments designated as accessible.
PART 2 - PRODUCTS

2.1 MATERIALS

A. Steel Sheet: Commercial steel sheet for exposed applications; mill phosphatized and selected for smoothness.
   1. Electrolytically Zinc Coated: ASTM A 879/A 879M, 01Z.

B. Zamac: ASTM B 86, commercial zinc-alloy die castings.

2.2 STEEL UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Accurate Partitions Corporation.
   2. All American Metal Corp.
   4. Ampco, Inc.
   5. Bradley Corporation; Mills Partitions.
   6. Flush Metal Partition Corp.
   8. Global Steel Products Corp.
   9. Hadrian Manufacturing Inc.
   11. Metpar Corp.

B. Toilet-Enclosure Style: Floor anchored or Floor and ceiling anchored.

C. Urinal-Screen Style: Wall hung, flat panel; Wall hung with integral flanges; Floor anchored]

D. Door, Panel, and Pilaster Construction: Seamless, metal facing sheets pressure laminated to core material; with continuous, interlocking molding strip or lapped-and-formed edge closures; corners secured by welding or clips and exposed welds ground smooth. Exposed surfaces shall be free of pitting, seam marks, roller marks, stains, discolorations, telegraphing of core material, or other imperfections.
   1. Core Material: Manufacturer's standard sound-deadening honeycomb of resin-impregnated kraft paper in thickness required to provide finished thickness of 1 inch for doors and panels and 1-1/4 inches for pilasters.
   2. Grab-Bar Reinforcement: Provide concealed internal reinforcement for grab bars mounted on units.
   3. Tapping Reinforcement: Provide concealed reinforcement for tapping (threading) at locations where machine screws are used for attaching items to units.

E. Urinal-Screen Construction:
1. Flat-Panel Urinal Screen: Matching panel construction.
2. Integral-Flange, Wall-Hung Urinal Screen: Similar to panel construction, with integral full-height flanges for wall attachment, and maximum 1-1/4 inches thick.

F. Facing Sheets and Closures: Electrolytically coated or hot-dip galvanized-steel sheet with nominal base-metal (uncoated) thicknesses standard with manufacturer.

G. Pilaster [hoes and Sleeves (Caps): Stainless-steel sheet, not less than 3 inches high, finished to match hardware.

H. Urinal-Screen Post: Manufacturer's standard post design of material matching the thickness and construction of pilasters] or 1-3/4-inch- square, aluminum tube with satin finish with shoe and sleeve (cap) matching that on the pilaster.

I. Brackets (Fittings):
   1. Stirrup Type: Ear or U-brackets; chrome-plated zamac; or stainless steel.
   2. Full-Height (Continuous) Type: Manufacturer's standard design; or stainless steel.

J. Steel-Sheet Finish: Manufacturer's standard baked-on or powder coated finish, with one color in each room.
   1. Color: As selected by Architect from manufacturer's full range.

2.3 ACCESSORIES

A. Hardware and Accessories: Manufacturer's standard design, heavy-duty operating hardware and accessories.
   1. Material: Chrome-plated zamac or Stainless steel.
   2. Hinges: Manufacturer's standard paired, self-closing type that can be adjusted to hold doors open at any angle up to 90 degrees continuous, or cam type that swings to a closed or partially open position.
   3. Latch and Keeper: Manufacturer's standard recessed or surface-mounted latch unit designed for emergency access and with combination rubber-faced door strike and keeper. Provide units that comply with regulatory requirements for accessibility at compartments designated as accessible.
   4. Coat Hook: Manufacturer's standard combination hook and rubber-tipped bumper, sized to prevent in-swinging door from hitting compartment-mounted accessories.
   5. Door Bumper: Manufacturer's standard rubber-tipped bumper at out-swinging doors.
   6. Door Pull: Manufacturer's standard unit at out-swinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at compartments designated as accessible.

B. Overhead Bracing: Manufacturer's standard continuous, extruded-aluminum head rail with antigrip profile and in manufacturer's standard finish.
C. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel or chrome-plated steel or brass, finished to match the items they are securing, with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use stainless steel, hot-dip galvanized steel, or other rust-resistant, protective-coated steel.

2.4 FABRICATION

A. Overhead-Braced Units: Provide manufacturer's standard corrosion-resistant supports, leveling mechanism, and anchors at pilasters to suit floor conditions. Provide shoes at pilasters to conceal supports and leveling mechanism.

B. Floor-Anchored Units: Provide manufacturer's standard corrosion-resistant anchoring assemblies with leveling adjustment nuts at pilasters for structural connection to floor. Provide shoes at pilasters to conceal anchorage.

C. Ceiling-Hung Units: Provide manufacturer's standard corrosion-resistant anchoring assemblies with leveling adjustment nuts at pilasters for connection to structural support above finished ceiling. Provide assemblies that support pilasters from structure without transmitting load to finished ceiling. Provide sleeves (caps) at tops of pilasters to conceal anchorage.

D. Floor-and-Ceiling-Anchored Units: Provide manufacturer's standard corrosion-resistant anchoring assemblies with leveling adjustment at tops and bottoms of pilasters. Provide shoes and sleeves (caps) at pilasters to conceal anchorage.

E. Urinal-Screen Posts: Provide manufacturer's standard corrosion-resistant anchoring assemblies with leveling adjustment at tops and bottoms of posts. Provide shoes and sleeves (caps) at posts to conceal anchorage.

F. Door Size and Swings: Unless otherwise indicated, provide 24-inch- wide, in-swinging doors for standard toilet compartments and 36-inch- wide, out-swinging doors with a minimum 32-inch- wide, clear opening for compartments designated as accessible.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Comply with manufacturer's written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position with manufacturer's recommended anchoring devices.

B. Clearances: Maximum 1/2 inch between pilasters and panels; 1 inch between panels and walls.

C. Stirrup Brackets: Secure panels to walls and to pilasters with no fewer than three brackets attached at midpoint and near top and bottom of panel. Locate wall brackets
so holes for wall anchors occur in masonry or tile joints. Align brackets at pilasters with brackets at walls.

3.2 ADJUSTING

A. Hardware Adjustment: Adjust and lubricate hardware according to hardware manufacturer's written instructions for proper operation. Set hinges on in-swinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on out-swinging doors to return doors to fully closed position.

END OF SECTION 102113
SECTION 102800 - TOILET ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Public-use washroom accessories.
   2. Public-use shower room accessories.
   3. Warm-air dryers.
   4. Under-lavatory guards.
   5. Custodial accessories.

B. Owner-Furnished Material: <Insert product>.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.
   1. Identify locations using room designations indicated.
   2. Identify products using designations indicated.

1.3 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.5 WARRANTY

A. Special Mirror Warranty: Manufacturer's standard form in which manufacturer agrees to replace mirrors that develop visible silver spoilage defects and that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: 10 years from date of Substantial Completion.

B. Provide two year warranty on all other accessories.
PART 2 - PRODUCTS

2.1 PUBLIC-USE WASHROOM ACCESSORIES

A. Toilet Tissue (Roll) Dispenser, Recessed/Single sided:
   1. Basis-of-Design Product: Bobrick B-3888 or B-2888.
   2. Description: Two-roll unit.
   3. Mounting: Recessed or Surface mounted.

B. Toilet Tissue Dispenser, Two-Sided Partition Mounted:
   2. Description: Two-roll unit.

C. Combination Towel (Folded) Dispenser/Waste Receptacle:
   2. Description: Combination unit for dispensing C-fold or multifold towels, with removable waste receptacle.
   3. Mounting: Semirecessed. (Use B-3699 where B-3944 cannot be mounted.)

D. Liquid-Soap Dispenser (for lavatory counter):
   1. Basis-of-Design Product: Bobrick B-82116 or approved Bobrick substitute.
   2. Description: Designed for dispensing soap in liquid form.
   3. Mounting: Deck mounted on lavatory counter

E. Liquid-Soap Dispenser (for showers):
   2. Description: Designed for dispensing soap in liquid form.

F. Grab Bar:
   3. Material: Stainless steel, 0.05 inch thick.
      a. Finish: Smooth, slip-resistant texture in grip area.
   5. Configuration and Length: As indicated on Drawings.

G. Napkin/Tampon Vendor:
   2. Type: Sanitary napkin and tampo.
   3. Mounting: Fully recessed or Semirecessed.
6. Lockset: Tumbler type with separate lock and key for coin box.

H. Sanitary-Napkin Disposal Unit:

I. Seat-Cover Dispenser:
   1. Basis-of-Design Product: Bobrick B-221

J. Fold-Down Utility (Purse) Shelf:
   2. Description: Hinged unit with spring-loaded shelf that automatically returns to vertical position.

K. Mirror Unit:
   2. Size: As indicated on Drawings.

2.2 PUBLIC-USE SHOWER ROOM ACCESSORIES

A. Shower Curtain Rod:
   1. Basis-of-Design Product: Insert manufacturer's name or product designation.
   2. Description: 1-1/4-inch OD; fabricated from nominal 0.05-inch-thick stainless steel.
   4. Finish: No. 4 (satin).

B. Shower Curtain:
   1. Basis-of-Design Product: None.
   2. Size: Minimum 6 inches wider than opening by 72 inches high.
   3. Material: Nylon-reinforced vinyl, minimum 10 oz. or 0.008-inch-thick vinyl, with integral antibacterial agent.
   5. Grommets: Corrosion resistant at minimum 6 inches o.c. through top hem.
   6. Shower Curtain Hooks: Chrome-plated or stainless-steel, spring wire curtain hooks with snap fasteners, sized to accommodate specified curtain rod. Provide one hook per curtain grommet.

C. Folding Shower Seat:
   2. Configuration: L-shaped seat, designed for wheelchair access.
D. Surface Mounted Towel Pin:

2.3 WARM-AIR DRYERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Dyson Air Blade.
   2. <Insert manufacturer's name>.

B. Warm-Air Dryer:
   5. Electrical Requirements: 115 V, 13 A, 1500 W.

2.4 UNDERLAVATORY GUARDS

A. Manufacturers: Subject to compliance with requirements, [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

B. Underlavatory Guard:
   1. Basis-of-Design Product:
      a. Plumberex Specialty Products, Inc.
      b. Truebro by IPS Corporation.
      c. <Insert manufacturer's name>.
   2. Description: Insulating pipe covering for supply and drain piping assemblies that prevent direct contact with and burns from piping; allow service access without removing coverings.

2.5 FABRICATION

A. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of four <4> keys to Owner's representative.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.

B. Grab Bars: Install to withstand a downward load of at least 250 lbf, when tested according to ASTM F 446.

END OF SECTION 102800
SECTION 104413 - FIRE EXTINGUISHER CABINETS

PART 1 - GENERAL

1.1 SUMMARY
   A. Section includes fire protection cabinets for fire extinguishers.

1.2 ACTION SUBMITTALS
   A. Product Data: For each type of product indicated.
   B. Shop Drawings: For fire protection cabinets. Include plans, elevations, sections, details, and attachments to other work.

1.3 QUALITY ASSURANCE
   A. Fire-Rated, Fire Protection Cabinets: Listed and labeled to comply with requirements in ASTM E 814 for fire-resistance rating of walls where they are installed.
   B. Coordinate size of fire protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.
   C. Coordinate sizes and locations of fire protection cabinets with wall depths (that utilize 3-5/8 studs).

PART 2 - PRODUCTS

2.1 MATERIALS
   A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.
   B. Aluminum: Alloy and temper recommended by aluminum producer and manufacturer for type of use and finish indicated, and as follows:
      2. Extruded Shapes: ASTM B 221.
   C. Stainless-Steel Sheet: ASTM A 666, Type 304.
   D. Transparent Acrylic Sheet: ASTM D 4802, Category A-1 (cell-cast sheet), with Finish 1-smooth or polished.
   E. Acrylic Bubble or Canopy: Not permitted.
2.2 FIRE PROTECTION CABINET

A. Cabinet Type: Suitable for fire extinguisher.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Fire End & Croker Corporation.
      c. Larsen’s Manufacturing Company.
      d. Modern Metal Products, Division of Technico Inc.
      e. Moon-American.
      f. Potter Roemer LLC.
      g. Watrous Division, American Specialties, Inc.

B. Cabinet Construction: Nonrated or rated is dependent upon the rating of the wall assembly where cabinet will be mounted.
   1. Fire-Rated Cabinets: Construct fire-rated cabinets with double walls fabricated from 0.0428-inch-thick, cold-rolled steel sheet lined with minimum 5/8-inch-thick, fire-barrier material. Provide factory-drilled mounting holes.

C. Cabinet Material: Aluminum or Stainless-steel sheet.

D. Recessed Cabinet: Cabinet box recessed in walls of sufficient depth to suit style of trim indicated.
   1. Trimless with Hidden Flange: Flange of same metal and finish as box overlaps surrounding wall finish and is concealed from view by an overlapping door.
   2. Exposed Flat Trim: One-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend).

E. Semirecessed Cabinet: Cabinet box partially recessed in walls of sufficient depth to suit style of trim indicated; with one-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend). Provide where walls are of insufficient depth for recessed cabinets but are of sufficient depth to accommodate semirecessed cabinet installation.
   1. Rolled-Edge Trim: 2-1/2-inch backbend depth.

F. Cabinet Trim Material: Same material and finish as door.

G. Door Material: Steel sheet, Aluminum sheet, extruded-aluminum shapes, or stainless-steel sheet.

H. Door Style: Fully glazed, frameless, backless, acrylic panel or fully glazed panel with frame.

I. Door Glazing: Acrylic sheet.
1. Acrylic Sheet Color: Clear transparent acrylic sheet.

J. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.

K. Accessories:

1. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.

2. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated.
   a. Identify fire extinguisher in fire protection cabinet with the words "FIRE EXTINGUISHER."
      1) Location: Applied to [cabinet door] [cabinet glazing].
      2) Application Process: Decals.
      3) Lettering Color: [Red] [Black]
      4) Orientation: Horizontal.

L. Finishes:

1. Manufacturer's standard baked-enamel paint for the following:
   a. Exterior of cabinet, door, and trim, except for those surfaces indicated to receive another finish.
   b. Interior of cabinet and door.

2. Aluminum: Baked enamel or powder coat.
   a. Color: Flat or semi-gloss white.

3. Steel: Baked enamel or powder coat.
   a. Color and Gloss: Flat or semi-gloss white.

4. Stainless Steel: No. 4.

2.3 FABRICATION

A. Fire Protection Cabinets: Provide manufacturer's standard box (tub), with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated. Miter and weld joints and grind smooth.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Examine walls and partitions for suitable framing depth and blocking where recessed and semirecessed cabinets will be installed and prepare recesses as required by type and size of cabinet and trim style.

B. Install fire protection cabinets in locations and at mounting heights indicated or, if not indicated, at heights acceptable to authorities having jurisdiction to comply with ADA requirements.

C. Fire Protection Cabinets: Fasten cabinets to structure, square and plumb.

D. Identification: Apply vinyl lettering at locations indicated.

E. Adjust fire protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.

F. Replace fire protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 104413
SECTION 110513 - COMMON MOTOR REQUIREMENTS FOR EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, alternating-current, small and medium, squirrel-cage induction motors, installed at equipment manufacturer's factory, and motors shipped separately by equipment manufacturer for field installation.

1.2 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices and features to be compatible with the following:
   1. Motor controllers.
   2. Torque, speed, and horsepower requirements of the load.
   3. Ratings and characteristics of supply circuit and required control sequence.
   4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with requirements in this Section except when stricter requirements are specified in equipment schedules or Sections.

B. Comply with NEMA MG 1 unless otherwise indicated.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 2500 feet above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Energy efficient, as defined in NEMA MG 1.
C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.
   1. For motors with 2:1 speed ratio, consequent pole, single winding.
   2. For motors with other than 2:1 speed ratio, separate winding for each speed.


F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

G. Temperature Rise: Match insulation rating.

H. Insulation: Class F.

I. Code Letter Designation:
   1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
   2. Motors Smaller than 15 HP: Manufacturer’s standard starting characteristic.

J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
   1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
   2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
   3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
   4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
   5. Measure shaft to ground voltage. If voltage exceeds 2v, install a shaft ground ring similar to “AEGIS SGR” on DE (driven end)

2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
   1. Permanent-split capacitor.
   2. Split phase.
   3. Capacitor start, inductor run.
   4. Capacitor start, capacitor run.
B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Termination – 5HP and above
   1. At motor peckerhead, mechanically terminate motor leads and conductors with crimped or compression “eyes”. Bolt eyes together, with lock washer and nut.
   2. Tape: First layer of tape is varnished Cambrick tape, tape over the Cambrick with self-sealing rubber wrap splicing tape. Finish with a wrap of #33 Scotch electrical tape (or equivalent).

END OF SECTION 110513
PART 1 GENERAL

1.01 SECTION INCLUDES:
The work of this section shall include all labor, equipment, material and services necessary to furnish and install miniblinds as indicated or specified.

1.02 QUALITY ASSURANCE
A. Specifications are based upon Riviera Blinds as manufactured by Levelor Lorentzen, Hoboken, NJ. Flexalum Blinds as manufactured by Win-Glo, Phoenix, AZ are also acceptable for bidding.
B. A warranty shall be provided that guarantees all slats against warp, twist, bow, brittleness, shrinkage, surface change and color change. This guarantee shall be non-prorated and cover all slats and associated parts for a period of 3 years from the date of installation. Warranty expiration date shall be shown on individual blinds in location adjacent to blind manufacturer's/installer's identification plate.

1.03 SUBMITTALS
A. Submit Product Data Sheets, shop drawings including location/layout plan, directions for installation and anchorage of blinds to other materials, and cleaning protection, operation and maintenance instructions.
B. Submit samples of each type, color, finish and pattern for blind components as indicated by the contract documents.

1.04 DELIVERY, STORAGE AND HANDLING
Blinds shall be delivered to site after building is secure, all finishes complete, and windows are ready for installation of coverings.

PART 2 PRODUCTS

2.01 FABRICATION
A. General
1. The blind shall have either nominal 1/2 inch micromini or 1 inch wide horizontal slats as indicated by contract documents, and shall be supported by braided ladders.
2. Operating hardware shall be machine clinched to an enclosed metal head to assure perfect alignment.
3. It shall be possible to tilt the slats to any horizontal angle by means of a transparent wand.
4. It shall be possible to raise and lower the slats to any height by means of lift cords.
5. All metal components shall be treated for corrosion resistance.
6. All visible components of the blind shall be selected from manufacturer's standard colors unless otherwise noted on the schedule.
7. All dry pigments used in components shall be for interior and exterior use and shall meet Federal lead content standards.
B. Head Channel
1. The head channel shall be .025" steel.
2. It shall have a plastic type coating cured at high temperature and shall be formed after coating.
3. It shall be "U" shaped, 1" high by 1-9/16" wide with flanged edges at the top.
4. The blind shall be free of sharp edges, burrs or other defects which might be harmful to its operation or to persons or materials in contact with them.
5. All workmanship, details and procedures shall comply with current manufacturer's specifications and standards.
C. Wand Tilter
1. The tilter shall be of enclosed construction. Its moving parts and mechanical drive shall be made of compatible materials for smooth operation. It shall tilt the slats to any desired angle and hold them at that angle so that any vibration or movement of ladders and slats will not drive and change the angle of slats. Location of wand shall be coordinated with the Architect.
2. The tilter shall be .042" steel or nylon.
3. It shall have a wand which by turning shall tilt all the slats to the desired angle.
4. An automatic disengagement of worm and gear shall eliminate over-drive to prevent strain or damage to wand, worm, gear, ladder or top slat.
5. Transparent wand shall have a hexagonal cross section 5/16" across slats for comfortable grip and shall hang vertically by its own weight.
6. It shall be of sufficient length and swivel for easy operation from any convenient position.
7. It shall be detachable by raising the locking sleeve.

D. Cord Lock
1. The cord lock shall be .042" thick steel securely attached to head. The cord for the cordlock shall be six inches long when blind is in the lowered position, and shall terminate with a one inch diameter metal ring hook.
2. It shall be crushproof type, with proper sensitivity to lock slats at desired height upon release of cords or by swinging cords toward jamb while lowering slats.
3. The revolving serrated cam shall gently snub all the cords to hold the raised slats level at the desired height, increasing its grip for heavier loads.

E. Drums and Cradles
1. All blinds shall have a cradle and drum for each ladder.
2. The cradle shall be .042" steel and holes with rolled edges to guide the ladder and cord through bottom of head. The cradle shall center the drum over the ladder openings. It shall provide bearing support for the tilt rod thus preventing weight of blind from being transferred to tilter.
3. The drum shall be .031" steel and shall have two holes with rolled edges to anchor the barbs of each of the two ladder ends.

F. Tilt Rod
1. The tilt rod shall be shaped to fit in only one possible correct position in the drum and gear openings and shall provide instant tilting responses.
2. For all blinds over 83" wide, also for blinds over 60" wide and over 50 square feet, the tilt rod shall be rolled steel. Average cross section dimension shall be 1/4" to limit torsional deflection to 6 degrees at 30" with an applied torque of one foot-pound.
3. For other blind sizes - the tilt rod shall be "U" shaped of .062" steel.

G. End Brace
1. To add rigidity, an end brace of .042" thick steel shall be fastened to each end of the head.
2. To assure a secure installation, eliminate lateral movement, and center blind in window, each brace shall have an adjustable tab.

H. Installation Brackets
1. Installation Brackets with riveted locking cover shall both be at least .047" thick steel and shall have baked finish in color to match head channel. A pair of these brackets shall support end of the head channel securely. The brackets shall permit easy removal of head.
2. The bracket shall be designed to safely support the load of the blind plus the forces applied to operate the blind. The size and distribution of screw holes shall be determined by these criteria.

I. Intermediate Brackets
1. Intermediate Brackets shall be installed on blinds over 60" wide or 45 square feet in area. They shall be spaced at maximum of 60" apart.
2. Brackets shall be "U" shaped, .050 +/- .004" thick steel.
3. The head shall be locked to the central bracket by either of the following methods: drive a self-tapping #6 x 1/4" Type 1 screw through bottom of bracket and head channel; or use latch type bracket.

J. Braided Ladders (slat supports)
1. These shall be braided of polyester yarn and stabilized. The vertical component shall have maximum flexibility with minimum stretch for tensile strength of 50 pounds.
2. The horizontal component or rungs shall consist of not less than 4 cables integrated with the vertical components.
3. Braided ladder shall support slats parallel and straight and assure proper tilt control and closure of slats.
4. A metal barb shall be securely and accurately machine clinched at all 4 ends of each ladder to lock in holes of drum and bottom rail. Barbed ladders shall be detachable.
5. Distance between end ladder and end of slats shall not exceed 7". Distance between braided ladder shall not exceed 23" for blinds under 80-1/8" long and 22" for blinds over 80".
6. Ladders shall be of sufficient length for bottom of the blind to land within 5/8" of sill or of specified overlap where there is no sill.
7. Ladders shall be dyed to match or blend into color of blinds.

K. Aluminum Slat
1. Slats shall be virgin aluminum alloyed for maximum strength, flexibility, and resistance to internal and external corrosion.
2. The slats shall be 1/2 inch wide for micromini blinds and 1 inch wide for mini blinds, plus 003" or minus .000".
3. Densely pigmented colors shall have a catalytic undercoat strongly bonded to the aluminum and plastic type finish coat applied under heavy pressure and cured at high temperature.
4. Transparent type finishes shall be applied under heavy pressure and cured at high temperature without an undercoat to permit the metallic surface to be reflective. They shall be formulated to provide superior adhesion, protection, and quality.
5. They shall have an elliptical crown of proper contour formed after coating and curing. The radius of each corner shall be 5/32" and tangent to the edges of the slat.
6. The end clearance of each slat shall not exceed 1/4" from each side of the window opening for jamb installation. For face installation, slats shall overlap jamb by 1-1/2" maximum at each end where possible.
7. Slat thickness and ladder support distances shall be such that there is no visible up or down (sag) bow even after continued usage in any indoor environment.

L. Bottom Rail
1. The bottom rail shall be .031" steel.
2. It shall have a plastic type coating cured at high temperature and shall be formed after coating.
3. It shall be shaped to impart stiffness, accommodate its accessories, and flexible to proportionately distribute load to each cord branch.
4. It shall be provided with pierced holes for the braided ladders and cord. Molded plastic caps shall lock onto rail to cover cord and ladder holes. Caps shall be shaped to offer maximum protection to braided ladders and window sill.
5. Molded plastic end caps with bottom flange shall protect jamb and sill.

M. Lift Cord
1. Cord shall be braided of high strength synthetic fibers of a diameter commensurate to the size of the rout hole in the slat. Location of cord shall be coordinated with Designated Representative.
2. It shall have a rayon cord or approved equal.
3. Cord shall be flexible with minimum stretch characteristics and maximum abrasion resistance.
4. Cord shall have a minimum breaking strength of 175 pounds.
5. Cord shall be of sufficient length and equalized to properly control the raising and lowering of the blind.
6. Ring shall equalize lift cords and be attached not less than 6 inches from the head.
7. Cord ends shall be securely anchored to the bottom rail at a maximum spacing of 46" between cords.
8. It shall be possible to detach and attach cords.
9. Stringing arrangement shall comply with standards set for the size and weight of the blind.
10. Cords shall be dyed to manufacturer's color standard.

PART 3 EXECUTION

3.01 INSTALLATION

A. Installation
   1. Miniblinds shall fit openings in accordance with manufacturer's standards. Exact location of blinds, within window frame or outside window frame, shall be coordinated with the Architect.
   2. Head channel shall be secured with brackets supported with plated self-tapping steel screws.

B. Protection
   Put miniblinds into full open retracted position and wrap with protective paper immediately after Installation.

END SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES:
The work of this section shall include all labor, materials, equipment, accessories and services necessary and required to furnish and install all vertical blinds as indicated or specified.

1.02 WARRANTY
A warranty shall be provided that guarantees all louvers against warp, twist, bow, brittleness, shrinkage, stretch, surface change and color change. This guarantee shall be non-prorated and cover all louvers and associated parts for a period of 3 years from the date of installation. The warranty expiration date shall be shown on the blind in a location adjacent to the blind manufacturer's/installer's identification name plate.

1.04 QUALITY ASSURANCE
A. The following specifications are based on "Louver Drape" to establish a product quality standard.
B. Actual measurements shall be taken in the field prior to ordering or fabricating any material.

1.05 SUBMITTALS
A. Submit Product Data Sheets, shop drawings including location/layout plan, directions for installation and anchorage of blinds to other materials, and cleaning, protection, operation and maintenance instructions. The windows and doors.
B. Submit samples of each type, color, finish, and pattern for blind components (drape, head track system, valance, etc.) as indicated by the contract documents.

1.06 DELIVERY, STORAGE AND HANDLING
The vertical blinds shall be delivered to the site after the building is secure and all finishes are complete and the windows are ready for installation of coverings.

PART 2 PRODUCT

2.01 HEAD TRACK SYSTEM
A. The "Louver Drape" traversing and rotating "Zirlon Wheeled System" shall be provided or approved equal.
1. Stack - Each track shall be 5/16" wide and pack when traversed to no more than 5/16" per louver.
2. Wheels - Each track shall traverse on "Zirlon" wheels or approved equal. No glides or sliders shall be allowed.
3. Channel - The channel shall be of extruded and anodized aluminum alloy (comply with ASTM B221, 6063-TS alloy), 1-15/16" wide by 1-7/16" high.
4. End Caps - Each track shall be equipped with "Delrin", or approved equal, control and idler end caps. End caps shall be equipped with covers to enclose sprockets and rotation rod ends. End caps shall have rollers for traverse cord. Location of the traverse cord shall be coordinated with the purchaser.
5. Spacer Links - 1/4" wide flexible stainless steel spacer links shall space and stabilize each truck by passing smoothly between special guide slots in each truck.
6. Louvers - Louvers shall rotate 180°. Pack when traversed into no more than 5/16" per louver. All louvers shall overlap not less than 3/8".

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Vertical Blinds (Solid Vinyl w/Fabric inserts)
7. Traversing - Blind shall traverse by means of a synthetic traverse cord. The desired design of left to right, right to left or split shall be coordinated with the Designated Representative.

8. Rotation - Heat sealed weights in each louver (without chains) shall synchronize and actuate 180° rotation. Turning a keyed aluminum rod—turns a "Delrin" worm and "Delrin" spur gear in each truck. Gears shall provide no less than 8 to 1 mechanical advantage and keep louvers fixed until reset by control. No cord or 1 to 1 ratio mechanisms shall be allowed.

9. Spacing - No matter what the width of the installation, the louver spacing shall be evened to eliminate overlap of the last louver.

10. Channel Finish - The head track channel shall be finished to match or blend into the vertical louver insert or solid vinyl louver.

B. Head Track System Attachment Hardware

The Vertical Drape Installation Contractor shall provide the necessary hardware that allows outside the window/door frame installation. The intent of the Purchaser shall be coordinated in the Shop Drawing phase, but generally prefers a continuous non-interrupted appearance in the valance and drape installation. The installation attaching hardware shall be finished so as to match the finish of the channel finish.

C. Vertical Louvers with Fabric Inserts and Valance

1. Each louver shall be "Louver Drape's" grooved louver (or approved equal) and extruded of flame retardant solid vinyl in opaque or translucent material as specified on the drawings or schedule. Each louver shall contain an insert of "Louver Drapes" flame retardant fabric as indicated by the contract documents. Each louver shall have heat-sealed weights without connection chains unless otherwise indicated by the contract documents.

2. Each louver shall be 3-1/2" in width and a height that extends from floor to ceiling unless specified otherwise on the drawings or schedule.

3. Each louver shall withstand 140°F heat chamber for thirty minutes without distortion and with no more shrinkage or stretch than 1/2 of 1%. Louvers shall be permanently flame resistant.

4. A continuous horizontal valance shall be provided to fully conceal the head track system and allow for the vertical blind to move freely. The valance shall visually appear continuous, unless noted otherwise on the drawing and/or schedule and have a finish that matches the louvers and/or fabric inserts.

PART 3 EXECUTION

3.01 INSTALLATION

A. Installation shall be in conformance with Contract Document requirements, approved shop drawing installation details, and manufacturer's installation instructions.

B. Each vertical louver suspended from the center of one end shall hang perfectly straight with no twist, warp, or bow. Edges shall be straight with no rippling, closing perfectly from top and bottom, and remain neat and sharp in appearance.

END SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES:
A. The work of this section shall include all labor, material, equipment, accessories and services necessary and required for the remanufacture of modular furnishings as indicated or specified.
B. All workmanship, material, and components utilized in the completion of this sections requirements shall comply with the respective manufacturer's specifications and recommendations for each product.

1.02 DEFINITIONS
A. Deflection - The movement or deviation of a surface or plane from its normally intended orientation or position as a result of stress.
B. Inspection - Visual examination without the use of special laboratory appliances or procedures, and without testing of physical and chemical properties by technical means.
C. Loss of Functionality - Loss of flexibility, adjustment capability, or normal function of components, including but not limited to, deficiencies resulting from unapproved substitutions in lieu of original manufacturer's standard parts or components, improper assembly, improper applications of finishes, or other practices which could result in incompatibility of components or impairment of normal function.
D. Racking - Distortion of misalignment of a component as a result of stress.
E. Refurbish - Partially restore or repair. Example: Replace fabric and missing hardware but do not repaint parts of a component.
F. Remanufacture - Restore component to "as new" condition. Example: Replace fabric, repaint, and repair or replace all parts of a component.
G. Structural Integrity - Having same structural performance requirements and characteristics of new component.
H. Tolerance - The total amount by which a specific dimension is permitted to deviate from standard.

1.03 SYSTEM DESCRIPTION
The term "Remanufactured Modular Furnishings" shall refer to refurbished and/or refinished units which are complete with all parts, equal to new modular systems. Panels and components, the units of the system, shall be capable of assembly, disassembly, relocation and reassembly without incurring damage or destruction, including any refinishing.

1.04 QUALITY ASSURANCE
A. All remanufactured modular furnishings shall meet the minimum acceptable requirements specified herein.
B. Workmanship shall comply with industry standards except where more rigid standards or more precise workmanship is indicated or specified.
C. Remanufactured systems shall not contain any surface projections, sharp corners or edges, rough areas or any other condition which could result in damage or injury.
D. Remanufactured components shall exhibit the structural integrity, dimensional stability, functionality and appearance equal to the manufacturer's new product. Replacement parts must be of the same manufacturer as the original equipment being refurbished.
E. The original manufacturer's requirements for tolerances shall be met.
F. All material used must comply with local air pollution control district regulations and federal lead content laws. MSDS sheets shall be provided for all materials.
G. All work shall comply with the manufacturer's specifications and recommendations for all products and applications.

1.05 SUBMITTALS
A. Submit Product Data Sheets, shop drawings, and cleaning and maintenance instructions.
B. The requirements unique to each manufacturer's system are identified in the manufacturer's "Standard Specification for (System Name) Modular Furnishings Remanufacture" document as published by each respective manufacturer. A copy of the specification developed for the system being remanufactured shall be submitted. Compliance with these recommendations and specifications is required.
C. Submit samples of each material and component being refurbished to indicate the color, finish, texture and workmanship. Samples shall be of sufficient size to include finished edge with applicable trim applied.
D. Submit a written description of the Packaging Process the contractor will use for protecting the returned Remanufactured Systems during warehousing and delivery to other sites.

1.06 INSPECTION CHECKLIST
A. The quality and completeness of finished work shall be evaluated in accordance with this Checklist, a copy of which is included at the end of this section.
B. Finished components shall comply with the qualities identified in the Checklist.

1.07 MANUFACTURER'S SERVICE PARTS MANUAL
The Contractor shall maintain a manual for each modular system which shall be used for procurement of replacement parts.

1.08 DELIVERY, STORAGE AND HANDLING
A. All components shall be labeled with the Contractor's name and date of remanufacture.
B. Locate labels in accordance with Inspection Checklists.
C. Concealed label locations are indicated by dashed lines on the drawings.
D. Appropriate loading methods and packaging materials shall be used during product delivery to avoid incurring damage during loading, transport and unloading processes.
E. Packages shall be clearly marked indicating purchase order number, release number, product description and quantity.
F. Small items shall be separately packaged and identified.
G. Product shall be delivered to the designated site in accordance with the established project schedule.

1.09 PROJECT/SITE CONDITIONS
A. Contractor shall insure against all conditions which may adversely affect successful accomplishment of the processes specified.
B. No work shall be executed when environmental conditions are unsuitable to the achievement of satisfactory results, or any condition unacceptable to the Designated Representative or not in compliance with the manufacturer's recommendations.
C. All floors and adjacent surfaces shall be free from dust, debris, etc., before commencing any painting or coating process.
D. The Contractor shall allow the Designated Representative access to the product, shop and storage areas during normal business hours.

PART 2 PRODUCTS

2.01 MATERIALS
A. System components
1. Systems to be remanufactured shall include all modular components and accessories, such as, but not limited to: Electrified and non-electrified panels, worksurfaces, lateral files, binder bins, open shelves, task lights, keyboard trays, shelf dividers, markerboards, tackboards, drawers, hardware, trim and finish pieces.
2. All components and parts used for remanufacture shall be the manufacturer's original parts and materials except where otherwise specified.
3. Defective parts shall be replaced with new or remanufactured parts as needed.
4. All parts used for repair shall be free of defects.
5. All hardware having worn or stripped threads shall be replaced.
6. All non-repairable substrates shall be replaced.
7. Particle board, plywood or wood panel frames shall be replaced, not repaired, when broken edges or corners exist.
8. Damaged work surfaces, countercaps and tackboards shall be cut down to the next standard size unless otherwise indicated.

B. Refurbishing Materials
1. New fabric shall replace existing fabric as indicated by the contract document.
2. New laminate shall replace existing laminate indicated by the contract documents. Old laminate shall be removed unless new laminate is post-formed.
3. Edge trims shall be reinstalled except trim with worn or torn edges which should be replaced.
4. Damaged markerboard surfaces shall be cut to the next smaller size or relaminated in lieu of any other type repair.

C. Refinishing Material
1. All components and parts shall be repainted as indicated by the contract documents.
2. All colors and coatings shall be tinted, mixed and applied in accordance with the manufacturer's specifications.
3. Each base coat shall have a slight color variation from the finish coat.
4. The Contractor shall furnish all refinishing material including but not limited to: Linseed oil, turpentine, paint thinners and other materials not specifically indicated but required to achieve the specified finishes.
5. Lacquer shall not be used for any condition.
6. Only compatible materials and equipment shall be used.
7. Thinner coats, intermediate coats and finish coats shall be chemically compatible.
8. Thinner coats shall be those specifically recommended by the manufacturer of the material to be thinned.
9. Metal paint shall be Cardinal, catalyzed acrylic, polyester polyurethane or approved equal.

D. Cleaning Material
1. Prior to refinishing, metal surfaces shall be wiped down with MEK/Methylethyl Keytone, Acetone or approved equal.
2. All cleaning materials shall be those specified by the manufacturer of the surface to be cleaned.

E. Fabrication
1. Screw sizes may be increased provided the functionality of parts and components is maintained.
2. Metalwork, consisting of shearing, cutting, punching, drilling, tapping or reinforcing, shall precede surface finishing.
3. Cut edges shall be smooth and free of imperfections.
4. All punched or drilled holes shall be correctly placed.
5. Holes shall be round and free from burrs, folds, depressed or upset edges.
6. Punching or drilling holes in bent members shall follow the bending operation.
7. Slotting of incorrectly punched or drilled holes shall not be accepted.
8. Welds shall possess the following characteristics.
   a. Seams shall be smooth, of uniform width and thickness throughout the full length.
   b. Sealing shall be complete with no voids at seams.
   c. Fissure to base metal shall be complete with no voids at seams.
   d. Gouging, grooving or reduction of base metal thickness shall not be acceptable.
3.01 EXAMINATION
The Contractor shall inspect all components before proceeding with remanufacturing process, insuring surface and substrate conditions are acceptable to receive work. Start of the remanufacturing process shall indicate acceptance of component condition.

3.02 PREPARATION
A. All hardware, trim, tape, fabric, backing material, staples and other fasteners shall be removed as necessary. 
B. Substrates shall be repaired or replaced, as needed, to achieve a uniform, smooth and clean surface, free of any voids or projections.

3.03 APPLICATION
A. Repainting - Refinishing
   1. The term "repainting" shall refer to all necessary preparation and finishing, including but not limited to filling, sealing, priming, sanding and coating.
   2. All hardware, accessories, machined surfaces and other items not scheduled to receive paint shall be masked off, removed, or otherwise completely protected.
   3. All surfaces to be refinished shall be thoroughly cleaned and prepared according to the best trade practices and the manufacturer's directions.
   4. All dirt, oil and foreign substances shall be removed.
   5. Manufacturer's recommendations shall be followed relative to the surface preparation, materials and products used, and the environmental conditions in which work is accomplished.
   6. All painted surfaces of component parts scheduled to receive paint shall be repainted, inside and outside as applicable.
   7. Each coat shall be applied smoothly and uniformly.
   8. Surfaces shall be sanded between each coating layer.
   9. Each coat shall be allowed to thoroughly dry before subsequent coats are applied.
B. Metal Refinishing
   1. All existing paint, primer, rust and mill scale shall be removed to assure a smooth substrate upon which to apply the new finish.
   2. All blemishes and surface imperfections shall be removed or repaired prior to cleaning, treating or applying surface finish.
   3. The edges of touch up areas shall be feathered and smoothed prior to applying the new finish.
   4. All bare metal shall be primed.
C. Laminates
   1. Existing laminate shall be removed as necessary, to accomplish uniform, finished surfacing edges.
   2. All surfaces to receive laminate shall be prepared in accordance with the Laminate Manufacturer's recommendations.
   3. Before installation, laminate shall be conditioned in accordance with the manufacturer's instructions.
   4. Correct positioning of laminate shall be insured.
   5. Bonding to substrate shall be uniform and complete. Spot bonding is not acceptable.
   6. Finished edges of laminate shall be smooth, finished and completely concealed by edge trim.
   7. Splicing of edge trim shall not occur at more than one location and shall not be visible when the component is installed.
D. Particle Board
   1. All untreated surfaces shall be sealed.
E. Fabric
   1. Include overlap when cutting new fabric.
2. Fabric shall be installed in accordance with the Component Manufacturer's installation specifications.
3. The fabric grain shall be straight with fabric closely fit to the component but not overstretched resulting in distortions of the grainline.
4. No puckers, sags, tears, frays, loose threads, exposed fabric edges and/or other defects shall be accepted.

3.04 ASSEMBLY
A. The Inspection Checklist shall be used as a resource for the Contractor to assure correct and complete assembly.
B. Doors, drawers, hardware, locks and other moving or operating parts shall be adjusted to assure smooth, correct functioning.
C. Finished product shall be free of grease, dust, dirt, stains, fingerprints and other foreign materials.

3.05 FIELD QUALITY CONTROL
A. The Designated Representative shall inspect finished work to identify material and workmanship deficiencies to be corrected by the Contractor.
B. Needed corrections shall be made by the Contractor at no additional cost to the Purchaser.
C. Acceptance by the Designated Representative during inspection does not release the Contractor from conformance to the requirements of the contract documents.
D. The Designated Representative shall use Abbreviation Codes to identify product that fails final inspection. The Codes, provided at the end of this section, have been developed in accord with the Inspection Checklist.

3.06 CHECKLISTS
A. Abbreviation Codes for Inspection Checklists:
   S  Soiled, Stained - Includes dirt, stains, foreign materials, or other related items.
   M  Missing - Includes missing parts, missing holes, missing labels, or other missing elements.
   D  Defective, Damaged, Poor Application, Nonuniform Coverage - Includes broken, punctured, cracked, deformed, dented, buckled, warped, or otherwise damaged parts; tears, snags, runs, flaws, or otherwise damaged fabric; wrinkling, alligatoring, checking, cracking, abrasion, incomplete or nonuniform coverage, runs, sags, scratched, foreign matter in coating, unacceptable touch-up, or otherwise unacceptable paint finish; exposed, incomplete, cracked or fractured welds, welds with sharp edges or burrs, or not finished as specified; cracked, scratched, or otherwise damaged laminate; incorrect or illegible label.
   NS  Non-specified - Use of non-specified parts, materials, or components.
   I  Installed or Assembled Incorrectly - Includes incorrectly installed or assembled parts; exposed threads or edges, loose, bunching or puckering or otherwise incorrectly installed fabric; incorrectly located holes or slots in metalwork; separation of joints, incomplete adhesion, or delamination of laminate, or other installation and assembly deficiencies.
   A  Alignment Off - Includes incorrect alignment of fabric warp and weave; racking of component; and other alignment deficiencies.
   WP  Wrong Paint - Includes use of paint that is not equivalent to original manufacturer's "as new" finish.
   R  Rust - Includes visible rust and evidence of rust damage beneath an applied finish.
   OP  Operates incorrectly or does not operate - Includes glides, mechanisms, and other parts that do not operate correctly.
   DT  Dimensional Tolerances not met
   V  Variations - in color, sheen, or texture between components or nonuniform color, sheen, or texture on single component.
   OS  Overspray
E  Exposed edge
WC  Wrong Color
WF  Wrong Fabric weave or pattern
WL  Wrong Laminate style, material, or finish

ABOVE CODES MAY BE USED IN COMBINATION WITH THE FOLLOWING ABBREVIATIONS TO CALL OUT THE SPECIFIC ITEM BEING REJECTED:
F  Fabric
H  Hardware
L  Laminate
P  Paint

For example, SF would indicate soiled or stained fabric, MH would indicate missing hardware, and so on.

END SECTION
SALT RIVER PROJECT
SECTION 12606
HAWORTH UNIGROUP
MODULAR SYSTEMS FURNISHINGS REMANUFACTURE

PART 1 GENERAL

1.01 SECTION INCLUDES:
The work of this section shall include all labor, material, equipment, accessories and services necessary and required to complete the remanufacture of Haworth Unigroup Modular furniture as indicated or specified.

PART 2 PRODUCTS

2.01 SUBMITTALS
Submit Product Data Sheets, shop drawings, and cleaning, protection and maintenance instructions.
   A. Provide new or remanufactured Haworth Unigroup products, as indicated by the contract documents specifically for the individually designated project.
   B. Refer to contract documents for component list, quantities, colors and finishes.

2.02 REMANUFACTURED COMPONENTS
Provide remanufactured components, complete with all required parts, according to Haworth Unigroup Inspection Checklists.

PART 3 EXECUTION

3.01 APPLICATION
Repair or replace all damaged or missing parts as specified on Inspection Checklists.

3.02 REPAIR/RESTORATION/RE-INSTALLATION
A. Remanufacturing Unigroup Panels
   1. Disassemble and check condition of all parts.
   2. Repaint or replace top cap as necessary.
   3. Repaint or replace siderails and glide housing as necessary.
      a. Replace all plastic glides when they exist.
      b. Insure that the correct style siderail (Allen wrench attachable or clip-on style) is used with the right panel when reassembling.
   4. Insure glide assemblies on both sides are the same style.
   5. Replace base on old style panels with non-electrified 5 wire power base.
   7. Replace fiber pad as necessary.
      a. Apply fabric so grainline is consistent with the original manufacture.
   9. Replace missing, damaged or worn top cap clips and side rail clips.
B. Remanufacturing Access Control Panels and Glazed Panels
   1. Disassemble parts and check condition.
      a. Do not remanufacture if door or glazed panel is damaged and requires repair or replacement.
   2. Repaint frames, siderails, top caps, glide housings, and jambs.
   3. Insure both glide assemblies are the same style.
   4. Reassemble to comply with Inspection Checklist.
C. Remanufacturing Panel Hardware
   1. Disassemble and check condition of parts where applicable.
   2. Repaint metal parts of wall mount assembly and panel support legs.
   3. Recover finish posts with fabric.
      a. Reassemble to comply with Inspection Checklists.
D. Remanufacturing Flipper Doors
   1. Disassemble and check condition of parts.
   2. Repaint inside and outside of surfaces not receiving fabric.
      a. Replace vinyl door fronts, do not refurbish.
      a. Apply fabric so grainline is consistent with original manufacture.
   6. Reassemble to comply with Inspection Checklist.

E. Remanufacturing End Panels
   1. Disassemble, removing screws and brackets where applicable.
   2. Replace end panel if vinyl is damaged or if inserts are loose or missing.
   3. Reassemble to include all necessary screws and brackets per Inspection Checklist.

F. Remanufacturing Shelves
   1. Remove dents and scratches.
   2. Straighten metal.
   3. Repaint both sides.

G. Remanufacturing Lateral Files
   1. Disassemble and check condition of all parts.
   2. Repair and straighten bin and housing, removing dents and scratches.
   3. Relaminate or replace drawer front, as necessary.
   4. Insure end panels are compatible with bin.
      a. Replace damaged end panels with new.
   5. Repaint bin and housing, inside and outside.
   6. Reassemble to comply with Inspection Checklist.

H. Remanufacturing Modular Drawers
   1. Disassemble and check condition of all parts.
   2. Remove dents and scratches, repair and straighten drawer, front and housing.
   3. Repaint drawer inside and outside, front outside and housing outside.
   4. Reassemble to comply with Inspection Checklist.

I. Remanufacturing Counter Tops and Worksurfaces
   1. Check condition of parts.
   2. Cut and drill as necessary.
   3. Relaminate as necessary.
   4. Replace worn or damaged T-mold.
   5. Insure all supports for a counter top are the same style.

J. Remanufacturing Adjustable Keyboard Pad and Mechanism
   1. Repaint mechanism.
   2. Replace keyboard pad with custom pad as specified.

K. Remanufacturing Tackboards
   1. Remove brackets and screws checking condition.
   2. Remove cardboard backsheet, reuse or replace as necessary.
   4. Repair substrate as necessary.
   5. Recover, installing new fabric, cardboard backsheet and hanger brackets.
      a. Apply fabric so grainline is consistent with original manufacture.
      b. Reinstall hanger brackets in original location insuring tight fit. Increase size of, or relocate hanger frame screws as necessary, in order to insure tight fit in pilot holes.
   6. Reassemble to comply with Inspection Checklist.
   7. Protect brackets and screws on tackboards from becoming loose or misaligned.

3.03 CHECKLISTS
   A. The Inspection Checklist included at the end of this section shall be used for final inspection of all remanufactured components.

END SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES:
The work of this section shall include all labor, materials, equipment accessories and services necessary and required to complete the remanufacture of Herman Miller Action Office and Encore Modular Furnishings as indicated or specified.

1.02 SUBMITTALS
   A. Submit Product Data Sheets, shop drawings including location/layout plan, and cleaning and maintenance instructions.
   B. The requirements unique to Herman Miller system are identified in the manufacturer's "Standard Specification for Herman Miller Modular Furnishings Remanufacture" document as published by the manufacturer. A copy of this specification shall be submitted. Compliance with these recommendations and specifications is required.
   C. Submit samples of each material and component being refurbished to indicate color, finish, texture and workmanship. Samples shall be of sufficient size to include finished edge with applicable trim applied.

PART 2 PRODUCTS

2.01 MATERIALS
   A. Provide new or remanufactured Herman Miller Action Office and Encore products, in accordance with contract document requirements, unless otherwise specifically indicated for an individual project.
   B. The contract documents provide the component list, quantities, colors and finishes to be provided for each specific project.
   C. Provide remanufactured components, complete with all required parts, according to Herman Miller Action Office or Encore Inspection Checklists.

PART 3 EXECUTION

3.01 APPLICATION
   A. Repair or replace all damaged or missing parts as specified on Inspection Checklists.
   B. Remanufacturing Action Office and Encore panels.
      1. Disassemble and check hardware and parts to determine and accomplish needed repair or replacement.
      2. Repaint hanger frame and shell.
      3. Repaint top cap or replace as necessary.
         a. Secure loose threads of panel base with cloth tape, stapled in place.
         b. Apply fabric so grainline is consistent with original manufacture.
      7. Increase size of, or relocate hanger frame screws as necessary, in order to insure tight fit in pilot holes.
      8. Reroute channel in panel top as necessary to accommodate top cap.
      9. Completely reassembly of panel to comply with Inspection Checklist.
C. Remanufacturing Glazed Panels and Door Panels
   1. Disassemble and check parts to determine and accomplish replacement and repair as needed.
   2. Repaint hanger frames, shells, door frames, door jambs, glazing trim, frame weldment and trim glazing.
   3. Repaint top cap or replace as necessary.
   4. Reassemble in accordance with Inspection Checklist.
D. Remanufacturing Panel Hardware
   1. Check condition of parts to determine and accomplish needed replacement.
   2. Repaint metal parts of end caps, connectors, hinges and wall hanger strips.
E. Remanufacturing Flipper Doors
   1. Disassemble and check parts to determine and accomplish needed replacement or repair.
   2. Repaint inside and outside surfaces not receiving fabric.
   3. Remove existing fabric, tape, lock assembly and retainer strips from flipper doors.
   4. Re-cover flipper doors with new fabric, replacing retainer strips as necessary.
      b. Apply fabric so grainline is consistent with original manufacture.
   5. Confirm lock is installed correctly to allow change-out of lock plug without damage to lock.
   6. Reassemble unit to comply with Inspection Checklist.
F. Remanufacturing End Panels
   1. Remove and check condition of parts where applicable, determine and accomplish replacement as needed.
   2. Replace end panel if inserts are loose or missing.
   3. Repair minor dents and scratches.
   4. Repaint all sides.
   5. Reinstall parts, as applicable, in accordance with Inspection Checklist.
G. Remanufacturing Shelves
   1. Remove dents and scratches.
   2. Straighten metal.
   3. Repaint all sides.
H. Remanufacturing Lateral Files
   1. Disassemble and check condition of parts to determine and accomplish replacement or repairs as needed.
   2. Remove dents and scratches, repair and straighten bin and bin cover.
   3. Repaint bin and bin cover inside and outside.
      a. Replace damaged edge trim where applicable.
   4. Relaminate or replace drawer front, as necessary.
      a. Replace damaged edge trim where applicable.
   5. Reassemble to comply with Inspection Checklist.
I. Remanufacturing Counter Caps and Worksurfaces
   1. Repaint supports where applicable.
   2. Check condition of parts to assure replacement as needed.
   3. Cut and drill as necessary.
   4. Relaminate as necessary.
   5. Replace damaged edging as necessary.
J. Remanufacturing Adjustable Keyboard Pad and Mechanism
   1. Disassemble and check condition of parts, replacing as needed.
   2. Repaint mechanism.
   3. Relaminate keyboard pad and replace vinyl edge or replace pad as specified.
K. Remanufacturing Tackboards
   1. Remove clip, and check for replacement if needed.
   2. Remove cardboard backsheet, reuse or replace as necessary.
4. Repair substrate as necessary.
   a. Apply fabric so grainline is consistent with original manufacture.
6. Install mounting screws into original pilot holes, insuring tight fit.
   a. Insure mounting screw heads are compatible with mounting brackets.

3.02 QUALITY CONTROL
A. Protect remanufactured product to avoid the following product problems and assure no damage occurs.
   1. Racking and distortion of flipper doors
   2. Loosening, misalignment or loss of small parts and screws
B. Inspection Checklists
   1. Inspect remanufactured components to assure compliance with the Inspection Checklists provided as an attachment to this section.

END SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES:
   A. The work of this section shall include all labor, material, equipment and services necessary and required to install modular furniture and conventional furniture as indicated or specified.
   B. Installation shall consist of the pick-up, transport, delivery and on-site set-up of all materials required for a complete installation, less installation of final electrical and telecommunications hook-ups.

1.02 SUBMITTALS
   Record "As-built drawings" shall be provided at the end of each project regardless of size. As-built information is required to be submitted to the Designated Representative prior to final payment.

1.03 QUALITY ASSURANCE
   The Contractor shall have a minimum of two years installation experience with the furniture product requested to be installed. In the event the Contractor does not have experience with the specific product installation, the Purchaser may request the Contractor be trained, at no cost to the Owner.

1.04 DELIVERY, STORAGE AND HANDLING
   A. The Contractor shall be responsible (unless directed otherwise) to make arrangements with Vendor to pick-up and return required products. This process shall be in accordance with SRP's standard operating procedures.
   B. Upon request, the Contractor shall establish on-site trailer type storage areas to store items of the work until Project site is available for installation.
   C. The Contractor shall establish a staging area at the Project site in locations agreed upon with the Designated Representative.
   D. The Contractor shall be responsible to see that all products picked up are in good working order, verifying the product quantity issued is in compliance with the Contract Document requirements, and shall keep products stored and stayed to prevent damage.
   E. Storage of Products
      1. The Contractor shall be responsible for storing the Products in a neat and orderly manner, whether on or off the site, to prevent damage thereto and to facilitate inspection and taking of inventories.
      2. The Contractor shall at all times maintain an accurate inventory of stored product.
      3. Unpacked products shall be stored in a fashion to prevent damage.
      4. Products stored at ground level shall be supported clear of ground on wood timbers or similar method.
      5. Products shall be stored to prevent loss by theft.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 INSTALLATION
   A. Contractor shall be responsible for properly installing products in compliance with the Contract Documents, and the manufacturer's installation guidelines and requirements. In the event a discrepancy exists, the Designated Representative shall be contacted for clarification. In the event the Designated Representative is not available and schedule is of the essence, the manufacturer's requirements shall prevail.
B. The Contractor shall be responsible for examining the Construction Documents and verifying accuracy prior to contacting the Product Vendor. This verification process shall include but not be limited by the following:
   1. Review Design Documents, verify the documents material take-offs against SRP’s Furniture Stores Order Form (FSO).
   2. Review Design Documents, verify the documents against manufacturer requirements; and if discrepancy exists, request clarification from the SRP designated Representative.
   3. Review Design Documents, verify the documents against actual field condition and request clarification from the SRP designated Representative if discrepancy.

C. The Contractor shall maintain the complete building site and the Project premises reasonably free of rubbish and debris caused by the Contractor's operations throughout the entire period of operations.

D. Remove empty cartons, crates and other combustible refuse from the building daily; be responsible for all disposal from the Project site. When separately designated dumpsters are provided by the purchaser, for use by the contractor for disposal of debris, the contractor shall use these dumpsters exclusively and maintain them and the adjacent area in a clean presentable condition acceptable to the Designated Representative.

E. Existing facilities shall be protected as required to prevent damage during the construction process. If damage occurs to the existing facility, the Contractor shall be responsible for correcting the damage to the Designated Representative’s satisfaction.

3.02 RETURN FURNITURE TO THE WAREHOUSE
A. Furniture being returned to warehouse stock will be of “ready to use” quality and condition or will not be accepted. The Designated Representative will verify that material received is of acceptable quality. Material that does not meet the defined acceptable quality shall be tagged for refurbishment and/or salvage.

3.03 AUTHORIZATION TO PULL INVENTORY
A. Persons authorized to issue an NTP for removal of product from warehouse inventory are:
   1. Peggy Lundeen
   2. Willie Babino
   3. Curtis Slife

B. Removal of Product From Inventory
   1. An NTP shall be obtained prior to any removal of inventory. The NTP request number will be issued by Willie Babino.
   2. If there is an emergency request, as determined by the Designated Representative, and the persons listed in “A” above are not available; product may be removed from the warehouse only by an SRP employee having proper identification. The SRP employee removing the inventory shall provide document tabulation, and sign for product removed. This documentation shall be given to Curtis Slife as soon thereafter as possible.

END SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES:
   A. The work of this section shall include all labor, material, equipment and services necessary and required to complete Project Work as established by the Designated Representative.
   B. Services shall comply with entire specification as herein stated. The intent of this specification is to provide other options/requirements that the Contractor shall provide upon request.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

3.01 COORDINATION
   A. At the early stage of a project, the Contractor may be requested to assist in the development of the schedule, staging and product delivery, and storage concepts.

3.02 INSTALLATION DRAWING AND MATERIAL TAKE OFF
   A. Based on Purchaser provided Conceptual Drawings develop Installation Drawings and respective Bill of Material as required for the Project.
   B. Installation Drawings are drawings, diagrams, schedules, material take-off and other data specially prepared for the work by the Contractor to illustrate material and design requirements of the work. This work shall be provided in hard line fashion or CADD as directed by the SRP Facility Planning Representative.
   C. Installation Drawings shall consist of the following Representative items and other pertinent information:
      1. Panel Plans - scaled drawings indicating panel location, panel dimensions (height and width) panel type, fabric and material types and/or color and locations of electrified panels, if applicable.
         a. Panels shall be located dimensionally from fixed building elements such as walls or columns.
         b. Electrical Plans - scaled drawings showing locations of outlets for electrified panels and locations for power poles and base power feeds.
         c. Component Plans - scaled drawings indicating location of all components and accessories with size, color, and material designations.
         d. Material Take-Off - listing of part number, description, color, and number required itemized on standard Stores Order Forms provided by the Designated Representative.
   D. Submit Installation Drawings in the form of one (1) reproducible velum as provided by SRP and three (3) blue line copies (printed from the transparency).
   E. Illustration Drawings shall comply with the criteria established by the Facilities Drawing Administration Manual. These shall be provided to the Contractor by the SRP designated Representative upon request.
   F. Each submittal will be reviewed by the SRP designated Representative. Results of the review will be marked on the drawings to provide direction for the Contractor's next action.

3.03 TEMPORARY WAREHOUSING OF PRODUCT
   A. Consolidation of all products in a warehouse (on-site or off-site) for a specific project may be required. Obtaining product from vendor, from a refurbishment vendor, and receiving new ordered product may be required.
   B. When receiving products from vendor, warehouse, refurbishment vendor, and/or manufacturer of new products, the following services shall be provided:
1. All material will be inspected and a tabulation made of any damage observed.
2. An accurate verification of quantities and product description.
3. All discrepancies will be noted on the packing slip and/or freight bill.
4. Packing slips and freight bills will be sent to the SRP Designated Representative.
5. Damaged material will be indicated on the freight bill and will require the transport driver's signature. If the driver refuses to sign, warehousing shall not accept or sign for the material. (Warehouse shall call the SRP Designated Representative before signing for damaged material.)
6. All receiving documents from the warehouse are to be transmitted on the day of delivery.

END SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES:
A. The work of this section shall include all labor, equipment, material, accessories and services necessary and required to prepare, refinish and refurbish used conventional metal furniture to a "like new" condition as indicated or specified.
B. Preliminary to acceptance of any work, all units to be refinished shall be inspected by the Contractor. In the event the work exceeds the scope/unit costs set forth in the Purchase Order agreement, the Contractor shall notify the Designated Representative before proceeding with the work.

1.02 QUALITY ASSURANCE
A. All preparation and refinish work shall comply with Recommendations of the Painting and Decorating Contractors of America, per their latest edition of "Modern Guide to Paint Specifications."
B. All material used must comply with local air pollution control district regulations and federal lead content laws.

1.03 SUBMITTALS
A. The requirements unique to the furniture manufacturer's product are covered in the manufacturer's Standard Specification/Recommendation for Furniture Refinishing and Refurbishing. A copy of this document shall be submitted. Compliance with these recommendations and specifications are required.
B. Color and luster samples shall be submitted for review. Approval shall be based on matching of existing warehoused product. The material used as the base for submitted samples shall be 8-1/2 by 11 inches in size and closely match the product upon which the coating will be applied.
C. The packaging/protection process to be used for returning refinished and refurbished product shall be submitted for review and acceptance. Procedures submitted must indicate adequate protection for product during warehousing and delivery to other sites.

1.04 PROJECT CONDITIONS
A. The Contractor shall use only workmen skilled in the particular trades required. In the acceptance or rejection of refinished/refurbished product, no allowance will be made for lack of skill resulting in poor workmanship.
B. A copy of the manufacturer's printed specifications shall be kept at the work site and be readily accessible at all times.
C. No work shall be executed when environmental conditions are unsuitable to the achievement of satisfactory results, such as wet or windy weather, dust storms, extreme temperatures, or any condition unacceptable to the Owner or not in compliance with the manufacturer's recommendations.

1.05 DELIVERY, STORAGE AND HANDLING
A. The Contractor shall pickup the product(s) to be refurbished/refinished at the location indicated by the contract documents.
B. Upon completion of work, the product shall be protected with approved packaging and delivered to a predetermined site.

PART 2 PRODUCT
2.01 MATERIALS
A. All materials and equipment shall be compatible with the specific application; finish coats shall be compatible with prime coats; prime coats shall be compatible with the surface to be coated; all tools and equipment shall be compatible with the coating to be applied, etc.
1. Thinners, when used, shall be those recommended by the manufacturer of the product to be thinned for the purpose intended.
2. Cleaning materials recommended and approved by the product manufacturer shall be used to wipe down all surfaces to be refinished.
3. Paint shall be as follows:
   a. Cardinal, catalyzed acrylic, polyester poly urethane
   b. Sherwin Williams Polene T
4. All colors and coatings shall be tinted, mixed and applied in accordance with the manufacturer's specifications.
5. Each base coat shall have a slight color variation from the finish coat.

PART 3 EXECUTION

3.01 APPLICATION
A. All floors and adjacent surfaces shall be free from dust, debris, etc., before commencing any painting or coating process.
B. Cleaning and refinishing processes should be scheduled to avoid contamination of newly refinished surfaces.
C. All surfaces to be refinished shall be thoroughly cleaned and prepared in accordance with the best trade practices and the manufacturer's directions. All dirt, oil and foreign substances shall be removed.
D. Completely mask, remove or otherwise adequately protect all hardware, accessories, surfaces, plates, fixtures and similar items in contact with the surface to be refinished but not scheduled to receive paint.
E. Remove rust, mill scale, etc. from metal down to a sound surface and bring forward to receive finish coats.
F. Machine sand entire unit.
G. All imperfections shall be repaired and sanded smooth.
H. Feather edges of all chips and scratches.
I. Machine grind/sand all large dents to bare metal.
J. Repair scratches and dings with Bondo, smoothing and feathering edges. Spot prime.
K. Furniture shall be painted inside and out.
L. All metal furniture shall be electrostatically painted.
M. Application shall consist of a catalyzed acrylic polyester sealer followed by two coats of color.
N. Reinstall all items removed for painting when refinished surface will permit without receiving damage.

3.02 ADJUSTING
All movable parts shall be lubricated per manufacturer's specification, and realigned before reinstallation. Drawer glides, bearings, locks, movable handles, etc. shall be fully operational.

END SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES:
The work of this section shall include all labor, material, equipment, accessories and services necessary and required to furnish fabric for modular furniture and related accessories as indicated and specified.

1.02 QUALITY ASSURANCE
A. All materials and services provided shall comply with the provisions of the following specifications and standards:
   1. ASTM D751 - method of testing coated fabrics
   2. ASTM D1308 - test method for effect of household chemicals on clear and pigmented organic finishes
   3. ASTM E84 - test method for surface burning characteristics of building materials
   4. FED STD 191/5041 - determination of weight of textile materials, small specimen method
   5. FED STD 191/5100 - strength and elongation, breaking of woven cloth; grab method.
   6. GSA 4-0995 guide specifications for wallcovering

1.03 DELIVERY, STORAGE AND HANDLING
Store materials flat in original packages or containers in dry area at a temperature not less than 70 or more than 100 degrees F. at least 24 hours before start of installation.

1.04 SUBMITTALS
A. Submit Product Data Sheets, shop drawings indicating location/layouts, and maintenance instructions for the proper cleaning of the fabric.
B. Submit samples of fabric for each dye lot that will be used to complete the work of this project as indicated or specified.
C. Samples of fabric shall be 6 by 6 inches in size. Each fabric sample will be labeled with the dye lot and available yardage within the dye lot.

1.05 WARRANTY
A. Provide a warranty for a period of two years against faulty materials and against failure of fabric, except where such failure is due to abuse or failure of related work installed under separate contract.
B. During the warranty period, restore defective fabric to the condition of new non-defective fabric at time of original installation, including all materials, labor, refinishing and other costs incidental to the work. Inspect the work within 24 hours after receipt of notice of defect from the Purchaser; and within 10 days after receipt of notice restore work found to be defective.

PART 2 PRODUCTS

2.01 MATERIALS
A. Material - Fabric shall be provided to meet the following requirements:
   1. Panel System Fabric
      Manufacturer: Knoll
      Style: Nuance
      Color: W270/2 Neutral Multi
      Width: 66 inches
      Content: Rayon 29%, Cotton 27%, Silk 20%, Wool 13%, Polyester 11%
      Weight: 18.5 ounces per linear yard
Flame Retardant Rating: NFPA 701 small scale - pass
ASTM-E84 Class A flame-spread rating
UBC 4202.A (delamination test) - pass

2. Flipper Door Fabric #1
Manufacturer: DesignTex
Style: Cumulus
Color: 1105-402 Lavender
Width: 51 inches
Content: Viscose 59%, Cotton 41%
Weight: 22.75 ounces per linear yard
Flame Retardant Rating: ASTM-E84 Class A flame-spread rating
UBC Standard No. 42-1,
NFPA 225, UL723

3. Flipper Door Fabric #2
Manufacturer: DesignTex
Style: Autumn
Color: 1006-502 Seafoam
Width: 52 inches
Content: Cotton 53%, Viscose 47%
Weight: 20.50 ounces per linear yard
Flame Retardant Rating: ASTM-E84 Class A flame-spread rating
UBC Standard No. 42-1,
NFPA 225, UL723

4. Tackboard Fabric #1
Manufacturer: DesignTex
Style: SRP Basket
Color: Rose; Gold
Width: 54 inches
Content: Mercerized Cotton 50%, Rayon 50%
Weight: 19 ounces per linear yard
Finish: Acrylic backed
Flame Retardant Rating: ASTM-E84 Class A flame-spread rating
UBC Standard No. 42-1, NFPA 225

5. Upholstery Fabric #1
Manufacturer: Stratford Hall
Style: Kensington Square
Color: 117/01 Cascade
Width: 54 inches
Content: Virgin Wool 100%
Flame Retardant Rating: ASTM-E84 Class A flame-spread rating

6. Upholstery Fabric #2
Manufacturer: Boris Kroll
Style: 99661X
Color: 13 Illusions
Width: 54 inches
Content: Wool 75%, Nylon 25%
Flame Retardant Rating: ASTM-E84 Class A flame-spread rating

7. Upholstery Fabric #3
Manufacturer: Unika Vaev
Style: Firenze
Color: 149/38 Verrocchio Azure
Width: 54 inches
Content: Worsted Wool 100%
Flame Retardant Rating: ASTM-E84 Class A flame-spread rating

2.02 SOURCE QUALITY CONTROL
A. Material Quality - All bolts of fabric shall be one continuous, flawless piece of fabric.
1. When fabric is ordered in quantities of 50 yards or more, cut bolts are unacceptable.
2. In the event flaws do occur, the following requirements shall be followed:
   a. Wallcovering Fabric - three (3) additional yards shall be provided at no cost to the Purchaser for each flaw.
   b. Flipper Door or Tackboard Fabric - two-thirds (2/3) yard of additional fabric shall be provided at no cost to the Purchaser for each flaw.
   c. Upholstery Fabric - one (1) yard of additional fabric shall be provided at no cost to the Purchaser for each flaw.
   d. Panel Fabric - two (2) yards of additional fabric shall be provided at no cost to the Purchaser for each flaw.

3.0 EXECUTION
A. Manufacturer's recommendations shall be followed relative to surface preparation, materials and products used, and the environmental conditions in which work is to be performed.

APPENDIX #1
The following fabric amounts are a conservative estimate of what SRP plans to use on an annual basis over the next five years.
- Fabric Wallcovering #1      800 yards
- Fabric Wallcovering #2      300 yards
- Panel System Fabric        6,500 yards
- Flipper Door Fabric #1      170 yards
- Flipper Door Fabric #2      170 yards
- Tackboard Fabric           300 yards
- Upholstery Fabric #1       100 yards
- Upholstery Fabric #2       100 yards
- Upholstery Fabric #3       50 yards

END SECTION
SECTION 133419 - METAL BUILDING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Structural-steel framing.
2. Metal roof panels.
3. Metal wall panels.
4. Metal soffit panels.
5. Thermal insulation.
6. Doors and frames.
7. Windows.
8. Accessories.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of metal building system component.

B. Shop Drawings: For metal building system components. Include plans, elevations, sections, details, and attachments to other work.

C. Samples: For each type of exposed finish required.

D. Delegated-Design Submittal: For metal building systems indicated to comply with performance requirements and design criteria, including analysis data and calculations signed and sealed by the qualified professional engineer responsible for their preparation.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Metal Building System Certificates: For each type of metal building system, from manufacturer.

1. Letter of Design Certification: Signed and sealed by a qualified professional engineer. Include the following:

   a. Name and location of Project.
   b. Order number.
   c. Name of manufacturer.
   d. Name of Contractor.
   e. Building dimensions including width, length, height, and roof slope.
f. Indicate compliance with AISC standards for hot-rolled steel and AISI standards for cold-rolled steel, including edition dates of each standard.

g. Governing building code and year of edition.

h. Design Loads: Include dead load, roof live load, collateral loads, roof snow load, deflection, wind loads/speeds and exposure, seismic design category or effective peak velocity-related acceleration/peak acceleration, and auxiliary loads (cranes).

i. Load Combinations: Indicate that loads were applied acting simultaneously with concentrated loads, according to governing building code.

j. Building-Use Category: Indicate category of building use and its effect on load importance factors.

k. AISC Certification for Category MB: Include statement that metal building system and components were designed and produced in an AISC-Certified Facility by an AISC-Certified Manufacturer.

C. Material test reports.

D. Source quality-control reports.

E. Field quality-control reports.

F. Warranties: Sample of special warranties.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer.

1. AISC Certification for Category MB: An AISC-Certified Manufacturer that designs and produces metal building systems and components in an AISC-Certified Facility.

2. Preparation of Shop Drawings and engineering analysis by a qualified professional engineer.

B. Erector Qualifications: An experienced erector who is acceptable to manufacturer.

C. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."

2. AWS D1.3, "Structural Welding Code - Sheet Steel."

D. Structural Steel: Comply with AISC 360, "Specification for Structural Steel Buildings," for design requirements and allowable stresses.
E. Cold-Formed Steel: Comply with AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members" for design requirements and allowable stresses.

F. Preinstallation Conference: Conduct conference as directed by SRP PM.

1.6 WARRANTY

A. Special Warranty on Metal Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Finish Warranty Period: 10 years from date of Substantial Completion.

B. Special Weathertightness Warranty for Standing-Seam Metal Roof Panels: Manufacturer's standard form in which manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that leak or otherwise fail to remain weathertight within specified warranty period.

1. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. A&S Building Systems, Inc.; Division of NCI Building Systems, L.P.
2. Alliance Steel, Inc.
3. American Buildings Company; Division of Magnatrax Corp.
4. American Steel Building Co., Inc.
5. BC Steel Buildings, Inc.
7. Bigbee Steel Buildings, Inc.
8. Butler Manufacturing Company; a BlueScope Steel company.
9. CBC Steel Buildings; Division of Magnatrax Corp.
10. Ceco Building Systems; Division of NCI Building Systems, L.P.
11. Chief Buildings; Division of Chief Industries, Inc.
12. Elite Structures, Inc.
13. Garco Building Systems; Division of NCI Building Systems, L.P.
14. Gulf States Manufacturers, Inc.; Division of Magnatrax Corp.
15. Inland Buildings; Subsidiary of Behlen Mfg. Co.
16. Kirby Building Systems; Division of Magnatrax Corp.
17. Mesco Building Solutions; Division of NCI Building Systems, L.P.
18. Metallic Building Company; Division of NCI Building Systems, L.P.
19. Metco Metal Supply.
20. Mid-West Steel Building Company; Division of NCI Building Systems, L.P.
22. Oakland Metal Buildings, Inc.
23. Olympia Steel Building Systems.
24. Package Industries, Inc.
25. Pinnacle Structures, Inc.
26. Robertson Building Systems; an NCI company.
27. Ruffin Building Systems, Inc.
28. Schulte Building Systems, LLP.
29. Spirco Manufacturing.
30. Star Building Systems; an NCI company.
31. Tyler Building Systems, L.P.
32. USA, Inc.
33. VP Buildings; a United Dominion company.
34. Vulcan Steel Structures, Inc.
35. Whirlwind Building Systems.

2.2 METAL BUILDING SYSTEM PERFORMANCE

A. Delegated Design: Design metal building system, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Metal building systems shall be designed according to procedures in MBMA's "Metal Building Systems Manual."

1. Design Loads: As indicated on Drawings.
3. Deflection Limits: Design metal building system assemblies to withstand design loads with deflections no greater than the following:
   a. Design secondary-framing system to accommodate deflection of primary framing and construction tolerances, and to maintain clearances at openings.
4. Metal panel assemblies shall withstand the effects of gravity loads and loads and stresses within limits and under conditions indicated according to ASTM E 1592.

C. Seismic Performance: Metal building systems shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

D. Thermal Movements: Allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, material surfaces.

E. Water Penetration for Metal Roof Panels: No water penetration when tested according to ASTM E 1646.

F. Water Penetration for Metal Wall Panels: No water penetration when tested according to ASTM E 331 at a wind-load design pressure of not less than 2.86 lbf/sq. ft.

G. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for Class 30.

H. Solar Reflectance Index: Not less than 78 when calculated according to ASTM E 1980 based on testing identical products by a qualified testing agency.

I. Energy Performance: Provide roof panels that are listed on the DOE’s ENERGY STAR Roof Products Qualified Product List for low-slope roof products.

J. Energy Performance: Provide roof panels with initial solar reflectance not less than 0.70 and emissivity not less than 0.75 when tested according to CRRC.

2.3 STRUCTURAL-STEEL FRAMING

A. Primary Framing: Manufacturer’s standard primary-framing system, designed to withstand required loads and specified requirements. Primary framing includes transverse and lean-to frames; rafter, rake, and canopy beams; sidewall, intermediate, end-wall, and corner columns; and wind bracing.

1. General: Provide frames with attachment plates, bearing plates, and splice members. Factory drill for field-bolted assembly.

B. Bolts: Provide plain-finish bolts for structural-framing components that are primed or finish painted. Provide zinc-plated or hot-dip galvanized bolts for structural-framing components that are galvanized.

C. Finish: Factory primed. Apply specified primer immediately after cleaning and pretreating.
2.4 METAL ROOF PANELS

A. Standing-Seam Metal Roof Panels: Formed with ribs at panel edges and intermediate stiffening ribs symmetrically spaced between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels and engaging opposite edge of adjacent panels.

1. Material: Zinc-coated (galvanized) or Aluminum-zinc alloy-coated steel sheet, 0.028-inch nominal thickness.
   
   b. Color: As selected by Architect from manufacturer's full range.

2. Clips: Manufacturer's standard.
3. Joint Type: Panels snapped together.
4. Joint Type: Mechanically seamed, folded according to manufacturer's standard.
6. Panel Height: 2 inches.
7. Uplift Rating: UL 30

B. Tapered-Rib-Profile, Lap-Seam Metal Roof Panels: Formed with raised, trapezoidal major ribs and intermediate stiffening ribs symmetrically spaced between major ribs; designed to be installed by lapping side edges of adjacent panels and mechanically attaching panels to supports using exposed fasteners in side laps.

1. Material: Zinc-coated (galvanized) or Aluminum-zinc alloy-coated steel sheet, 0.028-inch nominal thickness.
   
   b. Color: As selected by Architect from manufacturer's full range.

2. Major-Rib Spacing: 12 inches o.c.
3. Panel Coverage: 36 inches
4. Panel Height: [0.75 in] [1.125 in] [1.188 in] [1.25 in] [1.5 in].

2.5 METAL WALL PANELS

A. [Tapered-Rib-Profile,] [Reverse-Rib-Profile,] Exposed-Fastener Metal Wall Panels: Formed with raised, trapezoidal major ribs and intermediate stiffening ribs symmetrically spaced between major ribs; designed to be installed by lapping side edges of adjacent panels and mechanically attaching panels to supports using exposed fasteners in side laps.

1. Material: Zinc-coated (galvanized) or Aluminum-zinc alloy-coated steel sheet, 0.028-inch nominal thickness.
   
   b. Color: As selected by Architect from manufacturer's full range.

2. Major-Rib Spacing: 12 inches o.c.
4. Panel Height: [0.75 inch] [1.125 inches] [1.188 inches] [1.25 inches] [1.5 inches].

2.6 METAL SOFFIT PANELS

A. General: Provide factory-formed metal soffit panels designed to be installed by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners and sealant in side laps. Include accessories required for weathertight installation.

B. Metal Soffit Panels: Match profile and material of metal wall panels.
   1. Finish: Match finish and color of metal wall panels.

2.7 THERMAL INSULATION

A. Faced Metal Building Insulation: ASTM C 991, Type II, glass-fiber-blanket insulation; 0.5-lb/cu. ft. density; 2-inch- wide, continuous, vapor-tight edge tabs; with a flame-spread index of 25 or less.

B. Unfaced Metal Building Insulation: ASTM C 991, Type I, or NAIMA 202, glass-fiber-blanket insulation; 0.5-lb/cu. ft. density; 2-inch- wide, continuous, vapor-tight edge tabs; with a flame-spread index of 25 or less.
   1. Vapor-Retarder Facing: ASTM C 1136, with permeance not greater than 0.02 perm when tested according to ASTM E 96/E 96M, Desiccant Method.

2.8 DOORS AND FRAMES

A. Swinging Personnel Doors and Frames: Metal building system manufacturer's standard doors and frames; prepared and reinforced at strike and at hinges to receive factory- and field-applied hardware according to BHMA A156 Series.
   1. Hardware:
      a. Provide hardware for each door leaf, as follows:
         1) Hinges: BHMA A156.1. Three plain-bearing, standard-weight, full-mortise, stainless-steel or bronze, template-type hinges; 4-1/2 by 4-1/2 inches, with nonremovable pin.
         2) Lockset: BHMA A156.2. [Key-in-lever cylindrical] [Mortise, with lever handle] type.
         3) Exit Device: BHMA A156.3. Touch- or push-bar type.
         5) Silencers: Pneumatic rubber; three silencers on strike jambs of single door frames and two silencers on heads of double door frames.
7) Weather Stripping: Vinyl applied to head and jambs, with vinyl sweep at sill.

B. Finishes for Personnel Doors and Frames:

1. Prime Finish: Factory-apply manufacturer's standard primer immediately after cleaning and pretreating.
   a. Color and Gloss: As indicated by manufacturer's designations.

2.9 WINDOWS

A. Aluminum Windows: Metal building system manufacturer's standard, with self-flashing mounting fins, and as follows:

1. Type, Performance Class, and Performance Grade: Comply with AAMA/WDMA/CSA 101/I.S.2/A440 and as follows:
   a. Horizontal-Sliding Units: [HS-LC25] [HS-C30] <Insert designation>.
   c. Fixed Units: [F-LC25] [F-C30] <Insert designation>.

2. Hardware: Manufacturer's standard; of aluminum, stainless steel, die-cast steel, malleable iron, or bronze; including the following:
   a. Cam-action sweep sash lock and keeper at meeting rails.
   b. Spring-loaded, snap-type lock at jambs.
   c. Pole-operated, cam-action locking device on meeting rail where rail is more than 72 inches above floor.
   d. Lift handles for single-hung units.
   e. Nylon sash rollers for horizontal-sliding units.
   f. Steel or bronze operating arms.


4. Insect Screens: Provide removable insect screen on each operable exterior sash, with screen frame finished to match window unit.

B. Glazing: Comply with requirements specified in Section 088000 "Glazing."

C. Finish:

1. Mill finish.
2. Baked-Enamel Finish: Organic Coating: Thermosetting, modified-acrylic enamel primer/topcoat system complying with AAMA 2603 except with a minimum dry film thickness of 0.7 mil, medium gloss.

   a. Color: As indicated by manufacturer's designations.

2.10 ACCESSORIES

A. General: Provide accessories as standard with metal building system manufacturer and as specified. Fabricate and finish accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes. Comply with indicated profiles and with dimensional and structural requirements.

   1. Form exposed sheet metal accessories that are without excessive oil-canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.

B. Roof Panel Accessories: Provide components required for a complete metal roof panel assembly including copings, fasciae, corner units, ridge closures, clips, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal roof panels unless otherwise indicated.

C. Wall Panel Accessories: Provide components required for a complete metal wall panel assembly including copings, fasciae, mullions, sills, corner units, clips, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal wall panels unless otherwise indicated.

D. Flashing and Trim: Formed from 0.022-inch nominal-thickness, metallic-coated steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating; finished to match adjacent metal panels.

E. Gutters: Formed from 0.022-inch nominal-thickness, metallic-coated steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating; finished to match roof fascia and rake trim. Match profile of gable trim, complete with end pieces, outlet tubes, and other special pieces as required. Fabricate in minimum 96-inch-long sections, sized according to SMACNA's "Architectural Sheet Metal Manual."

   1. Gutter Supports: Fabricated from same material and finish as gutters.

   2. Strainers: Bronze, copper, or aluminum wire ball type at outlets.

F. Downspouts: Formed from 0.022-inch nominal-thickness, zinc-coated (galvanized) steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating; finished to match metal wall panels. Fabricate in minimum 10-foot-long sections, complete with formed elbows and offsets.

   1. Mounting Straps: Fabricated from same material and finish as gutters.

G. Roof Ventilators: Gravity type, complete with hardware, flashing, closures, and fittings.
1. Circular-Revolving Type: Minimum 20-inch-diameter throat opening; finished to match metal roof panels; with matching base and rain cap.
   a. Type: [Directional] [Stationary] revolving.
   b. Bird Screening: Galvanized steel or aluminum.
   c. Dampers: Spring-loaded, butterfly type; pull-chain operation; with pull chain of length required to reach within 36 inches of floor.

2. Continuous or Sectional-Ridge Type: Factory-engineered and fabricated, continuous unit; fabricated from 0.022-inch nominal-thickness, metallic-coated steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating; finished to match metal roof panels. Fabricated in minimum 10-foot-long sections. Provide throat size and total length indicated, complete with side baffles, ventilator assembly, end caps, splice plates, and reinforcing diaphragms.
   a. Bird Screening: Galvanized steel or aluminum.
   b. Dampers: Manually operated, spring-loaded, vertically rising type; chain and worm gear operator; with pull chain of length required to reach within 36 inches of floor.
   c. Throat Size: 9 or 12 inches, as standard with manufacturer, and as required to comply with ventilation requirements.

H. Roof Curbs: Fabricated from minimum 0.052-inch nominal-thickness, metallic-coated steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating; finished to match metal roof panels; capable of withstanding loads of size and height indicated.

I. Pipe Flashing: Premolded, EPDM pipe collar with flexible aluminum ring bonded to base.

2.11 SOURCE QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to evaluate product.

B. Special Inspector: Owner will engage a qualified special inspector to perform the following tests and inspections and to submit reports. Special inspector will verify that manufacturer maintains detailed fabrication and quality-control procedures and will review the completeness and adequacy of those procedures to perform the Work.

1. Special inspections will not be required if fabrication is performed by manufacturer registered and approved by authorities having jurisdiction to perform such Work without special inspection.
   a. After fabrication, submit copy of certificate of compliance to authorities having jurisdiction, certifying that Work was performed according to Contract requirements.

C. Testing: Test and inspect shop connections for metal buildings according to the following:
1. Bolted Connections: Shop-bolted connections shall be inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

2. Welded Connections: In addition to visual inspection, shop-welded connections shall be tested and inspected according to AWS D1.1/D1.1M and the following inspection procedures, at inspector's option:

   a. Liquid Penetrant Inspection: ASTM E 165.
   b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
   c. Ultrasonic Inspection: ASTM E 164.
   d. Radiographic Inspection: ASTM E 94.

D. Product will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

2.12 FABRICATION

A. General: Design components and field connections required for erection to permit easy assembly.

   1. Mark each piece and part of the assembly to correspond with previously prepared erection drawings, diagrams, and instruction manuals.
   2. Fabricate structural framing to produce clean, smooth cuts and bends. Punch holes of proper size, shape, and location. Members shall be free of cracks, tears, and ruptures.


C. Primary Framing: Shop fabricate framing components to size and section, with baseplates, bearing plates, stiffeners, and other items required for erection welded into place. Cut, form, punch, drill, and weld framing for bolted field assembly.

D. Secondary Framing: Shop fabricate framing components to size and section by roll-forming or break-forming, with baseplates, bearing plates, stiffeners, and other plates required for erection welded into place. Cut, form, punch, drill, and weld secondary framing for bolted field connections to primary framing.

E. Metal Panels: Fabricate and finish metal panels at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements. Comply with indicated profiles and with dimensional and structural requirements.
PART 3 - EXECUTION

3.1 ERECTION OF STRUCTURAL FRAMING

A. Do not field cut, drill, or alter structural members without written approval from metal building system manufacturer's professional engineer.

B. Set structural framing accurately in locations and to elevations indicated, according to AISC specifications referenced in this Section. Maintain structural stability of frame during erection.


1. Set plates for structural members on wedges, shims, or setting nuts as required.
2. Tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
3. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

D. Align and adjust structural framing before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with framing. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure.
2. Make allowances for difference between temperature at time of erection and mean temperature when structure will be completed and in service.

E. Primary Framing and End Walls: Erect framing level, plumb, rigid, secure, and true to line. Level baseplates to a true even plane with full bearing to supporting structures, set with double-nutted anchor bolts. Use grout to obtain uniform bearing and to maintain a level base-line elevation. Moist-cure grout for not less than seven days after placement.

1. Make field connections using high-strength bolts installed according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for bolt type and joint type specified.
   a. Joint Type: Snug tightened or pretensioned.

F. Secondary Framing: Erect framing level, plumb, rigid, secure, and true to line. Field bolt secondary framing to clips attached to primary framing.

1. Provide rake or gable purlins with tight-fitting closure channels and fasciae.
2. Locate and space wall girts to suit openings such as doors and windows.
3. Locate canopy framing as indicated.
4. Provide supplemental framing at entire perimeter of openings, including doors, windows, louvers, ventilators, and other penetrations of roof and walls.

G. Steel Joists: Install joists and accessories plumb, square, and true to line; securely fasten to supporting construction according to SJI's "Standard Specifications and Load Tables for Steel Joists and Joist Girders," joist manufacturer's written instructions, and requirements in this Section.

1. Before installation, splice joists delivered to Project site in more than one piece.
2. Space, adjust, and align joists accurately in location before permanently fastening.
3. Install temporary bracing and erection bridging, connections, and anchors to ensure that joists are stabilized during construction.
4. Bolt joists to supporting steel framework using carbon-steel bolts unless high-strength structural bolts are required by the manufacturer.
6. Install and connect bridging concurrently with joist erection, before construction loads are applied. Anchor ends of bridging lines at top and bottom chords if terminating at walls or beams.

H. Bracing: Install bracing in roof and sidewalls where indicated on erection drawings.

1. Tighten rod and cable bracing to avoid sag.
2. Locate interior end-bay bracing only where indicated.

I. Framing for Openings: Provide shapes of proper design and size to reinforce openings and to carry loads and vibrations imposed, including equipment furnished under mechanical and electrical work. Securely attach to structural framing.

J. Erection Tolerances: Maintain erection tolerances of structural framing within AISC 303.

3.2 METAL PANEL INSTALLATION, GENERAL

A. General: Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Field cut metal panels as required for doors, windows, and other openings. Cut openings as small as possible, neatly to size required, and without damage to adjacent metal panel finishes.
   a. Field cutting of metal panels by torch is not permitted unless approved in writing by manufacturer.
2. Install metal panels perpendicular to structural supports unless otherwise indicated.
3. Flash and seal metal panels with weather closures at perimeter of openings and similar elements. Fasten with self-tapping screws.
4. Locate and space fastenings in uniform vertical and horizontal alignment.
5. Locate metal panel splices over, but not attached to, structural supports with end laps in alignment.
6. Lap metal flashing over metal panels to allow moisture to run over and off the material.

B. Lap-Seam Metal Panels: Install screw fasteners using power tools with controlled torque adjusted to compress EPDM washers tightly without damage to washers, screw threads, or metal panels. Install screws in predrilled holes.

1. Arrange and nest side-lap joints so prevailing winds blow over, not into, lapped joints. Lap ribbed or fluted sheets one full rib corrugation. Apply metal panels and associated items for neat and weathertight enclosure. Avoid "panel creep" or application not true to line.

C. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with corrosion-resistant coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by metal roof panel manufacturer.

D. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weatherproof performance of metal panel assemblies. Provide types of gaskets, fillers, and sealants recommended by metal panel manufacturer.

1. Seal metal panel end laps with double beads of tape or sealant the full width of panel. Seal side joints where recommended by metal panel manufacturer.
2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."

3.3 METAL ROOF PANEL INSTALLATION

A. General: Provide metal roof panels of full length from eave to ridge unless otherwise indicated or restricted by shipping limitations.

1. Install ridge and hip caps as metal roof panel work proceeds.
2. Flash and seal metal roof panels with weather closures at eaves and rakes. Fasten with self-tapping screws.

B. Standing-Seam Metal Roof Panels: Fasten metal roof panels to supports with concealed clips at each standing-seam joint, at location and spacing and with fasteners recommended by manufacturer.

1. Install clips to supports with self-drilling or self-tapping fasteners.
2. Install pressure plates at locations indicated in manufacturer's written installation instructions.
3. Snap Joint: Nest standing seams and fasten together by interlocking and completely engaging factory-applied sealant.
4. Seamed Joint: Crimp standing seams with manufacturer-approved motorized seamer tool so that clip, metal roof panel, and factory-applied sealant are completely engaged.
5. Rigidly fasten eave end of metal roof panels and allow ridge end free movement due to thermal expansion and contraction. Predrill panels for fasteners.

6. Provide metal closures at [peaks] [rake edges] [rake walls] [and] each side of ridge [and hip] caps.

C. Lap-Seam Metal Roof Panels: Fasten metal roof panels to supports with exposed fasteners at each lapped joint, at location and spacing recommended by manufacturer.

1. Provide metal-backed sealing washers under heads of exposed fasteners bearing on weather side of metal roof panels.

2. Provide sealant tape at lapped joints of metal roof panels and between panels and protruding equipment, vents, and accessories.

3. Apply a continuous ribbon of sealant tape to weather-side surface of fastenings on end laps and on side laps of nesting-type metal panels, on side laps of ribbed or fluted metal panels, and elsewhere as needed to make metal panels weatherproof to driving rains.

4. At metal panel splices, nest panels with minimum 6-inch end lap, sealed with butyl-rubber sealant and fastened together by interlocking clamping plates.

D. Metal Fascia Panels: Align bottom of metal panels and fasten with blind rivets, bolts, or self-drilling or self-tapping screws. Flash and seal metal panels with weather closures where fasciae meet soffits, along lower panel edges, and at perimeter of all openings.

3.4 METAL WALL PANEL INSTALLATION

A. General: Install metal wall panels in orientation, sizes, and locations indicated on Drawings. Install panels perpendicular to girts, extending full height of building, unless otherwise indicated. Anchor metal wall panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Unless otherwise indicated, begin metal panel installation at corners with center of rib lined up with line of framing.

2. Shim or otherwise plumb substrates receiving metal wall panels.

3. When two rows of metal panels are required, lap panels 4 inches minimum.

4. When building height requires two rows of metal panels at gable ends, align lap of gable panels over metal wall panels at eave height.

5. Rigidly fasten base end of metal wall panels and allow eave end free movement due to thermal expansion and contraction. Predrill panels.

6. Flash and seal metal wall panels with weather closures at eaves, rakes, and at perimeter of all openings. Fasten with self-tapping screws.


8. Install flashing and trim as metal wall panel work proceeds.

9. Apply elastomeric sealant continuously between metal base channel (sill angle) and concrete, and elsewhere as indicated; or, if not indicated, as necessary for waterproofing.

10. Align bottom of metal wall panels and fasten with blind rivets, bolts, or self-drilling or self-tapping screws.

11. Provide weatherproof escutcheons for pipe and conduit penetrating exterior walls.
B. Metal Wall Panels: Install metal wall panels on exterior side of girts. Attach metal wall panels to supports with fasteners as recommended by manufacturer.

3.5 METAL SOFFIT PANEL INSTALLATION

A. Provide metal soffit panels the full width of soffits. Install panels perpendicular to support framing.

B. Flash and seal metal soffit panels with weather closures where panels meet walls and at perimeter of all openings.

3.6 THERMAL INSULATION INSTALLATION

A. General: Install insulation concurrently with metal panel installation, in thickness indicated to cover entire surface, according to manufacturer's written instructions.

1. Set vapor-retarder-faced units with vapor retarder toward warm side of construction unless otherwise indicated. Do not obstruct ventilation spaces except for firestopping.

2. Tape joints and ruptures in vapor retarder, and seal each continuous area of insulation to the surrounding construction to ensure airtight installation.

3. Install factory-laminated, vapor-retarder-faced blankets straight and true in one-piece lengths, with both sets of facing tabs sealed, to provide a complete vapor retarder.

B. Blanket Roof Insulation: Comply with the following installation method:


2. Between-Purlin Installation: Extend insulation and vapor retarder between purlins. Carry vapor-retarder-facing tabs up and over purlin, overlapping adjoining facing of next insulation course and maintaining continuity of retarder. Hold in place with bands and crossbands below insulation.

3. Over-Purlin-with-Spacer-Block Installation: Extend insulation and vapor retarder over and perpendicular to top flange of secondary framing. Install layer of filler insulation over first layer to fill space formed by metal roof panel standoffs. Hold in place by panels fastened to standoffs.

   a. Thermal Spacer Blocks: Where metal roof panels attach directly to purlins, install thermal spacer blocks.

4. Two-Layers-between-Purlin-with-Spacer-Block Installation: Extend insulation and vapor retarder between purlins. Carry vapor-retarder-facing tabs up and over purlin, overlapping adjoining facing of next insulation course and maintaining continuity of retarder. Install layer of filler insulation over first layer to fill space between purlins formed by thermal spacer blocks. Hold in place with bands and crossbands below insulation.
a. Thermal Spacer Blocks: Where metal roof panels attach directly to purlins, install thermal spacer blocks.

5. Retainer Strips: Install retainer strips at each longitudinal insulation joint, straight and taut, nesting with secondary framing to hold insulation in place.

C. Blanket Wall Insulation: Extend insulation and vapor retarder over and perpendicular to top flange of secondary framing. Hold in place by metal wall panels fastened to secondary framing.
   1. Retainer Strips: Install retainer strips at each longitudinal insulation joint, straight and taut, nesting with secondary framing to hold insulation in place.
   2. Sound-Absorption Insulation: Where sound-absorption requirement is indicated for metal liner panels, cover insulation with polyethylene film and provide inserts of wire mesh to form acoustical spacer grid.

3.7 DOOR AND FRAME INSTALLATION

A. General: Install doors and frames plumb, rigid, properly aligned, and securely fastened in place according to manufacturers' written instructions. Coordinate installation with wall flashings and other components. Seal perimeter of each door frame with elastomeric sealant used for metal wall panels.

B. Personnel Doors and Frames: Install doors and frames according to SDI A250.8.

C. Field Glazing: Comply with installation requirements in Section 088000 "Glazing."

D. Door Hardware: Mount units at heights indicated in DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
   1. Install surface-mounted items after finishes have been completed on substrates involved.
   2. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
   3. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
   4. Set thresholds for exterior doors in full bed of butyl-rubber sealant complying with requirements specified in Section 079200 "Joint Sealants."

3.8 WINDOW INSTALLATION

A. General: Install windows plumb, rigid, properly aligned, without warp or rack of frames or sash, and securely fasten in place according to manufacturer's written instructions. Coordinate installation with wall flashings and other components. Seal perimeter of each window frame with elastomeric sealant used for metal wall panels.

   1. Separate dissimilar materials from sources of corrosion or electrolytic action at points of contact with other materials by complying with requirements specified in AAMA/WDMA/CSA 101/I.S.2/A440.
B. Set sill members in bed of sealant or with gaskets, as indicated, for weathertight construction.

C. Install windows and components to drain condensation, water penetrating joints, and moisture migrating within windows to the exterior.

D. Mount screens directly to frames with tapped screw clips.

E. Field Glazing: Comply with installation requirements in Section 088000 "Glazing."

3.9 ACCESSORY INSTALLATION

A. General: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal roof panel assembly, including trim, copings, ridge closures, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.

2. Install components for a complete metal wall panel assembly, including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.

3. Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with corrosion-resistant coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by manufacturer.

B. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

1. Install exposed flashing and trim that is without excessive oil-canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.

2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped or bayonet-type expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

C. Gutters: Join sections with riveted-and-soldered or lapped-and-sealed joints. Attach gutters to eave with gutter hangers spaced as required for gutter size, but not more than 36 inches o.c. using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.
D. Downspouts: Join sections with 1-1/2-inch telescoping joints. Provide fasteners designed to hold downspouts securely 1 inch away from walls; locate fasteners at top and bottom and at approximately 60 inches o.c. in between.

1. Provide elbows at base of downspouts to direct water away from building.
2. Tie downspouts to underground drainage system indicated.

E. Circular Roof Ventilators: Set ventilators complete with necessary hardware, anchors, dampers, weather guards, rain caps, and equipment supports. Mount ventilators on flat level base. Install preformed filler strips at base to seal ventilator to metal roof panels.

F. Continuous Roof Ventilators: Set ventilators complete with necessary hardware, anchors, dampers, weather guards, rain caps, and equipment supports. Join sections with splice plates and end-cap skirt assemblies where required to achieve indicated length. Install preformed filler strips at base to seal ventilator to metal roof panels.

G. Roof Curbs: Install curbs at locations indicated on Drawings. Install flashing around bases where they meet metal roof panels.

H. Pipe Flashing: Form flashing around pipe penetration and metal roof panels. Fasten and seal to panel as recommended by manufacturer.

3.10 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform special inspections.

B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

C. Tests and Inspections:

1. High-Strength, Field-Bolted Connections: Connections shall be tested and inspected during installation according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
2. Welded Connections: In addition to visual inspection, field-welded connections shall be tested and inspected according to AWS D1.1/D1.1M and the following inspection procedures, at inspector's option:
   a. Liquid Penetrant Inspection: ASTM E 165.
   b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
   c. Ultrasonic Inspection: ASTM E 164.
   d. Radiographic Inspection: ASTM E 94.

D. Product will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.
END OF SECTION 133419
SECTION 133420 - PORTABLE AND MOBILE BUILDINGS

PART 1 GENERAL

1.01 SECTION INCLUDES:
A. All labor, materials, equipment, accessories and services necessary to furnish, install and make operational a complete Portable Building.

1.02 REFERENCES
A. Reference to standards and/or specifications herein shall be interpreted to mean the latest revision unless noted otherwise. The following abbreviations appear in the specification.
   1. APA American Plywood Association
   2. NFPA National Fire Protection Association/National Forest Products Association
   3. OSHA Occupational Safety and Health Act
   4. SMACNA Sheet Metal and Air Conditioning Contractors National Association
   5. UBC Uniform Building Code
B. Permission for deviation from these standards and/or specifications must be approved in writing by the Engineer in advance.

1.03 QUALITY ASSURANCE
A. Manufacturer shall be a nationally recognized company within the portable building industry, and have been continuously active in the construction of portable buildings for a minimum of 15 years.
B. Contractor shall be the portable building manufacturer’s approved installer.
C. Manufacturer shall provide the Engineer names and pertinent data of at least ten projects of same or similar installations of portable buildings as specified in these specifications. At least three projects shall be local and available for the Engineer’s inspection.
D. The manufacturer of the portable building shall provide the following warranties, providing for the repair/replacement of defective materials and workmanship not attributable to the occupants’ normal use of structure:
   a. Unlimited non-prorated one year warranty on all installed equipment, finishes and nonstructural items (nonbearing framing, acoustic system, HVAC system, light fixtures, etc.).
   b. Minimum, non-prorated, five year warranty on structural elements.
   c. 10 year unlimited non-prorated warranty on the roof system.
E. The completed portable building shall comply with UBC and applicable codes/ordinances of the municipality where the structure is located and with OSHA requirements.
F. The Contractor shall appoint a Project Manager who shall:
   1. Coordinate all work for this contract with Purchaser requirements and Purchaser-provided work (i.e., site preparation).
   2. Be responsible for coordination and scheduling of work by subcontractors.
   3. Advise the Engineer of scheduling requirements for work by Purchaser's forces.
   4. Process all shop drawings and be knowledgeable of products to be used in the portable building construction of this Project.
   5. Coordinate and maintain current schedules required.
   6. Be experienced in the portable building industry, with a minimum of five years experience in portable building installations.

1.04 DELIVERY, STORAGE AND HANDLING
A. Portable building unit(s) shall be delivered to jobsite in new condition. Materials which are accessory to the installation of the unit(s) shall be delivered to jobsite in the original packages, containers or bundles bearing the name of manufacturer and product. Accessory materials shall be stored on pallets or equivalent wood blocking and properly protected.
B. Deliver materials in a manner to allow continuous progress of work, in accordance with established schedules.
C. Delivery and on-site storage of unit(s) and accessory materials shall not hinder vehicular or pedestrian traffic except in areas approved by the Engineer or as shown on drawings. Move-on schedule shall be approved by the Engineer.
D. Material handling equipment used onsite shall conform to and be operated in conformance with the most recent OSHA and local building code requirements.

1.05 SITE CONDITIONS
A. Access to site and work shall be coordinated with the Engineer.
B. Installation of work performed during rainy or inclement weather shall be performed only with the Engineer's approval. Interiors of unit(s) shall be protected and maintained weathertight during inclement weather.
C. Contractor shall assume that existing buildings onsite, if any, will be occupied and utilized for ongoing operations. Contractor shall not interrupt Purchaser's operations unless written approval is received from the Engineer.
D. Site shall be prepared by others (unless noted otherwise on drawings) and shall be ready to accept portable building unit(s). At minimum: site utilities shall be in place in locations shown on. drawings, and landscaping that the Purchaser has determined may interfere with the installation will have been removed and will be reinstalled by the Purchaser unless otherwise noted on the drawings.
E. Contractor shall examine site for locations of utilities to service the portable building and verify existing "as-built" conditions as accurate. Site preparation requirements of the Contractor which differ or contradict the referenced drawings shall be brought to the attention of the Engineer. Submittal of bid constitutes statement that site preparation as shown on drawings is acceptable for move-on and setup.
F. All equipment, devices and accessories incidental to transporting, move-on, and setup of the portable unit(s) shall be provided by Contractor.

1.06 SUBMITTALS
A. Manufacturer's literature indicating all materials to be provided as part of the portable building conforming to the requirement of this specification.
B. Complete Shop Drawings, supporting data and calculations of the portable building construction and systems indicating type of materials, gauge, dimension, fastening and anchoring methods and joints. Indicate by note any deviations from Construction Documents. Submit manufacturer's recommendations and requirements for items required by this work but provided by others as noted on drawings (e.g., site utilities).
1. Schedules for:
   a. Manufacture of portable building unit(s) with milestones stipulating Purchaser requirements and confirmation of information and Shop Drawings (e.g., completion deadline for site preparation work by others).
   b. Duration of move-on and setup.
   c. Installation and completion of work after move on and setup with milestones stipulating work timeframe for work by others, nature and timeframe of work by Contractor or his subcontractor and date for final inspection.
   d. Certifications required by codes, laws, ordinances, building officials and this specification.

PART 2 PRODUCT

2.01 MATERIALS
A. Portable building unit(s) in size and configuration and with materials as defined herein and on referenced drawings, conforming to Uniform Building Code (UBC) Classification Type V (N) construction with fire sprinkler (or other equivalent construction type defined by local building code) and UBC Chapter 50, Prefabricated Construction requirements.
B. Provide required fire rated assemblies and protected materials in accordance with other more stringent codes where selection of alternative materials (wood versus metal) or systems (ducted versus plenum return air) is allowed.
C. Structural Foundations
1. Unless otherwise noted, Contractor to provide all bearing blocks, stands, shims, anchors, hold down straps, etc., required by manufacturer and/or building code(s) to support and anchor the unit(s). Contractor may, with the Engineer's approval, determine that placement of the portable building unit(s) over existing paving or concrete is adequate for substitution of some structural foundation elements (i.e., bearing locks). Substitution in no way lessens the warranty against settlement.
D. Structural Frame
1. Provide welded steel frame with long span beams or joists to provide clear spans and open spaces. Secondary floor joists and roof purlins shall be of steel or wood as required. Jo support code minimum floor and roof loads but not less than the following:
   a. Floor - Use Uniform Load Office space, Conference & Meeting Rooms 100 lbs/s.f.
      Storage, Library stacking areas 125 lbs/s.f.
   b. Concentrated floor load .2,000 lbs.
   c. Roof - Minimum live load 20 lbs/s.f.
   d. Wind load - Design wind speed shall be 75 mph with exposure "C".
2. Provide for special loading criteria noted on drawings (i.e., equipment, access flooring, computers, antennae).
3. Structural sheathing shall be provided by the manufacturer where required by building code or for structural stability of the unit(s) in place and/or transit.

E. Floor and Roof Construction
1. Floor and roof substrate to be exterior grade plywood or particle board in accordance with American Plywood Association (APA) standards. Thickness as required by code and to support loading specified herein and on drawings; minimum 5/8 inch floor, 7/16 inch roof or as required by Roof Manufacturer. Other more stringent requirements of materials manufacturers may require increased substrate thickness.

F. Roof Membrane
1. Single ply Membrane - All systems shall be installed in accordance with Roofing Manufacturer's recommendations including attachment sheets, insulation, roof tapes, fasteners, adhesives, sealants, flashings, accessories, equipment and services. All systems shall be coated with a reflective coating material as recommended by the Roof System Manufacturer and minimum 50 percent reflectance. The following are pre-approved roof systems:
   a. Firestone Ultra Ply 78, mechanically anchored system.
   c. Owens-Corning Fiberglass, Derbigum HPS Single-Ply system, fully adhered.
2. Built-up Roofing Systems - All systems shall be installed in accordance with Roofing manufacturer's recommendations including attachment sheets, insulation, roof tapes, fasteners, adhesives, sealants, flashings, accessories, equipment and services. Following are pre-approved roof systems:
   a. Owens-Corning Fiberglass, #33TC
   b. GAF Building Materials Corp., #103 M-B
   c. Tremco, THURmastic THERM 100 system
3. Galvanized Metal - 24 gauge, painted. Install in accordance with applicable SMACNA details and standards.
4. Asphalt - Fiberglass Shingles Class A and wind-resistant label shingles, meeting ASTM D3018, Type 1 and D3161; "sentinel" grade as manufactured by GAF Building Materials Corp.; 20 year warranty; or equivalent. Color shall be selected by Engineer from Roofing Manufacturer's standard colors. Install in accordance with Roofing Manufacturer's recommendations including roofing felt, fasteners, adhesives, sealants, flashings, accessories, equipment and services.

G. Exterior Wall Construction
1. Nonbearing Framing Members - Nonbearing framing shall be made of metal or wood. Typical minimum size and spacing: two inch by four inch wood or 3 5/8 inch metal, at maximum spacing of 24 inches on center. Other widths and spacing as required by codes, other more stringent requirements of this specification, or required to enclose concealed or recessed work.
2. Exterior Skin - Exterior finish materials to be provided and installed in accordance with applicable industry standards and Material Manufacturer's recommendations and, requirements. Exterior finish material may be used as structural sheathing if approved by the Engineer. Material and color shall be as noted on drawings and/or schedules. The following are pre-approved exterior skin materials unless noted otherwise on drawings:
   a. APA 303 siding, 6-S/W face grade, 24 inch on center span rating, 5/8 inch thick minimum, Group 1, exterior glue; T&G rough-sawn with grooves at 8 inches on center; stained or painted.
   b. 7/16 inch T&G primed hardboard exterior siding; rough sawn wood texture with grooves at 8 inches on center or sand finish stucco texture; painted.
c. .019 thick prefinished aluminum panels.

H. Vapor Barrier
1. Any of the following vapor material may be used:
   a. One half inch thick asphalt impregnated board.
   b. Asphalt saturated 15 pound rag felt.
   c. Four mil polyethylene sheet.
   d. Foil vapor barrier attached to batt insulation.

I. Interior Skin
1. All interior finish materials shall be provided and installed in accordance with respective Material Manufacturer's recommendations. Interior finish material of exterior wall may be used as structural sheathing if approved by the Engineer. Material and color shall be as noted on drawings and/or schedules.

J. Interior Nonbearing Partitions
1. Provide and install fixed interior nonbearing partitions in locations as shown on drawings including finish materials as noted and/or scheduled.
2. Stud Channel-stud system complete with head and floor tracks, bearings, accessories and anchorage; minimum 2 1/2 inches wide, 25 gauge electro-galvanized at maximum spacing of 24 inches on center. Other widths, gauges, and spacing as required by applicable building codes, other more stringent requirements of this specification or required to enclose concealed or recessed work.
3. Interior Finish - Material may not be used as structural sheathing without prior written approval of the Engineer. Material and color shall be as noted on drawings and/or schedules.

K. Doors, Door Frames and Hardware
1. Materials to be provided and installed as part of the Contractor's work.
2. Install doors, door frames and hardware in accordance with respective Material Manufacturers' specifications, codes, and other sections of this specification; free from bind or excess clearances; set to finish materials as detailed.

L. Windows, Glass and Glazing
1. General - Materials and installation to be in accordance with applicable building code provisions, industry standards, the Flat Glass Glazing Manual and other sections of this specification. Size, configuration an detail shall be as shown on drawings and/or schedules.
2. Exterior Windows, operable - Bronze anodized aluminum horizontal sliding with nail-on flanges, operable panel to glide on adjustable nylon glides; glass to be 3/16 inch thick minimum, solar bronze, factory glazed; provide solar mesh insect screen; Alenco Series 700 or equivalent by Reynolds Aluminum, International, or Aluminaire.
3. Non-operable Exterior Windows - Bronze anodized aluminum picture/fixed window with nail-on flanges; glass to be 3/16 inch thick minimum, solar bronze, factory glazed; provide solar mesh screen; Alenco Series 700 or equivalent by Reynolds Aluminum, International or Aluminaire.
4. Glass and Glazing other than factory glazed.
   a. Provide minimum thickness specified in respective sections, required by portable building manufacturer, or as required for compliance with applicable codes, ordinances, laws, regulations and glass manufacturer's recommendations. Factory label all glass for type, quality and thickness; provide permanent labels as required by law.
   b. Glass Color - Typical exterior, solar bronze. Typical interior, clear, unless otherwise noted on the drawings.

M. Insulation
1. Provide glass fibered batt insulation to meet applicable fire ratings and the following minimum R-values. Where framing space is restricted, use highest R-Factor space will allow. Provide accessories and attachment devices as required to attach and support insulation.
   a. Roof/Ceiling - R-30, foil faced.
   b. Exterior Walls - R-19.
   c. Interior Walls at Toilet Rooms - 3-1/2 inch sound attenuating batts.
   d. Floor - R-1 1 with protective board.

N. Fire Sprinkler System
1. Materials and installation are part of the contract work and shall be in accordance with latest standards of National Board of Fire Underwriters, NFPA #13.
2. Place all heads minimum one foot from edge of tile (centered in two foot by two foot area).
Specialty Items, Miscellaneous Construction and Accessories.

1. Provide and install all specialty items, miscellaneous construction, and accessories shown on drawings that are required to provide a completed facility installation. Install in accordance with manufacturers' directions and recommendations, and by skilled mechanics of trades generally associated with individual items. Secure all items in place as shown on drawings or as directed. Protect against damage at all times.

2. Specialty items may include access panels, lead walls, sound booths, etc.

3. Miscellaneous construction may include skirting, fascia panels, canopies, porch structures, steps, etc.

4. Accessories may include restroom accessories, toilet partitions, etc. Provide accessories as shown on drawings. Provide the following for restroom facilities:
   a. All exposed metal on accessories shall be satin finish stainless steel.
   b. One granular soap dispenser shall be provided for each restroom (Bobrick B-132).
   c. Each sink shall be provided with a counter mount liquid soap dispenser (Bobrick B-822).
   d. Use wall mount where applicable (Bobrick B-1 12 or B-1 11).
   e. One combination paper towel dispenser/disposal shall be provided for up to three sinks.
      In the event more than three sinks are provided, one paper towel dispenser/disposal shall be provided for every two sinks (Bobrick B-3944). The location shall be as close to sink as possible.
   f. Small restrooms with one sink shall be provided with a paper towel dispenser only (Bobrick B-369).
   g. A toilet tissue dispenser with backer plate shall be provided for each toilet compartment (Bobrick B-6867).
   h. Grab bars with anchor plates shall be provided as required for handicapped (Bobrick B-6293).
   i. One feminine napkin/tampon vendor shall be provided for each women's restroom (Bobrick B-35024).
   j. One feminine napkin disposal shall be provided for each women's toilet compartment. A two-compartment disposal shall be provided wherever possible (Bobrick B-354), otherwise provide single compartment (Bobrick B-353).
   k. One stainless steel shelf shall be provided for each restroom (Bobrick B-298). Size - 8 inches by 24 inches long.
   l. One hook and bumper shall be provided on each toilet partition door (Bobrick B-212).
   m. A towel hook shall be provided for each shower head (Bobrick B-677).
   n. All shower stall soap dispensers shall be recessed and of a material that is noncorrosive.
   o. One toilet seat cover dispenser shall be provided for each toilet compartment (Bobrick B-3013).
   p. Toilet partitions shall be baked enamel and mounted from ceiling and wall. Vertical stiles at handicapped toilet compartments, however, shall extend to floor (stainless steel screws shall be typically utilized in all mounting).
   q. Latches on toilet compartment doors shall be surface mounted.
   r. One free-standing waste receptacle shall be provided at each restroom (Bobrick B-2260).
   s. Each restroom shall receive a mirror (Bobrick B-290 or 7224).
   t. Mirror shall be provided at each sink (Bobrick B-290, 1830).

PART 3 EXECUTION

3.01 FIELD QUALITY CONTROL

A. Inspection
   1. Contractor shall inspect project site and report any unacceptable conditions. Commencement of work constitutes statement that conditions are suitable for installation of work of this section.

B. Protection
   1. Contractor shall be responsible for protection of property during course of work.
   2. Areas of existing landscaping and construction shall be protected from damage. All damage caused by Contractor will be repaired, at his expense, to its original condition to the complete satisfaction of the Engineer.
3.02 PREPARATION

A. Construction Preparation

1. Contractor's Project Manager shall be responsible for coordination and accuracy of placement of bearing blocks, stands, shims, anchors, hold-down straps and other structural items requiring placement in work provided as part of the project work (i.e., site concrete, asphaltic pavement).

2. The Contractor's Project Manager shall review all Shop Drawings and referenced drawings relating to site utilities that detail the size and location of utility lines, meters, piping, conduit, trench depth/width(s), voltage, diameter, etc. The Contractor's Project Manager shall notify the Engineer of any code violations and stop work until Violations are resolved.

B. Manufacture of Portable Building Unit(s)

1. General - All materials, installation, construction methods, and procedures used in the manufacture of the portable building unit(s) shall conform to the requirements of the UBC (specifically Chapter 50), OSHA, applicable industry standards, laws, ordinances and other regulations which govern the manufacture of portable and/or prefabricated assemblies.

2. Approvals, inspections, and other requirements of the governing code and/or industry standards shall be made in accordance with their requirements and shall be performed during manufacture of the unit(s). Every material shall be graded, marked or labeled where required and shall be inspected for conformance. Where said markings are not readily accessible for inspection, at site or at manufacturing plant, portable building manufacturer shall provide certificates of approval certifying that the assembly in question has been inspected and meets the requirements of the code.

C. Move-On

1. General - The move-on of the portable building unit(s) shall be supervised by the Contractor's Project Manager.

2. The Contractor shall secure required permits for transport of unit(s) from manufacturing plant to project site.

3. Place the portable building unit(s) on site, taking care not to damage adjacent buildings, landscaping and other site amenities.
   a. Secure unit(s) to bearing blocks, stands, shims, anchors, hold-down straps and other accessories required by code and as recommended by Portable Building Manufacturer.
   b. Remove wheels and hitch, if applicable, and store in place designated by Engineer.

4. After placement of unit(s) and prior to attachment of closure strips or other finishes which might conceal joints, align all units to provide true and plumb conditions with not more than 1/8-inch difference in alignment at horizontal and vertical joints. Unit(s) shall be level with not more than 1/8-inch variation in floor elevation in 20 feet. The Contractor's Project Manager and Engineer shall inspect joints prior to concealment.

5. Attach and finish all closure strips to ensure watertightness of completed unit. A water test may be required by the Engineer.

6. Contractor shall make all final connections of site utilities to the completed unit (electrical, sanitary sewer, water, natural gas, etc.) Set all ground-mounted equipment and make final connections.

7. Install skirting, canopies, fascias, stairs and other miscellaneous items noted on drawings or which are part of the work.

8. Adjust all operable windows, doors and hardware and put in working order free from binding, and within acceptable and/or specified tolerances.

D. Final Cleaning and Adjustment

1. Contractor's Project Manager shall provide a final inspection of the work. Any deficiencies found during final inspection will be corrected within ten (10) working days and will be reinspected by Project Manager and the Engineer.

2. Remove all protective coverings from exposed finished surfaces, clean off soil and other discoloration, clean and polish glass, mirrors and other installed items. Do not remove cleaning and care instructions adhered to installed items without authorization from Engineer. Do not remove glass and door labels required by law to remain permanently affixed. Clean all exposed surfaces of unit (interior and exterior walls, floors, ceilings, roof), window and door tracks, cabinetry. Leave premises in clean condition to complete satisfaction of Engineer. Remove all debris from project site.

3. Contractor to adjust for settlement 14 days after completion of his work or after completion of interior work by others, whichever is later. Inspect all joints and closure strips for alignment and...
watertightness and do work required to insure watertightness of structure. Additional water tests may be required.

END SECTION
PART 1 - GENERAL

1.1 SUMMARY
A. Section includes prefabricated steel control booths.

1.2 PERFORMANCE REQUIREMENTS
A. Structural Performance: Control booths shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to [ASCE/SEI 7] <Insert requirement>:

2. Wind Loads: <Insert loads>.
3. <Insert loads or load combinations>.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.
B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
C. Samples: For control booths with factory-applied color finishes.
D. Delegated-Design Submittal: For control booths indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS
A. Welding certificates.
B. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS
A. Maintenance data.

1.6 QUALITY ASSURANCE
A. Welding Qualifications: Qualify procedures and personnel according to the following:
1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."

B. Regulatory Requirements: Comply with applicable provisions in [the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines] [and] [ICC/ANSI A117.1].

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Safety Glazing Products: Category II materials complying with testing requirements in 16 CFR 1201.

E. Preinstallation Conference: Conduct conference at [Project site] <Insert location>.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair finish or replace wall panels that fail in materials or workmanship within specified warranty period.

1. Warranty Period: [Five] <Insert number> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Aluminum: Alloy and temper recommended by aluminum producer and manufacturer for type of use and finish indicated, and as follows:

1. Extruded Shapes: ASTM B 221.

B. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, commercial quality, G90 coating designation; mill phosphatized.

C. Galvanized, Rolled Steel Tread Plate: ASTM A 786/A 786M, rolled from steel plate complying with ASTM A 572/A 572M, Grade 55; hot-dip galvanized according to ASTM A 123/A 123M.

D. Steel Structural Tubing: ASTM A 500, Grade B.

E. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

F. Steel Mechanical Tubing: ASTM A 513, welded steel mechanical tubing.
G. Zinc-Coated (Galvanized) Steel: Hot-dip galvanized according to ASTM A 123/A 123M.

H. Stainless-Steel Sheet: ASTM A 666, Type 304.

I. Plastic Laminate: NEMA LD 3, HGS or HGL grade.

J. Plywood: DOC PS 1, Exterior grade.

K. Particleboard: ANSI A208.1, Grade M-2.

L. Clear Float Glass: ASTM C 1036, Type I, Class 1, Quality q3.

M. Clear Tempered Float Glass: ASTM C 1048, Kind FT, Condition A, Type I, Class 1, and Quality q3.

N. Insulating Glass: Units complying with ASTM E 774 for Class CBA and consisting of two lites of 2.5-mm-thick clear float glass and dehydrated air space, with a total overall unit thickness of 7/16 inch and with manufacturer's standard dual seal.

O. Ballistics-Resistant Glazing: Comply with requirements specified in Section 088000 "Glazing."

P. Anchorages: Anchor bolts; [hot-dip galvanized according to ASTM A 153/A 153M or ASTM F 2329] [stainless steel].

2.2 PREFABRICATED CONTROL BOOTHS, GENERAL

A. General: Provide a complete, integrated set of mutually dependent components that form a completely assembled, prefabricated control booth, ready for installation on Project site.

1. Building Style: [Standard square corners] [Radius corners] [Round corners] [Butt-glazed corners] [Wraparound type, with single rounded building end] [Wraparound type, with both building ends rounded] [As indicated on Drawings].

2. Doors: [Sliding door on one side] [Sliding doors on both sides] [Swinging door on back] [As indicated on Drawings].

B. Windows: Extruded-aluminum sash frames glazed with [6-mm-thick, clear tempered glass] [clear insulating glass] [ballistics-resistant glazing, UL 752 Level <Insert number>].

1. Frame Finish: [Mill] [Clear anodic].

2. Provide insect screens for each operable window.

3. Provide galvanized-steel security screens for each window.

4. Corner Shape: [Square] [Round].

C. Horizontal Sliding Windows: Extruded-aluminum sash frames glazed with 3-mm-thick, clear tempered float glass. Equip windows with cam locks, weather stripping, and [stainless-steel] [nylon] ball-bearing rollers.
1. Frame Finish: [Mill] [Clear anodic].
2. Provide insect screens for each operable window.
3. Corner Shape: [Square] [Round].

D. Work Counters: Full width of control booth, reinforced; with 16-inch- wide [storage] [cash] drawer below each counter, and an access opening for electrical cords at[ each] rear corner of counter.

1. Material: [0.078-inch- thick, stainless-steel sheet] [0.079-inch nominal-thickness, galvanized-steel sheet] [1/2-inch- thick particleboard with plastic-laminate finish].
2. Depth: [22 inches] [20 inches] [18 inches].

E. Electrical Power Service: 125-A, 120/240-V ac, single-phase, three-wire [load center, with no fewer than four open circuits] [service with 8-16 circuit-breaker panel]; located under one end of work counter. Run copper wiring in 1/2-inch EMT conduit.

1. Provide [one] <Insert number> 120-V [ground-fault circuit interrupter (GFCI)] power receptacle(s).

F. Lighting Fixtures: [One] [Two] ceiling-mounted fluorescent lighting fixture(s), 48 inches long, with acrylic lens and two 40-W lamps [in each fixture]. Provide single-pole switch mounted adjacent to door to control lighting fixture.

G. Heating Unit: [Wall] [Roof]-mounted, thermostatically controlled, 110-V, 1500-W electric heater with fan-forced operation and with capacity of not less than 5000 Btu/h. Enclose in enameled-steel cabinet [and mount under work counter].

H. Cooling Unit: [Wall] [Roof]-mounted, thermostatically controlled air conditioner with cooling capacity of not less than [13,500 Btu/h] <Insert value>. Enclose in enameled-steel cabinet.

I. Accessories: Provide the following for each control booth:

1. Through-wall transaction drawers [and speaking apertures].
2. Antifatigue mats.
3. Exterior stainless-steel counter.
4. [Floor] [Wall-mounted] safe.
5. Signage: <Insert requirements>.
7. Intercom.
8. Traffic control lights.

2.3 PREFABRICATED STEEL CONTROL BOOTHs

A. Manufacturers: Subject to compliance with requirements, [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
B. **Basis-of-Design Product:** Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:

1. AustinMohawk and Company, Inc.
2. B.I.G. Enterprises, Inc.
3. Canada Kiosk; an NRB company.
7. Mardan Fabricators.
11. <Insert manufacturer's name>.

C. Structural Framework: Fabricated from 2-by-2-by-0.075-inch steel structural or mechanical tubing. Connect framework by welding.

D. Base/Floor Assembly: [4-inch-] [3-inch-] high assembly consisting of perimeter frame welded to structural framework of booth. Fabricate frame from 2-by-4-inch galvanized-steel structural tubing; 0.108-inch nominal-thickness, C-shaped, galvanized-steel sheet channels; or galvanized structural-steel angles. Include anchor clips fabricated from 1/4-inch- thick galvanized-steel plate, predrilled and welded to exterior of integral floor frame.

1. Finished Floor: 0.108-inch nominal-thickness, galvanized, rolled steel tread plate.
2. Subfloor and Finished Floor: Assembly consisting of 0.079-inch nominal-thickness, galvanized-steel sheet underside with rigid insulation core; covered by 0.125-inch- thick, aluminum rolled tread plate; with overall assembly thickness of 2 inches.
3. Subfloor and Finished Floor: Assembly consisting of [one] [two] layer(s) of 3/4-inch- thick plywood or oriented strand board with [0.125-inch- thick, aluminum rolled tread plate] [vinyl composition flooring] [carpeting].

E. Base/Floor Assembly: No perimeter frame, with finished floor fabricated from 0.108-inch nominal-thickness, galvanized, rolled steel tread plate.

F. Base/Floor Assembly: No perimeter frame, with surface of supporting concrete base as finished floor.

G. Wall Panel Assembly: Assembly consisting of exterior face panel fabricated from 0.079-inch nominal-thickness, galvanized-steel sheet; and interior face panel fabricated from [0.064-inch] [0.052-inch] nominal-thickness, galvanized-steel sheet; with [2-inch-] [3-inch-] <Insert dimension> thick, rigid fiberglass or polystyrene board insulation in cavity between exterior and interior face panels.

H. Flat Roof/Ceiling Assembly: Consisting of exterior roof panels, interior ceiling panels, and insulation between exterior and interior panels; sloped to drain at booth perimeter.

1. Exterior Roof Panel: Fabricated from [0.079-inch] [0.064-inch] nominal-thickness, galvanized-steel sheet; with [painted finish] [EPDM membrane], continuously welded seams, and full-perimeter gutter.
2. Interior Ceiling Panel: Fabricated from 0.079-inch nominal-thickness, galvanized-steel sheet; with fiberglass insulation in cavity between ceiling and roof.
3. Insulated Exterior/Interior Panel: Fabricated from [0.028-inch nominal-thickness, galvanized-steel] [0.032-inch- thick, aluminum] sheet faces and expanded-foam insulation core.
4. Canopy Fascia: Fabricated from 0.079-inch nominal-thickness, galvanized-steel sheet, of [manufacturer's standard design] [custom design indicated on Drawings].
   a. Height: [6 inches] [8 inches] <Insert dimension>.
   b. Overhang: [3 inches beyond] [ <Insert dimension> beyond] [Flush with] face of walls below.
5. Downspouts: Integral, extending 3 inches beyond booth walls.
6. Roof scuppers.
7. Rooftop finial.

I. Sliding Door: Top suspended from aluminum track with ball-bearing rollers; 1-3/4 inches thick; tubular-frame design fabricated from [clear-anodized aluminum] [galvanized steel]; with top half of door glazed. Equip door with deadlock, lock support, guide hardware, and full weather stripping.

1. Glazing: [Fixed] [Horizontal sliding] unit with 6-mm-thick, clear tempered float glass.
2. Deadlock: Mortised, laminated-hook bolt type with removable cylinder capable of being master keyed.

J. Swinging Door: 1-3/4 inches thick; tubular-frame design fabricated from [clear-anodized aluminum] [galvanized steel]; with top half of door glazed. Equip door with deadlock, three butt hinges, closer, and full weather stripping.

1. Glazing: [Fixed] [Horizontal sliding] unit with 6-mm-thick, clear tempered float glass.
2. Deadlock: Mortised, with lever handle and removable cylinder capable of being master keyed.
K. Finish: Finish exposed metal surfaces, including structural framework, walls, canopy, and ceiling with rust-inhibitive primer and one finish coat of industrial air-dry [acrylic] [polyurethane] enamel.

   1. Color: [As indicated by manufacturer's designations] [Match Architect’s samples] [As selected by Architect from manufacturer's full range].

2.4 FABRICATION

   A. Fabricate control booths completely in factory.
   
   B. Preglaze windows and doors at factory.
   
   C. Prewire control booths at factory, ready for connection to service at Project site.
   
   D. Fabricate control booths with [forklift pockets in base of booth] [removable lifting eye centered in roof].
   
   E. Accessible Control Booths: Where indicated to be accessible, fabricate control booths as follows:
      
      1. Provide service windows located no higher than 34 inches above exterior grade.
      2. Provide door opening with minimum 32-inch clear width.
      3. Provide minimum 60-inch clear turning spacing within the booth.
      4. Provide minimum 27-inch clearance beneath interior work surfaces. Locate work surfaces 28 inches minimum and 34 inches maximum above the floor.
      5. Locate controls and operable parts no lower than 15 inches and no higher than 48 inches above the floor where reach is unobstructed. Where side reach is obstructed, locate controls and operable parts no lower than 15 inches and no higher than 46 inches above the floor.

2.5 FINISHES

   A. [Steel] [and] [Galvanized-Steel] Factory Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.

      1. Color and Gloss: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.

PART 3 - EXECUTION

3.1 INSTALLATION

   A. Install control booths according to manufacturer's written instructions.
B. Accessible Control Booths: Install with interior floor surface at same elevation as adjacent paved surfaces.

C. Set control booths plumb and aligned. Level baseplates true to plane with full bearing on concrete bases.

D. Fasten control booths securely to [cast-in anchor bolts] [concrete bases with expansion anchors].

E. Connect electrical power service to power distribution system.

F. Adjust doors, operable windows, and hardware to operate smoothly, easily, properly, and without binding. Confirm that locks engage accurately and securely without forcing or binding.

G. Lubricate hardware and other moving parts.

H. After completing installation, inspect exposed finishes and repair damaged finishes.

END OF SECTION 133423
SECTION 21 1313

WET PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 REFERENCES

A. The publications listed below form a part of this specification section to the extent referenced. The publications are referred to within the text by the basic designation only. Use the latest edition, unless noted otherwise.

B. ASME INTERNATIONAL (ASME)
   1. ASME B16.1 Gray Iron Pipe Flanges and Flanged Fittings; Classes 25, 125 and 250
   2. ASME B16.3 Malleable Iron Threaded Fittings, Classes 150 and 300
   3. ASME B16.4 Gray Iron Threaded Fittings; Classes 125 and 250

C. AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)
   1. ASSE 1013 Performance Requirements for Reduced Pressure Principle Backflow Preventers and Reduced Pressure Principle Fire Protection Backflow Preventers
   2. ASSE 1015 Performance Requirements for Double Check Backflow Prevention Assemblies and Double Check Fire Protection Backflow Prevention Assemblies

D. ASTM INTERNATIONAL (ASTM)
   2. ASTM A183 Standard Specification for Carbon Steel Track Bolts and Nuts
   4. ASTM A53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
   5. ASTM A536 Standard Specification for Ductile Iron Castings

E. AMERICAN WATER WORKS ASSOCIATION (AWWA)
   1. AWWA M14 Backflow Prevention and Cross-Connection Control: Recommended Practices
   2. AWWA C203 Standard for Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape – Hot Applied
   4. AWWA C104/A21.4 American National Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water

F. FM GLOBAL (FM)
G. INTERNATIONAL CODE COUNCIL


H. MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

1. MSS SP-71 Gray Iron Swing Check Valves, Flanged and Threaded Ends

I. NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)


J. SRP Codes

1. SRP AFC SRP Administrative Fire Code

K. UNDERWRITERS LABORATORIES (UL)

1. UL 668 Hose Valves for Fire Protection Service
2. UL 405 Fire Department Connection Devices
3. UL 213 Standard for Rubber Gasketed Fittings for Fire-Protection Service
4. UL 262 Standard for Gate Valves for Fire-Protection Service
5. UL 393 Standard for Indicating Pressure Gauges for Fire-Protection Service
6. UL 789 Standard for Indicator Posts for Fire-Protection Service

1.2 NOTICE TO BIDDERS

A. Before submittal of bid, examine all drawings, specification, addenda, alternatives, special conditions, and all other bidding documents of all sections of this project, verifying all governing conditions at the site, and become fully informed as to the extent and character of the work required, as well as its relation to other work in the building. Submittal of a bid is an agreement to all requirements of the contract documents and no consideration will be granted for any claimed misunderstanding thereof.

B. Submittal of a bid is deemed a representation by the bidder that he is qualified in all respects to properly perform the work for which he is bidding and has experience with similar work. Bidders are deemed to be aware, on the basis of their background and experience, of materials which may be required in the discharge of their responsibilities, even though unspecified.

C. Any case of error, omission, discrepancy, inconsistency or lack of clarity in the specification or drawings shall be promptly identified to SRP.

1.3 DESCRIPTION OF WORK

A. A wet pipe sprinkler system shall be provided in areas indicated on the drawings. The sprinkler system shall provide fire sprinkler protection for the entire building. Except as modified herein, the system shall be designed and installed in accordance with NFPA 13. Pipe sizes which are not indicated on drawings shall be determined by hydraulic calculation. The contractor shall design any
portions of the sprinkler system that are not indicated on the drawings or specified herein, including locating and sizing sprinklers, piping and equipment. The design of the sprinkler system shall be based on hydraulic calculations, and the other provisions specified herein.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical. Deviations from approved working plans for piping require written approval from SRP.

C. Hydraulic Design: The system shall be hydraulically designed to discharge a minimum density as indicated on the drawings. Hydraulic calculations shall be in accordance with NFPA 13. A 10-pound per square inch safety margin shall be provided at the point of connection to the city water main.

D. Basis for Calculations: A water flow test was performed on (DATE) at (LOCATION) and resulted in a static pressure of ___ psi with a residual pressure of ___ psi while flowing ____ gpm. The fire sprinkler subcontractor shall perform a fire hydrant flow test prior to shop drawings submittal. The results shall be included with the hydraulic calculations. Hydraulic calculations shall be based upon the Hazen-Williams formula with a "C" value of 120 for steel piping and 150 for underground plastic piping.

E. Sprinkler Coverage: Sprinklers shall be uniformly spaced on branch lines. Sprinklers shall provide coverage throughout 100 percent of the building. Coverage per sprinkler shall be in accordance with NFPA 13. Provide sprinklers below all ducts over 4'-0" wide; coordinate with HVAC drawings.

1. The Small Room Rule shall NOT apply in SRP facilities.

1.4 SUBMITTALS

A. Submit six copies of the following, no later than 21 days prior to the start of system installation, in accordance with the General Conditions of the Contract. Drawings, unless noted otherwise, shall be no smaller than the Contract Drawings.

1. Shop Drawings: Detail drawings conforming to the requirements prescribed in NFPA 13 and NFPA 170. Drawings shall include plan and elevation views which establish that the equipment will fit the allotted spaces with clearance for installation and maintenance. Each set of drawings shall include the following:
   a. A descriptive index with drawings listed in sequence by number. A legend sheet identifying device symbols, nomenclature, and conventions used in the package.
   b. Floor plans drawn to a scale not less than 1/8-inch equals 1-foot clearly showing locations of devices, equipment, risers, electrical power connections and other details required to clearly describe the proposed arrangement.
   c. Riser layout drawings drawn to a scale of not less than 1/2-inch equals 1-foot to show details of each system component, clearances between each other and from other equipment and construction in the room.
   d. Details of each type of pipe hanger and related components.
   e. Shop drawings and calculations shall be prepared by a qualified NICET Level III (or IB) Technician.

The Contractor shall not order any equipment and shall not begin any work until the submittals have been approved in writing by SRP. The contractor shall not perform any installation prior to the receipt of a written authority to proceed from SRP. If submittals are found not to conform to all of the requirements of this specification section and the applicable referenced Codes, Standards and Regulations, the contractor shall be required to revise and resubmit the package with modifications.
2. Hydraulic calculations shall be as outlined in NFPA 13 except that calculations shall be performed by computer using software intended specifically for fire protection system design using the design data shown on the drawings. Calculations shall be based on the water supply data provided in the specification section. Calculations shall substantiate that the design area used in the calculations is the most demanding hydraulically. Water supply curves and system requirements shall be plotted on semi-logarithmic graph paper so as to present a summary of the complete hydraulic calculation. A summary sheet listing sprinklers in the design area and their respective hydraulic reference points, elevations, actual discharge pressures and actual flows shall be provided. Elevations of hydraulic reference points (nodes) shall be indicated. Documentation shall identify each pipe individually and the nodes connected thereto. The diameter, length, flow, velocity, friction loss, number and type of fittings, total friction loss in the pipe, equivalent pipe length and Hazen-Williams coefficient shall be indicated for each pipe. For gridded systems, calculations shall show peaking of demand area friction loss to verify that the hydraulically most demanding area is being used.

3. Product Data: Annotated catalog data showing manufacturer’s name, model, and catalog number for all equipment and components, with data highlighted to indicate model, size, options, etc. proposed for installation. In addition, a complete equipment list with equipment description, model number, and quantity shall be provided. This shall include the following:
   a. Pipe, fittings, and mechanical couplings
   b. Valves, including gate, check, and globe
   c. Pipe hangers and supports
   d. Water flow and tamper switches
   e. Sprinklers
   f. Fire department connection
   g. Backflow prevention devices
   h. Fire hose valve
   i. Miscellaneous equipment (such as spare sprinkler cabinet, signs, etc.)

4. Installers Qualifications: Data approved, prior to submittal of any other data or drawings, to substantiate that the proposed installer is regularly engaged in the installation of the type and complexity of the fire protection system included in this project. Data shall identify the location of three systems recently installed by the proposed installer which are comparable to the system specified. Contractor shall certify that each system has performed satisfactorily, in the manner intended, for a period of not less than 6 months. Submit copy of license to perform work in the local jurisdiction and submit certification for the personnel working on the project as detailed in 1.5 Quality Assurance.


6. As-Built Drawings: In addition to six hard copies, furnish one set of CD or DVD discs containing software back-up and CAD based drawings in the latest version of AutoCAD and DXF format and pdf copy of as-built drawings and schematics. A separate set of approved submittal drawings of the overall system, marked-up to indicate as-built conditions, shall be maintained on site. These drawings shall be maintained in a current condition at all times, and shall be made available for review immediately upon request during normal working hours. Variations from approved drawings, for whatever reason, including those occasioned by modifications, change orders, optional materials, and/or required for coordination between trades shall be indicated in sufficient detail to accurately reflect the as-built conditions. These drawings shall be submitted within 14 calendar days after the final acceptance test of the system. At least two sets of as-built (marked-up) drawings shall be provided to SRP at the time of, or prior to the final acceptance test.
7. Operation and Maintenance Data: Six manuals in loose-leaf binder format and grouped by technical sections consisting of manufacturer’s brochures, schematics, printed instructions, general operating procedures, and safety precautions. Manuals shall be submitted and approved prior to on-site training. In addition to items specified in Division 01 Section 017823 "Operation and Maintenance Data", the Manual shall include the following documents and information at a minimum:
   a. A general description of the design and operation of the system(s)
   b. Specific open/close settings for all adjustable valves.
   c. Comply with the "Records" Section of NFPA 25.
   d. A copy of the as-built design drawings in 11 x 17-inch format, folded neatly within the binder.
   e. All applicable product installation sheets annotated as necessary.
   f. Step-by-step procedures required for system startup, operation, and shutdown, including the sequence or sequences of operation of the overall fire protection system and a separate description for each major subsystem.
   g. The manufacturer’s name, model number, service manual, parts list, and complete description of equipment and their basic operating features.
   h. Maintenance manual listing routine maintenance procedures, possible breakdowns and repairs, troubleshooting guide, and system warranty information.
   i. Routine maintenance checklist. The routine maintenance checklist shall be arranged in columnar format. The first column shall list all installed devices, the second column shall state the maintenance activity or state no maintenance required, the third column shall state the frequency of the maintenance activity, and the fourth column for additional comments or reference.

8. Impairment Plan: In the event the scope of work may remove from service or interfere with a fire suppression or alarm system, the design engineer shall consult and communicate with the SRP Fire Marshal to develop an Impairment Plan. The Impairment Plan developed by the design engineer shall be submitted at the same time as the design drawings for review and approval. The final plan shall be written on the drawings.

9. Training Documentation: Provide in manual format, lesson plans, operating instructions, maintenance procedures, and training data for the training courses. The operations training shall familiarize SRP’s designated personnel with proper operation of the installed system. The maintenance training course shall provide SRP’s designated personnel adequate knowledge required to diagnose, repair, maintain, and expand functions inherent to the system.

10. Schedule: Provide a schedule indicating the delivery dates of the equipment to be supplied; installation sequence; time frame and the total amount of on-site technical assistance time (in man-hours per phase) that the supplier of the equipment has included in their bid to comply with the requirements of this specification section and SRP’s requirements; and final acceptance test dates to meet SRP’s scheduled project completion dates.

11. In the event that the Contractor’s submittal package is required to be revised and resubmitted due to nonconformance with this specification, illegibility of the submittal, incomplete submittals, noncompliance with the referenced local, state and national Codes, Standards and Regulations or nonconformance with pertinent documentation relative to the project, the contractor shall pay all fees associated with the additional submittal review. Payment of the fee shall be solely the contractor’s responsibility.
1.5 QUALITY ASSURANCE

A. The recommended practices stated in the manufacturer’s literature or documentation shall be considered as mandatory requirements.

B. Qualifications - Contractor: The contractor shall be an Arizona licensed contractor in possession of a valid fire sprinkler contractor’s license. Design and installation must be performed by a sprinkler contractor whose business is located within a 75-mile radius of the project site. The contractor shall have a minimum of 3 years of experience in the installation of automatic sprinkler systems in similar facilities.

C. Qualification - Design Services: Shop (working) drawings and calculations shall be prepared under the direction of and signed by a qualified registered Professional Engineer or a NICET Level III (minimum) in water-based systems. For the purposes of meeting this requirement, a qualified engineer is defined as an individual meeting one of the following conditions:

1. A registered professional engineer having passed the NCEES examination in fire protection engineering.

2. Registered professional engineer with verification of experience and at least 5 years of current experience in the design of the fire protection and detection systems.

D. Qualifications - Supervisor: A NICET Level III (minimum) in water-based systems shall supervise the installation of the fire sprinkler system.

E. Qualifications - Installer: Fire sprinkler installers with a minimum of 2 years of experience or who possess a CSA certification shall be permitted to assist in the installation of the fire sprinkler system.

F. Qualifications - Test Personnel: Fire sprinkler technicians with a minimum of 8 years of experience shall be utilized to test and certify the installation of the fire sprinkler system. The fire sprinkler technicians testing the equipment shall be factory-trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

1.6 REGULATORY REQUIREMENTS

A. All system components shall be listed or approved for their intended use and shall be compatible with the system and its components. Where the terms "listed" or "approved" appear in this specification section, they shall mean UL-listed (UL Fire Prot Dir), FM-approved (FM App Guide), or listed by a nationally recognized testing laboratory (NRTL). The omission of these terms under the description of any item of equipment described shall not be construed as waiving the requirement for listing or approval. All listings or approvals shall be based on an existing ANSI or UL published standard.

B. Compliance with NFPA standards is mandatory. This includes advisory provisions listed in the appendices of such standards, as though the word "shall" had been substituted for the word "should" wherever it appears. In the event of a conflict between specific provisions of this specification section and applicable standards, this specification section shall govern.

C. Install all work in full conformance with the requirements of all local and governmental authorities having jurisdiction over these matters, utility company requirements, and requirements of the latest issues of all applicable Codes, including the IBC and IFC.

D. The fire protection installation and the installing contractor shall comply fully with all city, county and state laws, ordinances and regulations applicable to fire protection installations.
E. Should any change in plans or specification be required to comply with governmental regulations, the contractor shall notify the Engineer at the time of submitting his bid.

F. Secure and pay for necessary approvals, permits, inspections, etc., and deliver the official records of the granting of permits to the SRP Representative without additional cost to SRP.

G. A Work Authorization is required for all wet sprinkler work. The SRP Project Manager (PM) shall apply for and receive the Work Authorization. The fire protection contractor will receive the Work Authorization from the SRP PM. The Work Authorization must be prominently displayed at the jobsite before any work, to include demolition, can begin. Upon completion of the work, a final inspection by the SRP Fire Marshal, and the satisfactory resolution of all issues identified by the Final Inspection, the SRP Fire Marshal shall sign and close out the Work Authorization which indicates acceptance of the permitted work.

1.7 VERIFYING ACTUAL FIELD CONDITIONS

A. Before commencing work, examine all adjoining work on which the contractor’s work is in any way dependent for perfect workmanship according to the intent of this specification section, and report to the SRP Representative any condition which prevents performance of first class work. No “waiver of responsibility” for incomplete, inadequate or defective adjoining work will be considered unless notice has been filed before submittal of a proposal.

B. The contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall advise the SRP Representative of any discrepancy before performing the work.

1.8 COORDINATION OF TRADES

A. The contract documents are not intended to serve as coordinated construction drawings showing all minor adjustments in locations required for a fully coordinated installation that respects the work of all trades.

B. Piping offsets, fittings, and any other accessories required shall be furnished as required to provide a complete installation and to eliminate interference with other construction. Sprinklers shall be installed over and under ducts, piping and platforms when such equipment can negatively affect or disrupt the sprinkler discharge pattern and coverage.

C. Wherever the contractor’s work interconnects with work of other contractors, the contractor shall coordinate his work with other contractors to ensure that all contractors have the information necessary so that they may properly install all necessary connections and equipment. Identify all work items needing access (dampers, etc.) concealed above hung ceilings by permanent colored pins/tabs in the ceiling directly below the item.

D. Provide required supports and hangers for piping, conduit and equipment, so that loading will not exceed allowable loadings of structure. Submittal of a bid shall be a deemed representation that the contractor submitting such bid has ascertained allowable loadings and has included in his estimates the costs associated in furnishing required supports.

E. Field drilling and cutting of holes in structural decks, roofs, walls, etc., required for work under this section shall be coordinated through various trades in their respective materials and approved by the SRP Representative. All such drilling, cutting, and reinforcing costs shall be borne by the contractor.
F. Due to the type of installation, a fixed sequence of construction is required to properly install the complete systems. It shall be the responsibility of the contractor to coordinate, protect, and schedule his work with other trades in accordance with the construction sequence.

G. Cooperate with all other contractors and subcontractors to facilitate the completion of the work as a whole, subject to the direction of the SRP Representative.

1.9 SCHEDULING

A. Provide a schedule to SRP indicating the installation sequence and timeframe prior to beginning work. Provide weekly updates to SRP. All equipment, valve, piping and device installation shall be completed in time to conduct all tests as outlined in these specification sections.

B. Coordinate the Acceptance Test for each fire sprinkler system with SRP and other necessary parties identified by SRP.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Protect equipment delivered and placed in storage from the weather, humidity, and temperature variation, dirt and dust, and other contaminants in accordance with manufacturer's instructions.

B. All pipes shall either be capped or plugged until installation.

C. Coordinate the storage arrangement and location with SRP.

D. Deliver and store products in shipping containers/boxes, with labeling in place.

E. Provide temporary protective coating on cast iron and steel valves.

1.11 WASTE REMOVAL

A. At the conclusion of each day's work, clean up and stockpile on site all waste, debris, and trash, which may have accumulated during the day as a result of work by the contractor and of his presence on the job.

B. Sidewalks and street adjoining the property shall be kept broom clean and free of waste, debris, trash and obstructions of any kind caused by work of the contractor, which will affect the condition and safety of streets, walks, utilities and property.

1.12 SPARE PARTS

A. Repair Service/Replacement Parts: During warranty period, the service technician shall be on-site within 24 hours after notification. All repairs shall be completed within 24 hours of arrival on-site.

B. The contractor shall provide spare sprinklers, sprinkler wrench and sprinkler cabinet in accordance with NFPA 13.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Standard Products: Material and equipment shall be the standard products of a manufacturer, where possible, and not a combination of manufacturers for any particular classification of materials. Material and equipment shall be the standard products of a manufacturer regularly engaged in the
manufacture of the products for at least 2 years prior to bid opening. All materials and equipment supplied shall be new, first quality and the manufacturer's best type and latest model capable of complying with all requirements of this specification section and shall have been in continuous production and in continuous service in commercial applications for at least 1-year. Obsolete equipment shall not be used.

B. Nameplates: Major components of equipment shall have the manufacturer's name, model or serial number, and date of installation provided on a new plate permanently affixed to the item or equipment. Nameplates shall be etched metal or plastic, permanently attached by screws to panels or adjacent walls.

2.2 UNDERGROUND PIPING SYSTEMS

A. Pipe: Pipe shall comply with NFPA 24. Minimum pipe size shall be minimum 6 inches. Piping more than 5 feet outside the building walls shall comply with [Section 33 11 00] WATER UTILITY DISTRIBUTION PIPING. A continuous section of welded stainless steel fire water service piping from a point outside the building perimeter to a flanged fitting at least 1-foot above the finished floor within the building is acceptable.

B. Fittings and Gaskets: Fittings shall be ductile-iron conforming to AWWA C110/A21.10 with cement mortar lining conforming to AWWA C104/A21.4. Gaskets shall be suitable in design and size for the pipe with which such gaskets are to be used. Gaskets for ductile-iron pipe joints shall conform to AWWA C111/A21.11.

C. Gate Valve and Indicator Posts: Installation shall comply with NFPA 24. Gate valves for use with indicator post shall conform to UL 262. Indicator posts shall conform to UL 789. Provide each indicator post with one coat of primer and two coats of red enamel paint.

D. Valve Boxes: Except where indicator posts are provided, for each buried valve, provide a cast-iron, ductile-iron, or plastic valve box of a suitable size. Plastic boxes shall be constructed of acrylonitrile-butadiene-styrene (ABS) or inorganic fiber-reinforced black polyolefin. Provide cast-iron, ductile-iron, or plastic cover for valve box with the word "WATER" cast on the cover. The minimum box shaft diameter shall be 5.25 inches. Coat cast-iron and ductile-iron boxes with bituminous paint applied to a minimum dry-film thickness of 10 mils.

E. Buried Utility Warning and Identification Tape: Provide detectable aluminum foil plastic backed tape or detectable magnetic plastic tape manufactured specifically for warning and identification of buried piping. Tape shall be detectable by an electronic detection instrument. Provide tape 3 inches minimum width, color coded for the utility involved with warning and identification imprinted in bold block letters continuously and repeatedly over the entire tape length. Warning and identification shall read "CAUTION BURIED WATER PIPING BELOW" or similar wording. Use permanent code and letter coloring unaffected by moisture and other substances contained in trench backfill material.

2.3 ABOVEGROUND PIPING SYSTEMS

A. Pipe: Pipe shall be standard weight conforming to ASTM A795, ASTM A53, or ASTM A135. Piping less than 3-inch in diameter shall be minimum schedule 40 and joined by threaded fittings. Piping 4 inches and greater shall be minimum schedule 10 and joined by threaded, grooved or flanged fittings. Pipe in which threads or grooves are cut shall have a corrosion resistance ratio (CRR) of 1.00 or greater after threads or grooves are cut. Pipe shall be marked as to the brand or name of the manufacturer, kind of pipe and the ASTM designation in accordance with the "Product Marking" provisions of the ASTM standard.

B. Plastic Pipe: Plastic piping (PVC, CPVC, polybutylene) is not permitted.
C. Grooved Fittings and Couplings: Grooved fittings, couplings and bolts shall be provided by the same manufacturer. Fittings and couplings shall be malleable iron complying with ASTM A47 or ductile-iron complying with ASTM A536. Couplings shall be of the rigid type except that flexible type will be provided where flexible joints are specifically required by NFPA 13. Coupling gaskets shall be Grade E (EPDM) approved for fire protection service. Gasket shall be the flush type that fills the entire cavity between the coupling and the pipe. Nuts and bolts shall be heat-treated steel confroming to ASTM A183 and shall be cadmium plated or zinc electroplated. Plain-end fittings with mechanical couplings, fittings which require drilling a hole in the pipe, and fittings which use steel gripping devices to bite into the pipe, shall not be used.

D. Non-Grooved Fittings: Non-grooved fittings shall be threaded or flanged. Threaded fittings shall be cast-iron conforming to ASME B16.4, malleable iron conforming to ASME B16.3 or ductile-iron conformed to ASTM A536. Fittings into which sprinklers, drop nipples or riser nipples (sprigs) are screwed shall be threaded type. Plain-end fittings with mechanical couplings, fittings which require drilling a hole in the pipe, and fittings which use steel gripping devices to bite into the pipe, shall not be used.

E. Flanges and Gaskets: Flanges shall conform to NFPA 13 and ASME B16.1. Flanges shall be the type that are welded or threaded to the pipe. Flanges which are bolted to grooved pipe shall not be permitted. Gaskets shall be full-face type EPDM or other approved material.

F. Pipe Hangers: Hangers shall be listed or approved and be of the type suitable for the application, construction and size pipe involved. Earthquake bracing shall be listed.

G. Control Valve: Manually operated sprinkler control valve and gate valve shall be outside stem and yoke (OS&Y) type or butterfly type and shall be listed or approved.

H. Check Valve: Check valve 2 inches and larger shall be listed or approved. Check valves 4 inches and larger shall be of the swing type with flanged cast-iron body and flanged inspection plate, shall have a clear waterway and shall meet the requirements of MSS SP-71, for Type 3 or 4.

I. Hose Valve: Valve shall comply with UL 668 and shall have a minimum rating of 300 pounds per square inch. Valve shall be non-rising stem, all bronze, 90-degree angle type, with 2 1/2-inch American National Standard Fire Hose Screw Thread (NH) male outlet in accordance with NFPA 1963. Hose valves shall be equipped with lugged cap with drip drain, cap gasket and chain. Valve finish shall be polished brass.

2.4 ALARM INITIATING AND SUPERVISORY DEVICES

A. Sprinkler Water flow Indicator Switch, Vane Type: Switch shall be vane type with a cast aluminum housing. The device shall sense water movements and be capable of detecting a sustained flow of 10 gallons per minute or greater. The device shall contain a retard device adjustable from 0 to 90 seconds to reduce the possibility of false alarms caused by transient flow surges. The switch shall be tamper resistant and contain two SPDT (Form C) contacts arranged to transfer upon removal of the housing cover and shall be equipped with a silicone rubber gasket to assure positive water seal and a dustproof cover and gasket to seal the mechanism from dirt and moisture.

B. Valve Supervisory (Tamper) Switch: Switch shall be suitable for mounting to the type of control valve to be supervised open. The switch shall be tamper resistant and contain two sets of SPDT (Form C) contacts arranged to transfer upon removal of the housing cover or closure of the valve of more than two rotations of the valve stem.

2.5 SPRINKLERS
A. Sprinklers with internal O-rings shall not be used. Sprinklers shall be used in accordance with their listed coverage limitations. Extended coverage sprinklers shall not be used.

B. Areas with finished ceilings shall have the following characteristics:
   1. Pendent or sidewall, quick-response, recessed, white finish (unless noted otherwise), ordinary temperature rated, unless ambient temperatures require a higher temperature rating.

C. Areas without finished ceilings shall have the following characteristics:
   1. Pendent or upright type, quick-response, brass, ordinary temperature rated, unless ambient temperature requires the installation of sprinklers with higher temperature ratings.

D. Sprinklers shall be of the same manufacturer and same temperature characteristics throughout any single room or area, but not necessarily throughout the entire building.

2.6 BACKFLOW PREVENTION ASSEMBLY

A. [Reduced-pressure principle][Double-check] valve assembly backflow preventer complying with ASSE 1013, ASSE 1015 and AWWA M14. Each check valve shall have a drain. Backflow prevention assemblies shall have current "Certificate of Approval from the Foundation for Cross-Connection Control and Hydraulic Research, FCCCHR List" and be listed for fire protection use. Listing of the specific make, model, design, and size in the FCCCHR List shall be acceptable as the required documentation.

B. Backflow Preventer Test Connection: Test connection shall consist of a series of listed hose valves with 2 1/2-inch National Standard male hose threads with cap and chain. Provide one valve for each 250 gpm of system demand, and provide enough valves to flow the total system design demand, including interior hose steam allowances, during the test. Provide a permanent sign that reads "TEST VALVES" immediately adjacent to these valves on the wall.

2.7 FIRE DEPARTMENT CONNECTION

A. Fire department connection shall be [freestanding][projecting][flush] type with cast brass body, matching [wall] escutcheon lettered "Auto Spkr" with a [polished brass][chromium-plated] finish. The connection shall have individual self-closing clappers, caps with drip drains and chains. Female inlets shall have 2 1/2-inch diameter American National Fire Hose Connection Screw Threads (NH) per NFPA 1963 and comply with UL 405.

2.8 ACCESSORIES

A. Sprinkler Cabinet: Spare sprinklers shall be provided in accordance with NFPA 13 and shall be packed in a suitable metal or plastic cabinet. Spare sprinklers shall be representative of, and in proportion to, the number of each type and temperature rating of the sprinklers installed. At least one wrench of each type required shall be provided.

B. Pipe Escutcheon: Escutcheons shall be polished chromium-plated zinc alloy, or polished chromium-plated copper alloy. Escutcheons shall be either one-piece or split-pattern, held in place by internal spring tension or set screw.

C. Sprinkler Guard: Guards shall be a steel wire cage designed to encase the sprinkler and protect it from mechanical damage. Guards shall be provided on sprinklers subject to damage.
D. Identification Sign:

1. Furnish and install properly lettered and approved metal or plastic signs to each control valve, alarm device, inspector’s test valve, drain valve, and alarm bypass valve. Each sign shall indicate the normal valve position as well as the portion of the system that the valve serves. Valve identification signs shall be minimum 6 inches wide x 2 inches high with enamel baked finish on minimum 18 gage steel or 0.024-inch aluminum with red letters on a white background or white letters on red background. Wording of sign shall include, but not be limited to "main drain", auxiliary drain", "inspector’s test", "alarm test", "alarm line", and similar wording as required to identify operational components.

2. Permanently affix metallic hydraulic design data nameplates complying with NFPA 13 to the riser of each system. Hydraulic information shall be permanently engraved on the nameplate. The use of permanent marker only is not acceptable.

3. Provide a laminated 8.5-inch x 11-inch diagram, hung on each riser, showing the floor area protected by that riser.

2.9 SPECIALTY SPRINKLER FITTINGS

A. Listed or approved, made of steel, ductile-iron, or other materials compatible with piping.

B. Drop-Nipple Fittings: Adjustable drop nipples are not permitted.

C. Mechanical-T Fittings: UL 213, ductile-iron housing with pressure-responsive gasket, bolts, and threaded or locking-lug outlet.

D. Mechanical-Cross Fittings: UL 213, ductile-iron housing with pressure-responsive gasket, bolts, and threaded or locking-lug outlets.

E. Sprinkler, Drain and Alarm/Inspector’s Test Fittings: Cast-iron or ductile-iron body; with threaded inlet and outlet, test valve, and orifice and sight glass.

F. Sprinkler, Branch Line Test Fittings: Brass body; with threaded inlet and capped drain outlet and threaded outlet for sprinkler.

2.10 PRESSURE GAUGES

A. Pressure gauges shall be UL-listed (UL 393), 3 1/2-inch to 4 1/2-inch diameter dial with dial range of 0 to 250 pounds per square inch gauge.

PART 3 - EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. The installation shall be in accordance with the applicable provisions of NFPA 13, NFPA 24, NFPA 1963 and publications referenced herein.

B. The Work Authorization must be prominently displayed at the job site before any work, to include demolition, can begin.

C. Upon completion of the work, a final inspection by the SRP Fire Marshal, and the satisfactory resolution of all issues identified by the Final Inspection, the SRP Fire Marshal shall sign and close out the Work Authorization which indicates acceptance of the permitted work.
3.2 UNDERGROUND PIPING INSTALLATION

A. The fire protection water main shall be laid, and joints anchored, in accordance with NFPA 24. Minimum depth of cover shall be 3 feet from the top of the pipe.

B. The supply line shall terminate inside the building with a flanged piece, the bottom of which shall be set not less than 6 inches above the finished floor. A blind flange shall be installed temporarily on top of the flanged piece to prevent the entrance of foreign matter into the supply line. A concrete thrust block shall be provided at the elbow where the pipe turns up toward the floor.

C. Joints shall be anchored in accordance with NFPA 24 using pipe clamps and steel rods from the elbow to the flange above the floor and from the elbow to a pipe clamp in the horizontal run of pipe.

D. Buried steel components shall be provided with a corrosion protective coating in accordance with AWWA C203. Piping more than 5 feet outside the building walls shall meet the requirements of [Section 33 11 00] WATER UTILITY DISTRIBUTION PIPING.

3.3 ABOVEGROUND PIPING INSTALLATION

A. Piping: Group piping at common elevations where practical. Route piping in an orderly manner, plumb and parallel to the building structure where practical and as indicated on the approved drawings.

B. Piping in Exposed Areas: Exposed piping shall be installed so as not to diminish exit access widths, corridors, or equipment access. Exposed horizontal piping, including drain piping, shall be installed to provide maximum headroom.

C. Fittings: Use approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes. Install unions adjacent to each valve in pipes 2 inches and smaller. Unions are not required on flanged devices or in piping installations using grooved joints. Install flanges or flange adapters on non-grooved valves, apparatus, and equipment having 2 1/2-inch and larger connections.

D. Pendent Sprinklers: Drop nipples to pendent sprinklers shall consist of minimum 1-inch pipe with a reducing coupling into which the sprinkler shall be threaded. Where sprinklers are installed below suspended or dropped ceilings, drop nipples shall be cut such that sprinkler ceiling plates or escutcheons are of a uniform depth throughout the finished spaces. The outlet of the reducing coupling shall not extend more than 1-inch below the underside of the ceiling. On pendent sprinklers installed below suspended or dropped ceilings, the distance from the sprinkler deflector to the underside of the ceiling shall not exceed 4 inches. Recessed pendent sprinklers shall be installed such that the distance from the sprinkler deflector to the underside of the ceiling shall not exceed the manufacturer's listed range and shall be of uniform depth throughout the finished area.

1. All sprinklers in suspended ceilings shall be center of tile (+/- 2 inches).

E. Upright Sprinklers: Riser nipples or "sprigs" to upright sprinklers shall contain no fittings between the branch line tee and the reducing coupling at the sprinkler. Riser nipples exceeding 30 inches in length shall be individually supported.

F. Install specialty sprinkler fittings according to manufacturer's written instructions.

G. Pipe Joints: Pipe joints shall conform to NFPA 13, except as modified herein. Not more than four threads shall show after joint is made up. Welded joints shall be permitted, only if welding operations are performed as required by NFPA 13 at the contractor's fabrication shop, not at the
project construction site. Flanged joints shall be provided where indicated or required by NFPA 13. Grooved pipe and fittings shall be prepared in accordance with the manufacturer’s latest published specification according to pipe material, wall thickness and size. Grooved couplings, fittings, and grooving tools shall be products of the same manufacturer. The diameter of grooves made in the field shall be measured using a "go/no-go" gauge, vernier or dial caliper, narrow-land micrometer, or other method specifically approved by the coupling manufacturer for the intended application. Groove width and dimension of groove from end of pipe shall be measured and recorded for each change in grooving tool setup to verify compliance with coupling manufacturer’s tolerances. Grooved joints shall not be used to conceal locations, such as behind solid walls or ceilings, unless an access panel is shown on the drawings for servicing or adjusting the joint.

H. Reducers: Reductions in pipe sizes shall be made with one-piece tapered reducing fittings. The use of grooved-end or rubber-gasketed reducing couplings will not be permitted. When standard fittings of the required size are not manufactured, single bushings of the face type will be permitted. Where used, face bushings shall be installed with the outer face flush with the face of the fitting opening being reduced. Bushings shall not be used in elbow fittings, in more than one outlet of a tee, in more than two outlets of a cross, or where the reduction in size is less than 1/2-inch.

I. Pipe Penetrations: Cutting structural members for passage of pipes for pipe-hanger fastenings will not be permitted. Pipes that must penetrate concrete or masonry walls or concrete floors shall be core-drilled and provided with pipe sleeves. Each sleeve shall be Schedule 40 galvanized steel, ductile-iron or cast-iron pipe and shall extend through its respective wall or floor and be cut flush with each wall surface. Sleeves shall provide required clearance between the pipe and the sleeve per NFPA 13. The space between the sleeve and the pipe shall be firmly packed with mineral wool insulation. Where pipes penetrate fire walls, fire partitions, or floors, pipes shall be firestopped with a listed or approved through-penetration firestopping assembly. In penetrations that are not fire-rated or not a floor penetration, the space between the sleeve and the pipe shall be sealed at both ends with plastic waterproof cement that will dry to a firm but pliable mass or with a mechanically adjustable segmented elastomer seal.

J. Escutcheons: Escutcheons shall be provided for pipe penetration of ceilings and walls. Escutcheons shall be securely fastened to the pipe at surfaces through which piping passes.

K. Inspector’s Test Connection: Unless otherwise indicated, test connection shall consist of 1-inch pipe connected to the system riser; a test valve located approximately 7 feet above the floor; a sight glass assembly; a smooth bore brass outlet equivalent to the smallest orifice sprinkler used in the system; and a painted metal identification sign affixed to the valve with the words "Inspector’s Test". The discharge orifice shall be located outside the building wall directed so as not to cause damage to adjacent construction or landscaping during full flow discharge. Concrete splash blocks shall be provided.

L. Drains: Main drain piping shall be provided to discharge at a safe point outside the building. Auxiliary drains shall be provided as required by NFPA 13. Concrete splash blocks shall be provided.

M. Hangers and Supports: Comply with NFPA 13 for hanger materials and installation.

N. Sway Brace Protection: Install piping according to NFPA 13 to protect from building sway damage.

O. Identification Signs: Signs shall be affixed to each control valve, inspector test valve, main drain, auxiliary drain, test valve, and similar valves as appropriate or as required by NFPA 13. Hydraulic design data nameplates shall be permanently marked and permanently affixed to each sprinkler riser as specified in NFPA 13.
3.4 LABELING AND IDENTIFICATION

A. Manufacturers pipe labeling shall be visible.

B. Identify all bulk feed, cross mains, primary and secondary mains at maximum 20-foot intervals with red stenciled or adhesive pipe labels, readable from floor level.

3.5 ELECTRICAL WORK

A. Alarm signal wiring connected to the building fire alarm control system shall be by the fire alarm subcontractor.

3.6 PROTECTIVE PAINTING

A. Provide protective painting as herein specified.

1. Metal surfaces shall first be thoroughly wire brushed and cleaned of all dirt, rust, grease, or other foreign matter before priming coat is applied.

2. Paint all sprinkler piping exposed to view, except stainless steel piping, red.

B. Clean up all equipment and leave in condition for finish painting before acceptance.

C. Provide a heavy field coat of black asphaltum paint on all steel pipe, cradles, vibration isolating mounts, and the like, that will be encased or partially encased in building construction, set in cement or fill, before items are built into the general construction.

3.7 PRELIMINARY TESTS

A. The system, including the underground water mains, and the aboveground piping and system components, shall be tested to assure that equipment and components function as intended. The underground and aboveground interior piping systems and attached appurtenances subjected to system working pressure shall be tested in accordance with NFPA 13 and NFPA 24. Upon completion of specified tests, complete certificates as specified in paragraph SUBMITTALS.

B. Experienced technicians regularly employed by the contractor in the installation of the system and manufacturer’s representative referred to elsewhere in this section shall conduct the testing.

C. Underground Piping.

1. Flushing: Underground piping shall be flushed in accordance with NFPA 24. This includes the requirement to flush the lead-in connection to the fire protection system at a flow rate not less than the calculated maximum water demand rate of the system.

2. Hydrostatic Test: New underground piping shall be hydrostatically tested in accordance with NFPA 24. The allowable leakage shall be measured at the specified test pressure by pumping from a calibrated container. The amount of leakage at the joints shall not exceed 1.89 L2 quarts per hour per 100 gaskets or joints, regardless of pipe diameter.

D. Aboveground Piping.

1. Hydrostatic Test: Aboveground piping shall be hydrostatically tested in accordance with NFPA 13 at not less than 200psi or 50psi in excess of maximum system operating pressure and shall maintain that pressure without loss for 2 hours. There shall be no drop in gauge pressure or
visible leakage when the system is subjected to the hydrostatic test. The test pressure shall be read from a gauge located at the low elevation point of the system or portion being tested.

2. **Backflow Preventer Full Forward Flow Test:** Each backflow prevention assembly shall be tested at system flow demand, including all applicable hose streams, as specified in NFPA 13. Provide all equipment and instruments necessary to conduct a complete forward flow test, including 2.5-inch diameter hoses, playpipe nozzles, calibrated pressure gauges, pitot tube gauge, plus all necessary supports to safely secure hoses and nozzles during the test. At the system demand flow, the pressure readings and pressure drop (friction) across the assembly shall be recorded. Provide a metal placard on the backflow prevention assembly that lists the pressure readings both upstream and downstream of the assembly, total pressure drop, and the system test flow rate. The pressure drop shall be compared to the manufacturer’s data.

3. **Alarm Devices:** Each alarm switch shall be tested by flowing water through the inspector’s test connection. Each water-operated alarm device shall be tested to verify proper operation.

4. **Main Drain Flow Test:** Following flushing of the underground piping, a main drain test shall be made to verify the adequacy of the water supply. Static and residual pressures shall be recorded on the certificate specified in paragraph SUBMITTALS. In addition, a main drain test shall be conducted each time after a main control valve is shut and opened.

### 3.8 FINAL TEST

A. The system will be considered ready for acceptance testing only after the following have been accomplished:

1. Preliminary tests have been made and deficiencies corrected.

2. Testing reports have been submitted and approved.

B. Final acceptance testing shall be coordinated and performed by the contractor, in the presence of SRP Fire Protection Division. In order to assure attendance of the necessary representatives, each representative scheduled to witness the test shall be provided a minimum of 5 working days' notification of the proposed test date by the contractor. The test shall not be conducted until all parties agree on the scheduled test date. The contractor shall provide all the necessary personnel and equipment to conduct the tests.

C. The final acceptance test shall be a repeat of preliminary tests and shall include operation of control valves and flowing of inspector’s test connections to verify operation of associated workflow alarm switches. After operation of control valves has been completed, the main drain test shall be repeated to assure that control valves are in the open position. In addition, the contractor shall have available copies of as-built drawings and certificates of tests previously conducted. The installation shall not be considered accepted until identified discrepancies have been corrected and test documentation is properly completed and received. The contractor shall correct system failures and other deficiencies identified during testing and shall retest portions of the system affected by the required corrections.

D. If the Final Acceptance Test fails, the contractor shall pay all costs incurred to SRP for any and all retesting.

E. Upon satisfactory completion of the tests, the contractor shall leave the system in proper working order.
F. Warranty: Except as otherwise expressly provided in the contract documents, and excepting only items of routine maintenance, ordinary wear and tear or unusual abuse or neglect, contractor guarantees all work executed by the contractor and all supplies, materials, and devices of whatsoever nature incorporated in, or attached with the work, or otherwise delivered to SRP as part of the work pursuant to the contract to be absolutely free of all defects of workmanship and materials for a period of 2 years after final acceptance of the work by SRP. Include service directory with telephone numbers for 24-hour emergency service.

3.9 TRAINING

A. Instructor: Include in the project the services of an instructor, who has received specific training from the manufacturer for the training of other persons regarding the inspection, testing, and maintenance of the system provided. The instructor shall train the employees designated by SRP, in the care, adjustment, maintenance, and operation of the fire sprinkler system. Each instructor shall be thoroughly familiar with all parts of this installation. The instructor shall be trained in operating theory as well as in practical O&M work. Submit the instructor’s information and qualifications including training history to SRP prior to training.

B. Required Instruction Time: Provide [4][8] hours of instruction after final acceptance of the system. The instruction shall be given during regular working hours on such dates and times as selected by SRP. The instruction may be divided into two or more periods at the discretion of SRP. The training shall allow for rescheduling for unforeseen maintenance and/or fire department responses.

END OF SECTION
SECTION 21 1316

PREAMTION SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 REFERENCES

A. The publications listed below form a part of this specification section to the extent referenced. The publications are referred to within the text by the basic designation only. Use the latest edition, unless noted otherwise.

B. ASME INTERNATIONAL (ASME)

1. ASME B16.1 Gray Iron Pipe Flanges and Flanged Fittings; Classes 25, 125 and 250
2. ASME B16.3 Malleable Iron Threaded Fittings, Classes 150 and 300
3. ASME B16.4 Gray Iron Threaded Fittings; Classes 125 and 250

C. AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

4. ASSE 1013 Performance Requirements for Reduced Pressure Principle Backflow Preventers and Reduced Pressure Principle Fire Protection Backflow Preventers
5. ASSE 1015 Performance Requirements for Double Check Backflow Prevention Assemblies and Double Check Fire Protection Backflow Prevention Assemblies

D. ASTM INTERNATIONAL (ASTM)

2. ASTM A183 Standard Specification for Carbon Steel Track Bolts and Nuts
4. ASTM A53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
5. ASTM A536 Standard Specification for Ductile Iron Castings

E. AMERICAN WATER WORKS ASSOCIATION (AWWA)

7. AWWA M14 Backflow Prevention and Cross-Connection Control: Recommended Practices
8. AWWA C203 Standard for Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape – Hot Applied
10. AWWA C104/A21.4 American National Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water

F. FM GLOBAL (FM)

G. INTERNATIONAL CODE COUNCIL

H. INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)
   1. IEEE C62.41.1 Guide on the Surge Environment in Low-Voltage (1000 v and less) AC Power Circuits
   2. IEEE C62.41.2 Recommended Practice on Characterization of Surges in Low-Voltage (1000 v and less) AC Power Circuits

I. MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)
   1. MSS SP-71 Gray Iron Swing Check Valves, Flanged and Threaded Ends

J. NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

K. SRP Codes
   1. SRP AFC SRP Administrative Fire Code

L. UNDERWRITERS LABORATORIES (UL)
   1. UL 268 Smoke Detectors for Fire Protective Signaling Systems
   2. UL 521 Heat Detectors for Fire Protective Signaling Systems
   3. UL 668 Hose Valves for Fire Protection Service
   4. UL 405 Fire Department Connection Devices
   5. UL 213 Standard for Rubber Gasketed Fittings for Fire-Protection Service
   6. UL 262 Standard for Gate Valves for Fire-Protection Service
   7. UL 393 Standard for Indicating Pressure Gauges for Fire-Protection Service
   8. UL 789 Standard for Indicator Posts for Fire-Protection Service
   9. UL 864 Control Units and Accessories for Fire Alarm Systems

1.2 NOTICE TO BIDDERS

A. Before submittal of bid, examine all drawings, specification, addenda, alternatives, special conditions, and all other bidding documents of all sections of this project, verifying all governing conditions at the site, and become fully informed as to the extent and character of the work required, as well as its relation to other work in the building. Submittal of a bid is an agreement to all requirements of the contract documents and no consideration will be granted for any claimed misunderstanding thereof.

B. Submittal of a bid is deemed a representation by the bidder that he is qualified in all respects to properly perform the work for which he is bidding and has experience with similar work. Bidders are
deemed to be aware, on the basis of their background and experience, of materials which may be required in the discharge of their responsibilities, even though unspecified.

C. Any case of error, omission, discrepancy, inconsistency or lack of clarity in the specification or drawings shall be promptly identified to SRP.

1.3 DESCRIPTION OF WORK

A. Double-interlock preaction sprinkler systems shall be provided in areas indicated on the drawings. The sprinkler system shall provide preaction sprinkler protection for the entire area noted. Except as modified herein, the system shall be designed and installed in accordance with NFPA 13. Pipe sizes which are not indicated on drawings shall be determined by hydraulic calculation. The contractor shall design any portions of the sprinkler system that are not indicated on the drawings or specified herein, including locating and sizing sprinklers, piping and equipment. The design of the sprinkler system shall be based on hydraulic calculations, and the other provisions specified herein.

B. Control System: The control system shall meet the requirements of NFPA 72. The control panel shall be listed or approved for "releasing device service". The control panel and the solenoid valve that activates the water control valve shall be compatible with each other. Compatibility shall be in accordance with specific approval of the control equipment.

C. Power Supply: Provide the primary operating power from a single-phase 120 VAC circuit. Loss of primary power shall not prevent actuation of the respective automatic water control valve upon activation of any alarm initiating device. Provide backup power through use of rechargeable, sealed, storage batteries.

D. Circuit Requirements: All initiating device circuits (IDC), signal line circuits (SLC), and notification appliance circuits (NAC) shall be Class B in accordance with NFPA 72. Provide a separate circuit for each zone. Fully supervise the solenoid circuits so that the occurrence of a single open or a single ground fault condition is the interconnecting conductors will be indicated at the control panel.

E. System Operation Features: Include in the system a heat detection system (smoke detection in office buildings), supervisory and alarm switches, control panel and associated equipment.

F. System Actuation: Activation of any single detector shall actuate the associated alarm zone circuit on the control panel that, in turn, shall actuate the corresponding automatic water control valve. Actuation of the automatic water control valve shall cause water to fill the preaction system piping once the valve is tripped pneumatically from a loss of pressure in the piping.

G. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical. Deviations from approved working plans for piping require written approval from SRP.

H. Hydraulic Design: The system shall be hydraulically designed to discharge a minimum density as indicated on the drawings. Hydraulic calculations shall be in accordance with NFPA 13. A 10-psi safety margin shall be provided at the point of connection to the city water main.

I. Basis for Calculations: A waterflow test was performed on (DATE) at (LOCATION) and resulted in a static pressure of ___ psi with a residual pressure of ___ psi while flowing ____ gpm. The fire sprinkler subcontractor shall perform a fire hydrant flow test prior to shop drawings submittal. The results shall be included with the hydraulic calculations. Hydraulic calculations shall be based upon the Hazen-Williams formula with a "C" value of 120 for steel piping and 150 for underground plastic piping.
J. Sprinkler Coverage: Sprinklers shall be uniformly spaced on branch lines. Sprinklers shall provide coverage throughout 100 percent of the area noted. Coverage per sprinkler shall be in accordance with NFPA 13. Provide sprinklers below all ducts over 4'-0" wide; coordinate with HVAC drawings.

1. The Small Room Rule shall NOT apply in SRP facilities.

1.4 SUBMITTALS

A. Submit six copies of the following, no later than 21 days prior to the start of system installation, in accordance with the General Conditions of the Contract. Drawings, unless noted otherwise, shall be no smaller than the Contract Drawings.

1. Shop Drawings: Detail drawings conforming to the requirements prescribed in NFPA 13 and NFPA 170. Drawing shall include plan and elevation views which establish that the equipment will fit the allotted spaces with clearance for installation and maintenance. Each set of drawings shall include the following:
   a. A descriptive index with drawings listed in sequence by number. A legend sheet identifying device symbols, nomenclature, and conventions used in the package.
   b. Floor plans drawn to a scale not less than 1/8-inch equals 1-foot clearly showing locations of devices, equipment, risers, electrical power connections and other details required to clearly describe the proposed arrangement.
   c. Riser layout drawings drawn to a scale of not less than 1/2-inch equals 1-foot to show details of each system component, clearances between each other and from other equipment and construction in the room.
   d. Details of each type of pipe hanger and related components.
   e. Details of each type of riser assembly; pipe hanger; sway bracing for earthquake protection, and restraint of underground water main at point-of-entry into the building, and electrical devices and interconnecting wiring. The dimension from the edge of vertical piping to the nearest adjacent wall(s) shall be indicated on the drawings when vertical piping is located in stairs or other portions of the means of egress.
   f. Point-to-point wiring diagrams showing the points of connection and terminals used for electrical field connections in the system, including interconnections between the equipment or systems that are supervised or controlled by the system. Diagrams shall show connections from field devices to the releasing control panel.
   g. Complete riser diagrams indicating the wiring sequence of devices and their connections to the control equipment. Include a color code schedule for the wiring. Include floor plans showing the locations of devices and equipment.
   h. Shop drawings and calculations shall be prepared by a qualified NICET Level III (or IV) Technician.

2. The Contractor shall not order any equipment and shall not begin any work until the submittals have been approved in writing by SRP. The contractor shall not perform any installation prior to the receipt of a written authority to proceed from SRP. If submittals are found not to conform to all of the requirements of this specification section and the applicable referenced Codes, Standards and Regulations, the contractor shall be required to revise and resubmit the package with modifications.

3. Hydraulic calculations shall be as outlined in NFPA 13 except that calculations shall be performed by computer using software intended specifically for fire protection system design using the design data shown on the drawings. Calculations shall be based on the water supply data provided in the specification section. Calculations shall substantiate that the design area used in the calculations is the most demanding hydraulically. Water supply curves and system requirements shall be plotted on semi-logarithmic graph paper so as to present a summary of the complete hydraulic calculation. A summary sheet listing sprinklers in the design area and
their respective hydraulic reference points, elevations, actual discharge pressures and actual flows shall be provided. Elevations of hydraulic reference points (nodes) shall be indicated. Documentation shall identify each pipe individually and the nodes connected thereto. The diameter, length, flow, velocity, friction loss, number and type of fittings, total friction loss in the pipe, equivalent pipe length and Hazen-Williams coefficient shall be indicated for each pipe. For gridded systems, calculations shall show peaking of demand area friction loss to verify that the hydraulically most demanding area is being used.

4. Product Data: Annotated catalog data showing manufacturer’s name, model, and catalog number for all equipment and components, with data highlighted to indicate model, size, options, etc. proposed for installation. In addition, a complete equipment list with equipment description, model number, and quantity shall be provided. This shall include the following:
   a. Pipe, fittings, and mechanical couplings
   b. Valves, including preaction, gate, check, and globe
   c. Pipe hangers and supports
   d. Air compressor, air maintenance device
   e. Waterflow, tamper and low air switches
   f. Sprinklers
   g. Fire department connection
   h. Backflow prevention devices
   i. Fire hose valve
   j. Releasing control panel, initiating and notification devices, manual release station, relays, monitor modules and wire
   k. Miscellaneous equipment (such as spare sprinkler cabinet, signs, etc.)

5. Installers Qualifications: Data approved, prior to submittal of any other data or drawings, to substantiate that the proposed installer is regularly engaged in the installation of the type and complexity of the fire protection system included in this project. Data shall identify the location of three systems recently installed by the proposed installer which are comparable to the system specified. Contractor shall certify that each system has performed satisfactorily, in the manner intended, for a period of not less than 6 months.


7. As-Built Drawings: In addition to six hard copies, furnish one set of CD or DVD discs containing software back-up and CAD based drawings in the latest version of AutoCAD and DXF format and pdf copy of as-built drawings and schematics. A separate set of approved submittal drawings of the overall system, marked-up to indicate as-built conditions, shall be maintained on site. These drawings shall be maintained in a current condition at all times, and shall be made available for review immediately upon request during normal working hours. Variations from approved drawings, for whatever reason, including those occasioned by modifications, change orders, optional materials, and/or required for coordination between trades shall be indicated in sufficient detail to accurately reflect the as-built conditions. These drawings shall be submitted within 14 calendar days after the final acceptance test of the system. At least two sets of as-built (marked-up) drawings shall be provided to SRP at the time of, or prior to the final acceptance test.

8. Operation and Maintenance Data: Six manuals in loose-leaf binder format and grouped by technical sections consisting of manufacturer’s brochures, schematics, printed instructions, general operating procedures, and safety precautions. Manuals shall be submitted and approved prior to on-site training. In addition to items specified in Division 01 Section 017823 "Operation and Maintenance Data", the Manual shall include a narrative description of the sequence or sequences of operation of the overall fire protection system and a separate
description for each major subsystem. Information to be provided shall include specific open/close settings for all adjustable valves. The manual shall list routine maintenance procedures, possible breakdowns, and repairs, and troubleshooting guide. The manual shall include conduit layout, equipment layout, and simplified wiring and control diagrams for the system as installed. The manual shall include procedures and instructions pertaining to frequency of preventive maintenance, inspection, adjustment, lubrication and cleaning necessary to minimize corrective maintenance and repair.

9. Impairment Plan: In the event the scope of work may remove from service or interfere with a fire suppression or alarm system, the design engineer shall consult and communicate with the SRP Fire Marshal to develop an Impairment Plan. The Impairment Plan developed by the design engineer shall be submitted at the same time as the design drawings for review and approval. The final plan shall be written on the drawings.

10. Training Documentation: Provide in manual format, lesson plans, operating instructions, maintenance procedures, and training data for the training courses. The operations training shall familiarize SRP’s designated personnel with proper operation of the installed system. The maintenance training course shall provide SRP’s designated personnel adequate knowledge required to diagnose, repair, maintain, and expand functions inherent to the system.

11. Schedule: Provide a schedule indicating the delivery dates of the equipment to be supplied; installation sequence; time frame and the total amount of on-site technical assistance time (in man-hours per phase) that the supplier of the equipment has included in their bid to comply with the requirements of this specification section and SRP’s requirements; and final acceptance test dates to meet SRP’s scheduled project completion dates.

12. Preliminary Equipment List: Provide a preliminary equipment list identifying the type, quantity, make, and model number of each piece of equipment to be provided under this submittal. Types and quantities of equipment submitted shall coincide with the types and quantities of equipment used in the battery calculations and those shown on the shop drawings. A final equipment list shall be submitted with the Operating and Maintenance (O&M) manual.

13. In the event that the Contractor’s submittal package is required to be revised and resubmitted due to nonconformance with this specification section, illegibility of the submittal, incomplete submittals, noncompliance with the referenced local, state and national Codes, Standards and Regulations or nonconformance with pertinent documentation relative to the project, the contractor shall pay all fees associated with the additional submittal review. Payment of the fee shall be solely the contractor’s responsibility.

1.5 QUALITY ASSURANCE

A. The recommended practices stated in the manufacturer’s literature or documentation shall be considered as mandatory requirements.

B. Qualifications - Contractor: The contractor shall be an Arizona licensed contractor in possession of a valid fire sprinkler contractor’s license. Design and installation must be performed by a sprinkler contractor whose business is located within a 75-mile radius of the project site. The contractor shall have a minimum of 3 years of experience in the installation of automatic sprinkler systems in similar facilities.

C. Qualification - Fire Sprinkler Design Services: Shop (working) drawings and calculations shall be prepared under the direction of and signed by a qualified registered Professional Engineer or a NICET
Level III (minimum) in water-based systems. For the purposes of meeting this requirement, a qualified engineer is defined as an individual meeting one of the following conditions:

1. A registered professional engineer having passed the NCEES examination in fire protection engineering.
2. Registered professional engineer with verification of experience and at least 5 years of current experience in the design of the fire protection and detection systems.

D. Qualifications - Fire Sprinkler Supervisor: A NICET Level III (minimum) in water-based systems shall supervise the installation of the fire sprinkler system.

E. Qualifications - Fire Sprinkler Installer: Fire sprinkler installers with a minimum of 2 years of experience or who possess a CSA certification shall be permitted to assist in the installation of the fire sprinkler system.

F. Qualifications - Fire Sprinkler Test Personnel: Fire sprinkler technicians with a minimum of 8 years of experience shall be utilized to test and certify the installation of the fire sprinkler system. The fire sprinkler technicians testing the equipment shall be factory-trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

G. Qualifications - Releasing System Design Services: Shop (working) drawings and calculations shall be prepared under the direction of and signed by a qualified registered Professional Engineer or a NICET Level III in fire alarm systems. For the purposes of meeting this requirement, a qualified engineer is defined as an individual meeting one of the following conditions:

1. A registered professional engineer having passed the NCEES examination in fire protection engineering.
2. Registered professional engineer with verification of experience and at least 5 years of current experience in the design of the fire protection and detection systems.

H. Qualifications - Releasing System Supervisor: A NICET Level III (minimum) fire alarm technician shall supervise the installation of the releasing system. The technician shall be factory-trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

I. Qualifications - Releasing System Technician: Technicians with a minimum of 4 years of experience shall be utilized to assist in the installation and termination of fire alarm devices, cabinets, and panels. The technicians installing the equipment shall be factory-trained in the installation and adjustment of the equipment specified herein and on the drawings.

J. Qualifications - Releasing System Installer: Installer with a minimum of 2 years of experience shall be permitted to assist in the installation of fire alarm devices, cabinets and panels. An electrician shall be permitted to install wire, cable, conduit and backboxes for the fire alarm system.

K. Qualifications – Releasing System Test Personnel: Technicians with a minimum of 8 years of experience shall be utilized to test and certify the installation of the releasing system devices, cabinets, and panels. The fire alarm technicians testing the equipment shall be factory-trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.
1.6 REGULATORY REQUIREMENTS

A. All system components shall be listed or approved for their intended use and shall be compatible with the system and its components. Where the terms "listed" or "approved" appear in this specification section, they shall mean UL-listed (UL Fire Prot Dir), FM-approved (FM App Guide), or listed by a nationally recognized testing laboratory (NRTL). The omission of these terms under the description of any item of equipment described shall not be construed as waiving the requirement for listing or approval. All listings or approvals shall be based on an existing ANSI or UL published standard.

B. Compliance with referenced standards is mandatory. This includes advisory provisions listed in the appendices of such standards, as though the word "shall" had been substituted for the word "should" wherever it appears. In the event of a conflict between specific provisions of this specification section and applicable standards, this specification section shall govern. Reference to "authority having jurisdiction" shall be interpreted to mean SRP or SRP’s Representative.

C. Install all work in full conformance with the requirements of all local and governmental authorities having jurisdiction over these matters, utility company requirements, and requirements of the latest issues of all applicable Codes. The building permit will be secured by SRP, any additional permits, inspections, close out shall be the responsibility of the contractor.

D. The fire protection installation and the installing contractor shall comply fully with all city, county and state laws, ordinances and regulations applicable to fire protection installations.

E. Should any change in plans or specification be required to comply with governmental regulations, the contractor shall notify the Engineer at the time of submitting his bid.

F. Secure and pay for necessary approvals, permits, inspections, etc., and deliver the official records of the granting of permits to the SRP Representative without additional cost to SRP.

G. A Work Authorization is required for all sprinkler work. The SRP Project Manager (PM) shall apply for and receive the Work Authorization. The fire protection contractor will receive the Work Authorization from the SRP PM. The Work Authorization must be prominently displayed at the jobsite before any work, to include demolition, can begin. Upon completion of the work, a final inspection by the SRP Fire Marshal, and the satisfactory resolution of all issues identified by the Final Inspection, the SRP Fire Marshal shall sign and close out the Work Authorization which indicates acceptance of the permitted work.

1.7 VERIFYING ACTUAL FIELD CONDITIONS

A. Before commencing work, examine all adjoining work on which the contractor’s work is in any way dependent for perfect workmanship according to the intent of this specification section, and report to the SRP Representative any condition which prevents performance of first class work. No "waiver of responsibility" for incomplete, inadequate or defective adjoining work will be considered unless notice has been filed before submittal of a proposal.

B. The contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall advise the SRP Representative of any discrepancy before performing the work.

1.8 COORDINATION OF TRADES

A. The contract documents are not intended to serve as coordinated construction documents showing all minor adjustments in locations required for a fully coordinated installation that respects the work of all trades.
B. Piping offsets, fittings, and any other accessories required shall be furnished as required to provide a complete installation and to eliminate interference with other construction. Sprinklers shall be installed over and under ducts, piping and platforms when such equipment can negatively affect or disrupt the sprinkler discharge pattern and coverage.

C. Wherever the contractor’s work interconnects with work of other contractors, the contractor shall coordinate his work with other contractors to ensure that all contractors have the information necessary so that they may properly install all necessary connections and equipment. Identify all work items needing access (dampers, etc.) concealed above hung ceilings by permanent colored pins/tabs in the ceiling directly below the item.

D. Provide required supports and hangers for piping, conduit and equipment, so that loading will not exceed allowable loadings of structure. Submittal of a bid shall be a deemed representation that the contractor submitting such bid has ascertained allowable loadings and has included in his estimates the costs associated in furnishing required supports.

E. Field drilling and cutting of holes in structural decks, roofs, walls, etc., required for work under this section shall be coordinated through various trades in their respective materials and approved by the SRP Representative. All such drilling, cutting, and reinforcing costs shall be borne by the contractor.

F. Due to the type of installation, a fixed sequence of construction is required to properly install the complete systems. It shall be the responsibility of the contractor to coordinate, protect, and schedule his work with other trades in accordance with the construction sequence.

G. Cooperate with all other contractors and subcontractors to facilitate the completion of the work as a whole, subject to the direction of the SRP Representative.

1.9 SCHEDULING

A. Provide a schedule to SRP indicating the installation sequence and timeframe prior to beginning work. Provide weekly updates to SRP. All wiring, circuit testing and device installation shall be completed in time for the equipment supplier to make all final connections and conduct all tests as outlined in these specification sections.

B. Coordinate the Acceptance Test for each fire alarm system with SRP and other necessary parties identified by SRP.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Protect equipment delivered and placed in storage from the weather, humidity, and temperature variation, dirt and dust, and other contaminants in accordance with manufacturer’s instructions.

B. All pipes shall either be capped or plugged until installation.

C. Coordinate the storage arrangement and location with SRP.

D. Deliver and store products in shipping containers/boxes, with labeling in place.

E. Provide temporary protective coating on cast iron and steel valves.
1.11 WASTE REMOVAL

A. At the conclusion of each day's work, clean up and stockpile on site all waste, debris, and trash, which may have accumulated during the day as a result of work by the contractor and of his presence on the job.

B. Sidewalks and street adjoining the property shall be kept broom clean and free of waste, debris, trash and obstructions of any kind caused by work of the contractor, which will affect the condition and safety of streets, walks, utilities and property.

1.12 SPARE PARTS

A. Repair Service/Replacement Parts: During warranty period, the service technician shall be on-site within 24 hours after notification. All repairs shall be completed within 24 hours of arrival on-site.

B. The contractor shall provide spare sprinklers, sprinkler wrench and sprinkler cabinet in accordance with NFPA 13.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Standard Products: Material and equipment shall be the standard products of a manufacturer, where possible, and not a combination of manufacturers for any particular classification of materials. Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 2 years prior to bid opening. All materials and equipment supplied shall be new, first quality and the manufacturer’s best type and latest model capable of complying with all requirements of this specification section and shall have been in continuous production and in continuous service in commercial applications for at least 1-year. All equipment furnished shall be new and listed for its intended application. Obsolete equipment shall not be used.

B. Nameplates: Major components of equipment shall have the manufacturer’s name, model or serial number, and date of installation provided on a new plate permanently affixed to the item or equipment. Nameplates shall be etched metal or plastic, permanently attached by screws to panels or adjacent walls.

2.2 UNDERGROUND PIPING SYSTEMS

A. Pipe: Pipe shall comply with NFPA 24. Minimum pipe size shall be minimum [4 inches][6 inches]. Piping more than 5 feet outside the building walls shall comply with [Section 33 11 00] WATER UTILITY DISTRIBUTION PIPING. A continuous section of welded stainless steel fire water service piping from a point outside the building perimeter to a flanged fitting at least 1-foot above the finished floor within the building is acceptable.

B. Fittings and Gaskets: Fittings shall be ductile-iron conforming to AWWA C110/A21.10 with cement mortar lining conforming to AWWA C104/A21.4. Gaskets shall be suitable in design and size for the pipe with which such gaskets are to be used. Gaskets for ductile-iron pipe joints shall conform to AWWA C111/A21.11.

C. Gate Valve and Indicator Posts: Installation shall comply with NFPA 24. Gate valves for use with indicator post shall conform to UL 262. Indicator posts shall conform to UL 789. Provide each indicator post with one coat of primer and two coats of red enamel paint.
D. Valve Boxes: Except where indicator posts are provided, for each buried valve, provide a cast-iron, ductile-iron, or plastic valve box of a suitable size. Plastic boxes shall be constructed of acrylonitrile-butadiene-styrene (ABS) or inorganic fiber-reinforced black polyolefin. Provide cast-iron, ductile-iron, or plastic cover for valve box with the word "WATER" cast on the cover. The minimum box shaft diameter shall be 5.25 inches. Coat cast-iron and ductile-iron boxes with bituminous paint applied to a minimum dry-film thickness of 10 mils.

E. Buried Utility Warning and Identification Tape: Provide detectable aluminum foil plastic backed tape or detectable magnetic plastic tape manufactured specifically for warning and identification of buried piping. Tape shall be detectable by an electronic detection instrument. Provide tape 3 inches minimum width, color coded for the utility involved with warning and identification imprinted in bold block letters continuously and repeatedly over the entire tape length. Warning and identification shall read "CAUTION BURIED WATER PIPING BELOW" or similar wording. Use permanent code and letter coloring unaffected by moisture and other substances contained in trench backfill material.

2.3 ABOVEGROUND PIPING SYSTEMS

A. Pipe: Pipe shall be standard weight conforming to ASTM A795, ASTM A53, or ASTM A135. Piping less than 3-inch in diameter shall be minimum schedule 40 and joined by threaded fittings. Piping 4 inches and greater shall be minimum schedule 10 and joined by threaded, grooved or flanged fittings. Pipe in which threads or grooves are cut shall have a corrosion resistance ratio (CRR) of 1.00 or greater after threads or grooves are cut. Pipe shall be marked as to the brand or name of the manufacturer, kind of pipe and the ASTM designation in accordance with the "Product Marking" provisions of the ASTM standard.

B. Plastic Pipe: Plastic piping (PVC, CPVC, polybutylene) is not permitted.

C. Grooved Fittings and Couplings: Grooved fittings, couplings and bolts shall be provided by the same manufacturer. Fittings and couplings shall be malleable iron complying with ASTM A47 or ductile-iron complying with ASTM A536. Couplings shall be of the rigid type except that flexible type will be provided where flexible joints are specifically required by NFPA 13. Coupling gaskets shall be Grade E (EPDM) approved for dry pipe fire protection service. Gasket shall be the flush type that fills the entire cavity between the coupling and the pipe. Nuts and bolts shall be heat-treated steel conforming to ASTM A183 and shall be cadmium plated or zinc electroplated. Plain-end fittings with mechanical couplings, fittings which require drilling a hole in the pipe, and fittings which use steel gripping devices to bite into the pipe, shall not be used.

D. Non-Grooved Fittings: Non-grooved fittings shall be threaded or flanged. Threaded fittings shall be cast-iron conforming to ASME B16.4, malleable iron conforming to ASME B16.3 or ductile-iron conforming to ASTM A536. Flanged fittings shall be cast-iron conforming to ASME B16.1. Fittings into which sprinklers, drop nipples or riser nipples (sprigs) are screwed shall be threaded type. Plain-end fittings with mechanical couplings, fittings which require drilling a hole in the pipe, and fittings which use steel gripping devices to bite into the pipe, shall not be used.

E. Flanges and Gaskets: Flanges shall conform to NFPA 13 and ASME B16.1. Flanges shall be the type that are welded or threaded to the pipe. Flanges which are bolted to grooved pipe shall not be permitted. Gaskets shall be full-face type EPDM or other approved material.

F. Pipe Hangers: Hangers shall be listed or approved and be of the type suitable for the application, construction and size pipe involved. Earthquake bracing shall be listed.

G. Control Valve: Manually operated sprinkler control valve and gate valve shall be outside stem and yoke (OS&Y) type or butterfly type and shall be listed.
H. Check Valve: Check valve 2 inches and larger shall be listed or approved. Check valves 4 inches and larger shall be of the swing type with flanged cast-iron body and flanged inspection plate, shall have a clear waterway and shall meet the requirements of MSS SP-71, for Type 3 or 4.

I. Hose Valve: Valve shall comply with UL 668 and shall have a minimum rating of 300 pounds per square inch. Valve shall be non-rising stem, all bronze, 90-degree angle type, with 2 1/2-inch American National Standard Fire Hose Screw Thread (NH) male outlet in accordance with NFPA 1963. Hose valves shall be equipped with lugged cap with drip drain, cap gasket and chain. Valve finish shall be polished brass.

J. Preaction Valve: Preaction valve shall be electrically and pneumatically actuated and rated for a working pressure of 175 pounds per square inch. Valve shall be capable of being reset without opening the valve. Electrical solenoid valve used to actuate the water control valve shall be an integral component of the valve or shall be approved for use by the water control valve manufacturer. Solenoid valve shall be rated at 24 volts direct current, and shall be normally closed type that operates when energized. Solenoid valves shall be rated for a maximum pressure differential of 175 pounds per square inch. Preaction valve shall be equipped with a means to prevent the valve from returning to the closed position until being manually reset. Assembly shall be complete with the valve manufacturer's standard trim piping, drain and test valves, pressure gauges, and other required appurtenances.

2.4 ALARM INITIATING AND SUPERVISORY DEVICES

A. Sprinkler Waterflow Indicator Switch, Vane Type: Switch shall be vane type with a cast aluminum housing. The device shall sense water movements and be capable of detecting a sustained flow of 10 gallons per minute or greater. The device shall contain a retard device adjustable from 0 to 90 seconds to reduce the possibility of false alarms caused by transient flow surges. The switch shall be tamper resistant and contain two SPDT (Form C) contacts arranged to transfer upon removal of the housing cover, and shall be equipped with a silicone rubber gasket to assure positive water seal and a dustproof cover and gasket to seal the mechanism from dirt and moisture.

B. Valve Supervisory (Tamper) Switch: Switch shall be suitable for mounting to the type of control valve to be supervised open. The switch shall be tamper resistant and contain two sets of SPDT (Form C) contacts arranged to transfer upon removal of the housing cover or closure of the valve of more than two rotations of the valve stem.

C. High/Low-Air Pressure Supervisory Switch: Each preaction system shall be provided with an air pressure switch connected to the control panel. The pressure switch shall supervise the air pressure in the system and shall be set to activate at 10 psi above the dry pipe valve trip point pressure (low) and 10 psi above normal air pressure (high). The switch shall have an adjustable range between 5 and 80 psi. The switch shall have screw terminal connection and shall be capable of being wired for normally open or normally closed circuit.

2.5 SPRINKLERS

A. Sprinklers with internal O-rings shall not be used. Sprinklers shall be used in accordance with their listed coverage limitations. Extended coverage sprinklers shall not be used.

B. Areas with finished ceilings: Pendent sprinkler, recessed, quick-response, glass bulb, white finish (unless noted otherwise), ordinary temperature, minimum k-factor of 5.6. Pendent sprinklers shall be dry pendent or installed on return bends.

C. Areas without finished ceilings: Upright sprinkler, standard-response, glass bulb, brass finish, ordinary temperature, minimum k-factor of 5.6.
D. Sprinklers shall be of the same manufacturer and same temperature characteristics throughout any single room or area, but not necessarily throughout the entire building.

2.6 SUPERVISORY AIR SYSTEM

A. Air Compressor: Air compressor shall be single stage, oil-less type, air-cooled, electric motor driven, equipped with a check valve, centrifugal pressure and moisture unloader, pressure switch for automatic starting and stopping. A safety relief valve, set to operate at 65 pounds per square inch shall be provided. The compressor shall be sized to pressurize the system to its designed pressure within 30 minutes.

B. Air Pressure Maintenance Device: Device shall be a pressure regulator that automatically reduces supply air pressure to the minimum pressure required to be maintained in the piping system. The device shall have a cast bronze body and valve housing complete with diaphragm assembly, spring, filter, ball check to prevent backflow, 1/16-inch restriction to prevent rapid pressurization of the system, and adjustment screw. The device shall be capable of reducing maximum inlet pressure of 100 pounds per square inch into a fixed outlet pressure adjustable to 10 pounds per square inch.

C. High/Low-Air Pressure Switch: Each system shall be provided with a high/low-air pressure switch connected to the control panel.

2.7 BACKFLOW PREVENTION ASSEMBLY

A. [Reduced-pressure principle][Double-check] valve assembly backflow preventer complying with ASSE 1013, ASSE 1015 and AWWA M14. Each check valve shall have a drain. Backflow prevention assemblies shall have current "Certificate of Approval from the Foundation for Cross-Connection Control and Hydraulic Research, FCCCHR List" and be listed for fire protection use. Listing of the specific make, model, design, and size in the FCCCHR List shall be acceptable as the required documentation.

B. Backflow Preventer Test Connection: Test connection shall consist of a series of listed hose valves with 2 1/2-inch National Standard male hose threads with cap and chain. Provide one valve for each 250 gpm of system demand and provide enough valves to flow the total system design demand, including interior hose steam allowances, during the test. Provide a permanent sign that reads "TEST VALVES" immediately adjacent to these valves on the wall.

2.8 FIRE DEPARTMENT CONNECTION

A. Fire department connection shall be [freestanding][projecting][flush] type with cast brass body, matching [wall ]escutcheon lettered "Auto Spkr" with a polished brass or chromium-plated finish. The connection shall have individual self-closing clappers, caps with drip drains and chains. Female inlets shall have 2 1/2-inch diameter American National Fire Hose Connection Screw Threads (NH) per NFPA 1963 and comply with UL 405.

2.9 RELEASING CONTROL PANEL (RCP)

A. Panel shall be listed or approved for "releasing device service" or shall have modules approved for this purpose. The panel shall be capable of supporting independent detection and releasing zones. The panel shall be capable of putting one zone in maintenance mode without affecting operation of the other zones.

B. Primary Electric Power: Power shall be 120 VAC for the RCP from the normal AC service to the building in accordance with NFPA 72.
C. Provide for system operation in the event of primary power source failure. Transfer from normal to auxiliary (secondary) power or restoration from auxiliary to normal power shall be automatic and shall not cause transmission of a false alarm.

D. Batteries: Provide sealed, maintenance-free, lead-acid batteries as the source for emergency power to the RCP. Batteries shall contain suspended electrolyte. The battery system shall be maintained in a fully charged condition by means of a solid-state battery charger. Provide an automatic transfer switch to transfer the load to the batteries in the event of a failure of primary power. Upon return of building power, the system shall automatically retransfer thereto, and the batteries shall automatically recharge.

1. Capacity, Releasing System: Battery size shall have sufficient capacity to operate the releasing system under supervisory and trouble conditions, including audible trouble signal devices for 24 hours and audible and visual signal devices under alarm conditions for an additional [5][15] minutes.

2. Battery Power Calculations: Verify that battery capacity exceeds supervisory and alarm power requirements. Substantiate the battery calculations for alarm, alert, and supervisory power requirements. Include ampere-hour requirements for each system component and each panel component, and compliance with UL 864. Provide complete battery calculations for the alarm, alert, and supervisory power requirements. Include a 1.2 derating factor in all calculations.

3. For battery calculations use the following assumptions: Assume a starting voltage of 24 VDC for starting the calculations to size the batteries. Calculate the required amp-hours for the specified standby time, and then calculate the required amp-hours for the specified alarm time. Calculate the nominal battery voltage after operation on batteries for the specified time period.

E. Battery Chargers: Provide a solid state, fully automatic, variable charging rate battery charger. The charger shall be capable of providing 120 percent of the connected system load and shall maintain the batteries at full charge. In the event the batteries are fully discharged (20.4 VDC), the charger shall recharge the batteries back to 95 percent of full charge within 48 hours after a single discharge cycle as described in paragraph Capacity above. Provide a pilot light to indicate when batteries are manually placed on a high rate of charge as part of the unit assembly if a high rate switch is provided.

F. Maintenance Switch: Provide a supervised, keyed maintenance releasing bypass switch for each zone. Activation of switch shall physically interrupt the solenoid power and annunciate a supervisory condition at the panel.

2.10 COMBINATION FIXED TEMPERATURE AND RATE-OF-RISE HEAT DETECTORS

A. Provide heat detectors for detection of fire by combination fixed temperature and rate-of-rise principle. Heat detector spacing shall be rated in accordance with UL 521. Detectors shall be supported independently of wiring connections. Contacts shall be self-resetting after response to rate-of-rise principle. Under fixed temperature actuation, the detector shall have a permanent external indication which is readily visible. The UL 521 test rating for the fixed temperature portion shall be 135 degrees F. The UL 521 test rating for the rate-of-rise detectors shall be rated for 50 by 50 feet.

2.11 SMOKE DETECTORS

A. Photoelectric Smoke Detectors: Provide addressable photoelectric smoke detectors as follows:
1. Provide analog/addressable photoelectric smoke detectors utilizing the photoelectric light scattering principle for operation in accordance with UL 268. Smoke detectors shall be listed for use with the releasing control panel.

2. Provide self-restoring type detectors that do not require any re-adjustment after actuation at the RCP to restore them to normal operation.

3. Components shall be rust and corrosion resistant. Vibration shall have no effect on the detector’s operation. Protect the detection chamber with a fine mesh metallic screen that prevents the entrance of insects or airborne materials. The screen shall not inhibit the movement of smoke particles into the chamber.

4. Provide twist lock bases constructed of white, high impact polycarbonate designed for mounting on a standard 3 1/2-inch or 4-inch octagonal or 4-inch square outlet box for detectors. The detectors shall maintain contact with their bases without the use of springs. Provide companion mounting base with screw terminals for each conductor. Terminate field wiring on No. 12 AWG screw terminals. The detector shall have a visual indicator to show actuation. Insertion of an incorrect detector type into the base shall cause a "Wrong Device" trouble condition at the RCP until the proper type of detector is installed, or the system is reprogrammed. The system program shall recognize the insertion of a wrong device and shall automatically default to the set point values corresponding to the inserted device and shall monitor alarm and trouble conditions according to the default parameters.

5. Sounder bases shall produce a minimum of 90 dBA at 10 feet.

6. The detector address shall identify the particular unit, its location within the system, and its sensitivity setting. Detectors shall be of the low voltage type rated for use on a 24 VDC system.

7. An operator at the control panel, having the proper access level, shall have the capability to manually access the following information for each initiating device.
   a. Primary status.
   b. Device type.
   c. Present average value.
   d. Present sensitivity selected.
   e. Detector range (normal, dirty, etc.)

2.12 NOTIFICATION APPLIANCES

A. Notification appliances shall be suitable for connection to supervised notification appliance circuits. Appliance shall have a separate screw terminal for each conductor. The surface of the appliance shall be red in color.

B. Alarm Horn: [Surface-mounted][Recessed], [[single][double] projector,] grill,] vibrating type suitable for use in an electrically supervised circuit and shall have a sound output rating of at least 90 decibels at 10 feet.

2.13 WIRING

A. Provide wiring materials under this section as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM with the additions and modifications specified herein. NFPA 70 accepted fire alarm cables that do not require the use of raceways except as modified herein are permitted.

B. Alarm Wiring: The SLC wiring shall be solid copper cable in accordance with the manufacturers requirements. Copper signaling line circuits and initiating device circuit field wiring shall be No. 16
AWG size twisted and shielded solid conductors at a minimum. Notification appliance circuit conductors shall be solid copper No. 14 AWG size conductors at a minimum. Wire size shall be sufficient to prevent voltage drop problems. Circuits operating at 24 VDC shall not operate at less than the listed voltages for the detectors and/or appliances. Power wiring, operating at 120 VAC minimum, shall be a minimum No. 12 AWG solid copper having similar insulation. Acceptable power-limited cables are FPL, FPLR or FPLP as appropriate with red colored covering. Non-power-limited cables shall comply with NFPA 70.

2.14 LINE VOLTAGE SURGE PROTECTIVE DEVICES

A. Line voltage surge protective devices shall be provided to suppress all voltage transients which might damage fire alarm panel components. The surge protective device shall wire in series to the power supply of the protected equipment with screw terminations. Line voltage surge arrestor shall be installed directly adjacent to power panel where FACU breaker is located.

B. Line voltage surge protective devices for nominal 120 volt shall be UL 1449 listed with a maximum 500 volt suppression level and have a maximum response of 5 nanoseconds. The surge protective device shall also meet IEEE C62.41.1 and IEEE C62.41.2 category B tests for surge capacity. The surge protective device shall feature multi-stage construction and be provided with a long life indicator lamp (either light emitting diode or neon) which extinguishes upon failure of protected components. Any unit fusing shall be externally accessible.

C. Line voltage surge protective device for nominal 24 volt shall be UL 497B listed and have a maximum response time of 1 nanosecond. The surge protective device shall feature multi-stage construction and be self-resetting. Surge protective device shall be a base and plug style. Base assembly shall have screw terminals for fire alarm wiring. Base assembly shall accept "plug-in" surge protective module.

D. Line voltage surge protective devices for alarm telephone dialer shall be UL 497B listed and have a maximum response time of 1 nanosecond. The surge protective device shall feature multi-stage construction and be self-resetting. The base assembly shall have screw terminals for fire alarm devices. Base assembly shall accept a "plug-in" surge protective module.

E. All surge protective devices (SPD) shall be the standard product of a single manufacturer and be equal or better than the following:
   1. For 120 VAC nominal line voltage: DITEK DTK-120S20A series-connected, 20 A AC power SPD.
   2. For 24 volt nominal line voltage: DITEK DTK-24MHLP24WB series-connected, modular, 5A maximum current SPD.
   3. For alarm telephone dialers: DITEK DTK-MRJ31XSCPWP or approved equal.

2.15 ACCESSORIES

A. Sprinkler Cabinet: Spare sprinklers shall be provided in accordance with NFPA 13 and shall be packed in a suitable metal or plastic cabinet. Spare sprinklers shall be representative of, and in proportion to, the number of each type and temperature rating of the sprinklers installed. At least one wrench of each type required shall be provided.

B. Sprinkler Escutcheon: Sprinkler escutcheons shall be white finish unless otherwise noted. Escutcheons shall be either one-piece or split-pattern, held in place by internal spring tension or set screw.
C. Escutcheon Plates: Provide escutcheons for pipes passing through walls, partitions, and suspended ceilings. Escutcheons shall be steel, primed and finish painted to match the adjacent wall or ceiling finish.

D. Sprinkler Guard: Guards shall be a steel wire cage designed to encase the sprinkler and protect it from mechanical damage. Guards shall be provided on sprinklers subject to damage.

E. Identification Sign: Valve identification signs shall meet the following:

1. Furnish and install properly lettered and approved metal or plastic signs to each control valve, alarm device, inspector's test valve, drain valve, and alarm bypass valve. Each sign shall indicate the normal valve position as well as the portion of the system that the valve serves. Valve identification signs shall be minimum 6 inches wide x 2 inches high with enamel baked finish on minimum 18 gage steel or 0.024-inch aluminum with red letters on a white background or white letters on red background. Wording of sign shall include, but not be limited to "main drain", auxiliary drain", "inspector's test", "alarm test", "alarm line", and similar wording as required to identify operational components.

2. Permanently affix metallic hydraulic design data nameplates complying with NFPA 13 to the riser of each system. Hydraulic information shall be permanently engraved on the nameplate. The use of permanent marker only is not acceptable.

3. Provide a laminated 8.5-inch x 11-inch diagram, hung on each riser, showing the floor area protected by that riser.

2.16 SPECIALTY SPRINKLER FITTINGS

A. Listed, made of steel, ductile-iron, or other materials compatible with piping.

B. Drop-Nipple Fittings: Adjustable drop nipples are not permitted.

C. Mechanical-T Fittings: UL 213, ductile-iron housing with pressure-responsive gasket, bolts, and threaded or locking-lug outlet.

D. Mechanical-Cross Fittings: UL 213, ductile-iron housing with pressure-responsive gasket, bolts, and threaded or locking-lug outlets.

E. Sprinkler, Drain and Alarm/Inspector's Test Fittings: Cast-iron or ductile-iron body; with threaded inlet and outlet, test valve, and orifice and sight glass.

F. Sprinkler, Branch Line Test Fittings: Brass body; with threaded inlet and capped drain outlet and threaded outlet for sprinkler.

2.17 PRESSURE GAUGES

A. Pressure gauges shall be UL-listed (UL 393), 3 1/2-inch to 4 1/2-inch diameter dial with dial range of 0 to 250 pounds per square inch gauge.

PART 3 - EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. The installation shall be in accordance with the applicable provisions of NFPA 13, NFPA 24, NFPA 1963, NFPA 72 and publications referenced herein.
B. The Work Authorization must be prominently displayed at the job site before any work, to include demolition, can begin.

C. Upon completion of the work, a final inspection by the SRP Fire Marshal, and the satisfactory resolution of all issues identified by the Final Inspection, the SRP Fire Marshal shall sign and close out the Work Authorization which indicates acceptance of the permitted work.

3.2 UNDERGROUND PIPING INSTALLATION

A. The fire protection water main shall be laid, and joints anchored, in accordance with NFPA 24. Minimum depth of cover shall be 3 feet from the top of the pipe.

B. The supply line shall terminate inside the building with a flanged piece, the bottom of which shall be set not less than 6 inches above the finished floor. A blind flange shall be installed temporarily on top of the flanged piece to prevent the entrance of foreign matter into the supply line. A concrete thrust block shall be provided at the elbow where the pipe turns up toward the floor.

C. Joints shall be anchored in accordance with NFPA 24 using pipe clamps and steel rods from the elbow to the flange above the floor and from the elbow to a pipe clamp in the horizontal run of pipe.

D. Buried steel components shall be provided with a corrosion protective coating in accordance with AWWA C203. Piping more than 5 feet outside the building walls shall meet the requirements of [Section 33 11 00] WATER UTILITY DISTRIBUTION PIPING.

3.3 ABOVEGROUND PIPING INSTALLATION

A. Piping: Group piping at common elevations where practical. Route piping in an orderly manner, plumb and parallel to the building structure where practical and as indicated on the approved drawings.

B. Piping in Exposed Areas: Exposed piping shall be installed so as not to diminish exit access widths, corridors, or equipment access. Exposed horizontal piping, including drain piping, shall be installed to provide maximum headroom.

C. Fittings: Use approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes. Install unions adjacent to each valve in pipes 2 inches and smaller. Unions are not required on flanged devices or in piping installations using grooved joints. Install flanges or flange adapters on non-grooved valves, apparatus, and equipment having 2 1/2-inch and larger connections.

D. Pendent Sprinklers: Drop nipples to pendent sprinklers shall consist of minimum 1-inch pipe with a reducing coupling into which the sprinkler shall be threaded. Where sprinklers are installed below suspended or dropped ceilings, drop nipples shall be cut such that sprinkler ceiling plates or escutcheons are of a uniform depth throughout the finished spaces. The outlet of the reducing coupling shall not extend more than 1-inch below the underside of the ceiling. On pendent sprinklers installed below suspended or dropped ceilings, the distance from the sprinkler deflector to the underside of the ceiling shall not exceed 4 inches. Recessed pendent sprinklers shall be installed such that the distance from the sprinkler deflector to the underside of the ceiling shall not exceed the manufacturer’s listed range and shall be of uniform depth throughout the finished area.

1. All sprinklers in suspended ceilings shall be center of tile (+/- 2 inches).
E. Upright Sprinklers: Riser nipples or "sprigs" to upright sprinklers shall contain no fittings between the branch line tee and the reducing coupling at the sprinkler. Riser nipples exceeding 30 inches in length shall be individually supported.

F. Install specialty sprinkler fittings according to manufacturer’s written instructions.

G. Pipe Joints: Pipe joints shall conform to NFPA 13, except as modified herein. Not more than four threads shall show after joint is made up. Welded joints shall be permitted, only if welding operations are performed as required by NFPA 13 at the contractor’s fabrication shop, not at the project construction site. Flanged joints shall be provided where indicated or required by NFPA 13. Grooved pipe and fittings shall be prepared in accordance with the manufacturer’s latest published specification according to pipe material, wall thickness and size. Grooved couplings, fittings, and grooving tools shall be products of the same manufacturer. The diameter of grooves made in the field shall be measured using a "go/no-go" gauge, vernier or dial caliper, narrow-land micrometer, or other method specifically approved by the coupling manufacturer for the intended application. Groove width and dimension of groove from end of pipe shall be measured and recorded for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances. Grooved joints shall not be used to conceal locations, such as behind solid walls or ceilings, unless an access panel is shown on the drawings for servicing or adjusting the joint.

H. Reducers: Reductions in pipe sizes shall be made with one-piece tapered reducing fittings. The use of grooved-end or rubber-gasketed reducing couplings will not be permitted. When standard fittings of the required size are not manufactured, single bushings of the face type will be permitted. Where used, face bushings shall be installed with the outer face flush with the face of the fitting opening being reduced. Bushings shall not be used in elbow fittings, in more than one outlet of a tee, in more than two outlets of a cross, or where the reduction in size is less than 1/2-inch.

I. Pipe Penetrations: Cutting structural members for passage of pipes for pipe-hanger fastenings will not be permitted. Pipes that must penetrate concrete or masonry walls or concrete floors shall be core-drilled and provided with pipe sleeves. Each sleeve shall be Schedule 40 galvanized steel, ductile-iron or cast-iron pipe and shall extend through its respective wall or floor and be cut flush with each wall surface. Sleeves shall provide required clearance between the pipe and the sleeve per NFPA 13. The space between the sleeve and the pipe shall be firmly packed with mineral wool insulation. Where pipes penetrate fire walls, fire partitions, or floors, pipes shall be firestopped with a listed or approved through-penetration firestopping assembly. In penetrations that are not fire-rated or not a floor penetration, the space between the sleeve and the pipe shall be sealed at both ends with plastic waterproof cement that will dry to a firm but pliable mass or with a mechanically adjustable segmented elastomer seal.

J. Escutcheons: Escutcheons shall be provided for pipe penetration of ceilings and walls. Escutcheons shall be securely fastened to the pipe at surfaces through which piping passes.

K. Inspector’s Test Connection: Unless otherwise indicated, test connection shall consist of 1-inch pipe; a test valve located approximately 7 feet above the floor; a sight glass assembly; a smooth bore brass outlet equivalent to the smallest orifice sprinkler used in the system; and a painted metal identification sign affixed to the valve with the words "Inspector’s Test". The discharge orifice shall be located outside the building wall directed so as not to cause damage to adjacent construction or landscaping during full flow discharge. Concrete splash blocks shall be provided.

L. Drains: Main drain piping shall be provided to discharge at a safe point outside the building. Auxiliary drains shall be provided as required by NFPA 13. Concrete splash blocks shall be provided.

M. Hangers and Supports: Comply with NFPA 13 for hanger materials and installation.
N. Sway Brace Protection: Install piping according to NFPA 13 to protect from building sway damage.

O. Air Supply Piping System: Each preaction system shall be equipped with a separate pressure maintenance device, shutoff valve, bypass valve and pressure gauge. Piping shall be galvanized steel in accordance with ASTM A795 or ASTM A53.

P. Identification Signs: Signs shall be affixed to each control valve, inspector test valve, main drain, auxiliary drain, test valve, and similar valves as appropriate or as required by NFPA 13. Hydraulic design data nameplates shall be permanently marked and permanently affixed to each sprinkler riser as specified in NFPA 13.

3.4 LABELING AND IDENTIFICATION

A. Manufacturers pipe labeling shall be visible.

B. Identify all bulk feed, cross mains, primary and secondary mains at maximum 20-foot intervals with red stenciled or adhesive pipe labels, readable from floor level.

3.5 ELECTRICAL WORK

A. Overcurrent and Surge Protection: All equipment connected to alternating current circuits shall be protected from surges in accordance with IEEE C62.41.1, IEEE C62.41.2, and NFPA 70. Cables and conductors that serve as communications links, except fiber optics, shall have surge protection circuits installed at each end. Fuses shall not be used for surge protection.

B. Grounding: Grounding shall be provided to building ground.

C. Wiring: System field wiring shall be installed in 3/4-inch minimum diameter electrical metallic tubing or metallic conduit. Wiring for the sprinkler system fire detection and control system shall be installed in tubing or conduits dedicated for that use only and not installed in conduit, outlet boxes or junction boxes which contain lighting and power wiring or equipment. Circuit conductors entering or leaving any mounting box, outlet box enclosure or cabinet shall be connected to screw terminals with each terminal marked and labeled in accordance with the wiring diagram. No more than one conductor shall be installed under any screw terminal. Connections and splices shall be made using screw terminal blocks. The use of wire nut type connectors is not permitted. Wiring within any control equipment shall be readily accessible without removing any component parts. Conductors shall be color-coded and shall be identified within each enclosure where a connection or termination is made. Conductor identification shall be by plastic-coated, self-sticking, printed markers or by heat-shrink type sleeves. Circuits shall be wired to maintain electrical supervision so that removal of any single wire from any device shall cause a "trouble" condition on the control panel.

D. Control Panel: The control panel and its assorted components shall be mounted so that no part of the enclosing cabinet is less than 24 inches and not more than 78 inches above the finished floor.

E. Conductor Terminations: Labeling of conductors at terminal blocks in terminal cabinets and control panel shall be provided at each conductor connection. Each conductor or cable shall have a shrink-wrap label to provide a unique and specific designation. Each terminal cabinet and control panel shall contain a laminated drawing that indicates each conductor, its label, circuit, and terminal. The laminated drawing shall be neat, using 12-point lettering minimum size, and mounted within each cabinet, panel, or unit so that it does not interfere with the wiring or terminals. Maintain existing color scheme where connecting to existing equipment.
F. Releasing Control Panel (RCP): Locate the RCP where indicated on the drawings. Semi-recess the enclosure with the top of the cabinet 6 feet above the finished floor or center the cabinet at [5][___] feet, whichever is lower.

G. Smoke and Heat Detectors: Locate detectors [as required by NFPA 72 and their listings][as indicated] on a 4-inch mounting box. Locate smoke and heat detectors on the ceiling. Install heat detectors not less than 4 inches from a side wall to the near edge. Heat detectors located on the wall shall have the top of the detector at least 4 inches below the ceiling, but not more than 12 inches below the ceiling. Smoke detectors are permitted to be on the wall no lower than 12 inches from the ceiling with no minimum distance from the ceiling. Install smoke detectors no closer than 5 feet from air handling supply outlets.

H. Manual Stations: Locate manual stations as required by NFPA 72 shall be mounted so that their operating handles are 4 feet above the finished floor. Mount stations so they are no farther than 5 feet from the exit door they serve, measured horizontally.

I. Notification Appliance Devices: Locate notification appliance devices as required by NFPA 72 where indicated. Mount assemblies on walls as required by NFPA 72 and to meet the intelligibility requirements.

3.6 PROTECTIVE PAINTING

A. Provide protective painting as herein specified.

1. Metal surfaces shall first be thoroughly wire brushed and cleaned of all dirt, rust, grease, or other foreign matter before priming coat is applied.

2. Paint all sprinkler piping exposed to view, except stainless steel piping, red.

B. Clean up all equipment and leave in condition for finish painting before acceptance.

C. Provide a heavy field coat of black asphaltum paint on all steel pipe, cradles, vibration isolating mounts, and the like, that will be encased or partially encased in building construction, set in cement or fill, before items are built into the general construction.

1. All equipment where the surface is not factory finished shall be fully painted with one priming coat and two finishing coats of oil paint and finished with one coat of spar varnish.

3.7 PRELIMINARY TESTS

A. The system, including the underground water mains, and the aboveground piping and system components, shall be tested to assure that equipment and components function as intended. The underground and aboveground interior piping systems and attached appurtenances subjected to system working pressure shall be tested in accordance with NFPA 13 and NFPA 24. Upon completion of specified tests, complete certificates as specified in paragraph SUBMITTALS.

B. Experienced technicians regularly employed by the contractor in the installation of the system and manufacturer’s representative referred to elsewhere in this section shall conduct the testing.

C. Underground Piping.

1. Flushing: Underground piping shall be flushed in accordance with NFPA 24. This includes the requirement to flush the lead-in connection to the fire protection system at a flow rate not less than the calculated maximum water demand rate of the system.
2. Hydrostatic Test: New underground piping shall be hydrostatically tested in accordance with NFPA 24. The allowable leakage shall be measured at the specified test pressure by pumping from a calibrated container. The amount of leakage at the joints shall not exceed 1.89 L² quarts per hour per 100 gaskets or joints, regardless of pipe diameter.

D. Aboveground Piping.

1. Hydrostatic Test: Aboveground piping shall be hydrostatically tested in accordance with NFPA 13 at not less than 1400 kPa200 psi or 350 kPa50 psi in excess of maximum system operating pressure and shall maintain that pressure without loss for 2 hours. There shall be no drop in gauge pressure or visible leakage when the system is subjected to the hydrostatic test. The test pressure shall be read from a gauge located at the low elevation point of the system or portion being tested.

2. Backflow Preventer Full Forward Flow Test: Each backflow prevention assembly shall be tested at system flow demand, including all applicable hose steams, as specified in NFPA 13. Provide all equipment and instruments necessary to conduct a complete forward flow test, including 2.5-inch diameter hoses, playpipe nozzles, calibrated pressure gauges, pitot tube gauge, plus all necessary supports to safely secure hoses and nozzles during the test. At the system demand flow, the pressure readings and pressure drop (friction) across the assembly shall be recorded. Provide a metal placard on the backflow prevention assembly that lists the pressure readings both upstream and downstream of the assembly, total pressure drop, and the system test flow rate. The pressure drop shall be compared to the manufacturer’s data.

3. Alarm Devices: Each alarm switch shall be tested by flowing water through the inspector’s test connection. Each water-operated alarm device shall be tested to verify proper operation.

4. Main Drain Flow Test: Following flushing of the underground piping, a main drain test shall be made to verify the adequacy of the water supply. Static and residual pressures shall be recorded on the certificate specified in paragraph SUBMITTALS. In addition, a main drain test shall be conducted each time after a main control valve is shut and opened.

E. Air Pressure Test: As specified in NFPA 13, an air pressure leakage test at 350 kPa50 psi shall be conducted for 24 hours. There shall be no drop in gauge pressure in excess of 10 kPa1.5 psi for the 24 hours. This air pressure test is in addition to the required hydrostatic test.

F. Detection and Control Panel Tests: Conduct preliminary tests to ensure that devices and circuits are functioning properly. Tests shall meet the requirements of paragraph entitled "Minimum System Tests". After preliminary testing is complete, provide a letter certifying that the installation is complete and fully operable. The letter shall state that each initiating and indicating device was tested in place and operated properly. The letter shall also state that panel functions were tested and operated properly. The letter shall include the names and titles of the witnesses to the preliminary tests. The contractor and an authorized representative from each supplier of equipment shall be in attendance at the preliminary testing to make necessary adjustments.

G. Minimum System Tests: Test the system in accordance with the test procedures in NFPA 72. The required tests are as follows:

1. Loop Resistance Tests: Measure and record the resistance of each circuit with each pair of conductors in the circuit short-circuited at the farthest point from the circuit origin. The test shall be witnessed by SRP and test results recorded for use at the final acceptance test.

2. Verify the absence of unwanted voltages between circuit conductors and ground. The tests shall be accomplished at the preliminary test with results available at the final system test.
3. Verify that the control unit is in the normal condition as detailed in the manufacturer's O&M manual.

4. Test each initiating device and notification appliance and circuit for proper operation and response at the control unit. Detectors shall be tested in accordance with manufacturer’s recommended calibration test method. Use of magnets is prohibited. At least 20 percent of devices shall be disconnected and tested for circuit supervision. If there is a failure at these devices, then supervision shall be tested at each device.

5. Test the system for specified functions in accordance with the contract drawings and specification and the manufacturer's O&M manual.

6. Test both primary power and secondary power. Verify, by test, the secondary power system is capable of operating the system for the time period and in the manner specified.

7. Determine that the system is operable under trouble conditions as specified.

8. Visually inspect wiring.

9. Test the battery charger and batteries.

10. Verify that red-line drawings are accurate.

11. Measure the current in circuits to ensure there is the calculated spare capacity for the circuits.

12. Measure voltage readings for circuits to ensure that voltage drop is not excessive.

13. Disconnect the verification feature for smoke detectors during tests to minimize the amount of smoke needed to activate the detectors. Testing of smoke detectors shall be conducted using real smoke or the use of canned smoke which is permitted.

14. Measure the voltage drop at the most remote appliance (based on wire length) on each notification appliance circuit.

3.8 FINAL TEST

A. The system will be considered ready for acceptance testing only after the following have been accomplished:

1. Preliminary tests have been made and deficiencies corrected.

2. Testing reports have been submitted and approved.

B. Final acceptance testing shall be coordinated and performed by the contractor, in the presence of SRP. In order to assure attendance of the necessary representatives, each representative scheduled to witness the test shall be provided a minimum of 5 working days’ notification of the proposed test date by the contractor. The test shall not be conducted until all parties agree on the scheduled test date. The contractor shall provide all the necessary personnel and equipment to conduct the tests.

C. The final acceptance test shall be a repeat of preliminary tests and shall include operation of control valves and flowing of inspector’s test connections to verify operation of associated waterflow alarm switches. After operation of control valves has been completed, the main drain test shall be repeated to assure that control valves are in the open position. In addition, the contractor shall have available copies of as-built drawings and certificates of tests previously conducted. The installation shall not
be considered accepted until identified discrepancies have been corrected and test documentation is properly completed and received. The contractor shall correct system failures and other deficiencies identified during testing and shall retest portions of the system affected by the required corrections.

D. If the Final Acceptance Test fails, the contractor shall pay all costs incurred to SRP for any and all retesting.

E. Upon satisfactory completion of the tests, the contractor shall leave the system in proper working order.

F. Warranty: Except as otherwise expressly provided in the contract documents, and excepting only items of routine maintenance, ordinary wear and tear or unusual abuse or neglect, contractor guarantees all work executed by the contractor and all supplies, materials, and devices of whatsoever nature incorporated in, or attached with the work, or otherwise delivered to SRP as part of the work pursuant to the contract to be absolutely free of all defects of workmanship and materials for a period of 2 years after final acceptance of the work by SRP. Include service directory with telephone numbers for 24-hour emergency service.

3.9 TRAINING

A. Instructor: Include in the project the services of an instructor, who has received specific training from the manufacturer for the training of other persons regarding the inspection, testing, and maintenance of the system provided. The instructor shall train the employees designated by SRP, in the care, adjustment, maintenance, and operation of the fire sprinkler system. Each instructor shall be thoroughly familiar with all parts of this installation. The instructor shall be trained in operating theory as well as in practical O&M work. Submit the instructor's information and qualifications including training history to SRP prior to training.

B. Required Instruction Time: Provide [4][8] hours of instruction after final acceptance of the system. The instruction shall be given during regular working hours on such dates and times as selected by SRP. The instruction may be divided into two or more periods at the discretion of SRP. The training shall allow for rescheduling for unforeseen maintenance and/or fire department responses.

END OF SECTION
SECTION 21 2200

NOVEC 1230 FIRE EXTINGUISHING SYSTEM

PART 1 - GENERAL

1.1 REFERENCES

A. The publications listed below form a part of this specification section to the extent referenced. The publications are referred to within the text by the basic designation only. Use the latest edition, unless noted otherwise.

B. AMERICAN NATIONAL STANDARDS INSTITUTE
   1. ANSI B1.20.1 Standard for Pipe Threads, General Purpose

C. ASTM INTERNATIONAL (ASTM)

D. FM GLOBAL (FM)
   2. FM-5600 Approved Guide for Clean Agent Extinguishing System

E. INTERNATIONAL CODE COUNCIL
   3. [IMC (2012) International Mechanical Code]

F. MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

G. NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

H. SRP Codes
   1. SRP AFC SRP Administrative Fire Code
I. UNDERWRITERS LABORATORIES (UL)

1. UL 268  Smoke Detectors for Fire Protective Signaling Systems
2. UL 521  Heat Detectors for Fire Protective Signaling Systems
3. UL 668  Hose Valves for Fire Protection Service
4. UL 864  Standard for Safety for Control Units and Accessories for Fire Alarm Systems
5. UL 2166 Standard for Halocarbon Clean Agent Extinguishing System Units

1.2 NOTICE TO BIDDERS

A. Before submittal of bid, examine all drawings, specification, addenda, alternatives, special conditions, and all other bidding documents of all sections of this project, verifying all governing conditions at the site, and become fully informed as to the extent and character of the work required, as well as its relation to other work in the building. Submittal of a bid is an agreement to all requirements of the contract documents and no consideration will be granted for any claimed misunderstanding thereof.

B. Submittal of a bid is deemed a representation by the bidder that he is qualified in all respects to properly perform the work for which he is bidding and has experience with similar work. Bidders are deemed to be aware, on the basis of their background and experience, of materials which may be required in the discharge of their responsibilities, even though unspecified.

C. Any case of error, omission, discrepancy, inconsistency or lack of clarity in the specification or drawings shall be promptly identified to SRP.

1.3 DESCRIPTION OF WORK

A. Provide an approved high-pressure total flooding Novec 1230 fire extinguishing system conforming to NFPA 2001. The system shall be complete in all ways. It shall include all mechanical and electrical installation, all detection and control equipment, agent storage containers, agent, discharge nozzles, pipe and fittings, manual release and abort stations, audible and visual alarm devices, auxiliary devices and controls, shutdowns, alarm interface, caution/advisory signs, functional checkout and testing, training and all other operations necessary for a functional clean agent extinguishing system. Design discharge nozzles to uniformly distribute the clean agent throughout the hazard area. Arrange system for fully automatic and manually operated electronic control operation, with operating controls of the enclosed release type to prevent accidental operation. Discharge nozzles shall be provided, within the manufacturer's guidelines, to distribute the clean agent unobstructed throughout the protected space. The installed nozzles shall be designed to provide the proper clean agent quantity and distribution. Provide manual release stations, dead-man style abort stations and keyed override. Provide material and equipment that are listed. Each protected area shall have audible and visible notification appliances with separate and distinct audible and visual pre-discharge and discharge signals. The discharge signals shall be distinct from those used by the building fire evacuation system.

B. The design shall include fluid storage capacity to provide a single discharge to each zone. Each protected area shall have its own agent storage container and piping. One common control panel may control all systems individually. Each system shall include all materials, accessories and equipment inside and outside the building necessary to provide each system complete and ready for use.

C. Design and install each system to give full consideration to built-in spaces, piping, electrical equipment, ductwork and all other construction and equipment and to be free from operating and maintenance difficulties.
D. Design the total flooding system to a minimum concentration (by volume) of 4.5 percent for Class A fires, 5.9 percent for Class B fires, and 4.7 percent for Class C fires for 10 minutes. System design shall not exceed 10.0 percent for normally occupied spaces, adjusted for maximum space temperature anticipated, with provisions for room evacuation before agent release. Concentration shall be based upon shutting down the heating, ventilation and air conditioning (HVAC) systems at the time of agent discharge. The maximum liquid discharge time shall be 10 seconds.

E. The contractor shall be responsible for sealing and securing the protected space against agent loss and/or leakage during the 10-minute "hold" period.

F. Performance Requirements: Provide construction type, test, and mark of high-pressure cylinders in accordance with US Department of Transportation (USDOT) specifications for seamless steel cylinders. Each cylinder is to be provided with a safety device to relieve excess pressure safely, in advance of the rated cylinder test pressure. Devices are to be Interstate Commerce Commission approved frangible safety disks. Provide cylinder support racks that anchor to walls and floors.

G. Main System: Arrange system for fully automatic and manually operated electric control operation, with operating controls of the enclosed release type to prevent accidental operation. Also provide for manual release stations, dead-man style abort stations and keyed override operations as indicated on the drawings.

H. Clean Agent Recharging Station: The installing contractor shall maintain, or have access to, a clean agent recharging station. The installing contractor shall provide proof of his ability to recharge the system with clean agent within 24 hours of notification.

I. Reserve Cylinders: If requested by the SRP Fire Marshal, provide and install a connected reserve cylinder bank supply.

J. Work also included, but is not limited to the following:

1. Installation of required pressure gauges, signs to identify all valves, interconnection to the fire alarm control unit (releasing panel), hangers, and audible and visible notification appliances. Any necessary core drilling through concrete or masonry floors or walls, with approval of SRP and or a structural engineer. Firestopping of all extinguishing system piping and conduit penetrations through fire-rated walls, partitions, and floor-ceiling assemblies. Through-penetration firestop details, including Underwriter’s Laboratories reference number, shall be shown on the shop drawings.

2. The contractor shall verify Novec 1230 supply information for those systems that are reconnected, refurbished, or expanded to comply with the applicable Codes and Standards.

K. It is the contractor’s responsibility to consult other specification sections, determine the extent and character of related work, and properly coordinate work specified herein with that specified elsewhere to produce a complete operational installation.

L. The work shall meet IBC and IFC requirements, SRP requirements and includes all labor, materials, tools, equipment, transportation, and temporary construction necessary to design, fabricate, install and test complete Novec 1230 fire extinguishing systems specified hereinafter.

1.4 SYSTEM SEQUENCE

A. [Automatic operation of each protected area with spot-type detection shall be as follows:

1. Actuation of one detector, within the system, shall:
a. Activate the "ALARM" indicator lamp on the releasing control panel (RCP).
b. Energize the alarm audible and visible notification device located in the hazard area for evacuation of the protected area.
c. Operate door holder/closures on access doors.
d. Transmit an alarm signal to the main fire alarm control unit (FACU).
e. Activate the building fire alarm system.
f. [Activate an individual visible indicator for that device on the graphic annunciator.]

2. Actuation of a second detector, within the system, shall:
   a. Activate the "PRE-DISCHARGE" indicator on the RCP.
   b. Energize the pre-discharge audible and visible notification device located in the hazard area.
   c. Shut down the HVAC system and close smoke dampers.
   d. Start time delay sequence (not to exceed 60 seconds).
   e. System abort sequence is enabled at this time.
   f. [Shunt power to protected equipment.]
   g. [Light an individual lamp for that device on the graphic annunciator.]

B. Automatic operation of each protected area with air-aspirating smoke detection shall be as follows:

1. Actuation of Alarm Level 1 (Alert) within the system shall:
   a. Activate the "ALERT" indicator lamp on the air-aspirating smoke detection control panel.
   b. Transmit a supervisory signal to the [main fire alarm control unit (FACU)][releasing control panel (RCP)].

2. Actuation of Alarm Level 2 (Action) within the system shall:
   a. Activate the "Alarm" indicator lamp on the releasing control panel (RCP).
   b. Energize the alarm audible and visible notification device located in the hazard area for evacuation of the protected area.
   c. Operate door holder/closures on access doors.
   d. Transmit an alarm signal to the main fire alarm control unit (FACU).
   e. Activate the building fire alarm system.
   f. [Activate an individual visible indicator for that device on the graphic annunciator.]

3. Actuation of Alarm Level 3 (Fire 1) within the system shall:
   a. Activate the "PRE-DISCHARGE" indicator on the RCP.
   b. Energize the pre-discharge audible and visible notification device located in the hazard area.
   c. Shut down the HVAC system and/or close smoke dampers.
   d. Start time-delay sequence (not to exceed 60 seconds).
   e. System abort sequence is enabled at this time.
   f. Shunt power to protected equipment.
   g. Light an individual lamp for that device on the graphic annunciator.

C. After completion of the time-delay sequence, the clean agent fire extinguishing system shall activate and the following shall occur:

1. Activate the "RELEASE" indicator on the RCP.
2. Energize the visible notification device(s) outside the hazard area in which the discharge occurred.
3. [Energize the "System Release" audible device.]
4. Transmit a system release signal to the FACP.
D. The system shall be capable of being actuated by manual release stations located at each hazard exit. Operation of a manual release station shall duplicate the sequence description above except that the time delay and abort functions SHALL be bypassed. The manual release station shall be of the double-action, electrical actuation type and shall be supervised at the RCP.

1.5 SUBMITTALS

A. Submit installation drawings for Novec 1230 extinguishing system in accordance with the contract drawings, specification and applicable standards. Approval by SRP is required prior to installation.

B. Shop Drawings: Provide six copies of the shop drawings, no later than 21 days prior to the start of system installation. Detail drawings conforming to the requirements for "Plans" as prescribed in NFPA 2001; drawings shall be 34 x 22 inches. Drawings shall include plan and elevation views which establish that the equipment will fit the allotted spaces with clearance for installation and maintenance. Annotate system piping layout with reference points for design. In field wiring diagrams, show locations of devices and points of the system. Include data essential to the proper installation of each system. Integrate with alarm and detection system specified. Each set of drawings shall include the following:

1. A descriptive index with drawings listed in sequence by number. A legend sheet identifying device symbols, nomenclature, and conventions used in the package.

2. Floor plans drawn to a scale not less than 1/8-inch equals 1-foot clearly showing locations of devices, equipment, risers, electrical power connections and other details required to clearly describe the proposed arrangement.

3. Riser layout drawings drawn to a scale of not less than 1/2-inch equals 1-foot to show details of each system component, clearances between each other and from other equipment and construction in the room.

4. Include details of equipment layout and design, including wire counts and approximate location of conduit. Indicate the general physical layout of all controls, manual release station[s], detectors, abort stations, and wiring details. Show isometric details of agent storage containers, mounting details and proposed pipe runs and sizes. Electrical layout drawings shall show the location of all devices and include point-to-point conduit runs and a description of the method(s) used for detector mounting. Provide an internal control panel wiring diagram which shall include power supply requirements and field wiring termination points.

5. Give full consideration to built-in spaces, piping, electrical equipment, ductwork, and all other construction and equipment for the layout of the system.

6. A complete sequence of operation shall be submitted detailing all alarm devices, shutdown functions, remote signaling, damper operation, time delay and agent discharge for each zone or system.

7. Details of each type of pipe hanger and related components.

8. Shop drawings and calculations shall be prepared by a qualified NICET Level III (or IV) Technician.

9. Provide electronic drawings in AutoCAD dwg format. Use standard AutoCAD fonts and line styles and furnish the pcp file.
C. Calculations: Submit Novec 1230 discharge calculations verifying total storage requirements, flooding concentrations, discharge times, flow through the piping network, pipe sizes, and nozzle orifice sizes, in accordance with the manufacturer's listed design manual and NFPA 2001.

D. Product Data: Submit product data for all equipment to be used, including but not limited to high-pressure cylinders, piping materials, pipe hangers and supports, pressure alarm switch, nozzle, manual release stations, abort stations, escutcheons, storage batteries, battery charger, smoke detectors, audible alarms, visual alarms, releasing control panel.

E. Battery Calculations: Submit battery calculations for the battery stand-by power supply taking into consideration the power requirements of all alarms, initiating devices and auxiliary components under full load conditions.

F. Test Procedures: Submit proposed procedures for preliminary tests, no later than 14 days prior to the proposed start of the tests and proposed date and time to begin the preliminary tests.

G. Preliminary Test Report: Provide three copies of the completed preliminary test report, no later than 7 days after the completion of the preliminary tests. The preliminary test report shall be as outlined in NFPA 2001.

H. Final Acceptance Test report: Provide three copies of the completed final acceptance test reports, no later than 7 days after the completion of the final acceptance tests. Final acceptance test reports shall be as outlined in NFPA 2001.

I. Installer’s Qualifications: Data approved prior to submittal of any other data or drawings, to substantiate that the proposed installer is regularly engaged in the installation of the type and complexity of fire protection system included in this project. Data shall identify the location of three systems recently installed by the proposed installer which are comparable to the system specified. Contractor shall certify that each system has performed satisfactorily, in the manner intended, for a period of not less than 6 months. Submit copy of license to perform work in the local jurisdiction.

J. As-Built Drawings: In addition to six hard copies, furnish one set of CD or DVD discs containing software back-up and CAD based drawings in the latest version of AutoCAD and DXF format and pdf copy of as-built drawings and schematics. A separate set of approved submittal drawings of the overall system, marked up to indicate as-built conditions, shall be maintained on-site. These drawings shall be maintained in a current condition at all times and shall be made available for review immediately upon request during normal working hours. Variations from the approved drawings, for whatever reason, including those occasioned by modifications, change orders, optional materials, and/or required for coordination between trades shall be indicated in sufficient detail to accurately reflect the as-built conditions. Submit a complete set of as-built (record) working drawings including complete as-built circuit diagrams of each clean agent system for record purposes within 14 calendar days after the final acceptance test of the system. At least two sets of as-built (marked-up) drawings shall be provided to SRP at the time of, or prior to the final acceptance test.

K. Operation and Maintenance Data: Six manuals in loose-leaf binder format and grouped by technical sections consisting of manufacturer’s brochures, schematics, printed instructions, general operating procedures, and safety precautions. Manuals shall be submitted and approved prior to on-site training. In addition to the items specified in Division 01 Section 01723 "Operation and Maintenance Data", the Manual shall include a narrative description of the sequence or sequences of operation of the overall fire protection system and a separate description of each major subsystem. Information to be provided shall include specific open/close settings for all adjustable valves. The manuals shall list routine maintenance procedures, possible breakdowns, and repairs, and troubleshooting guide. The manual shall include system piping layout, conduit layout, equipment layout, and simplified wiring and control diagrams for the system as installed. The manual shall include procedures and
instructions pertaining to frequency of preventive maintenance, inspection, adjustment, lubrication and cleaning necessary to minimize corrective maintenance and repair.

L. Training Documentation: Provide in manual format, lesson plans, operating instructions, maintenance procedures, and training data for the training courses. The operations training shall familiarize SRP’s designated personnel with proper operation of the installed system. The maintenance training course shall provide SRP’s designated personnel adequate knowledge required to diagnose, repair, maintain, and expand functions inherent to the system.

M. Schedule: Provide a schedule indicating the delivery dates of the equipment to be supplied; installation sequence; time frame, and the total amount of on-site technical assistance (in ma-hours per phase) that the supplier of the equipment has included in their bid to comply with the requirements of this specification section and SRP’s requirements; and final acceptance test dates to meet SRP’s scheduled project completion dates.

N. Preliminary Equipment List: Provide a preliminary Equipment List identifying the type, quantity, make, and model number of each piece of equipment to be provided under this submittal. The Equipment List shall include the type, quantity, make and model of spare equipment. Types and quantities of equipment submitted shall coincide with the types and quantities of equipment used in the battery calculations and those shown on the shop drawings. A final Equipment List shall be submitted with the Operating and Maintenance (O&M) manual.

O. In the event that the contractor’s submittal package is required to be revised and resubmitted due to nonconformance with this specification section, illegibility of the submittal, incomplete submittals, noncompliance with the referenced local, state and national Codes, Standards and Regulations or nonconformance with pertinent documentation relative to the project, the Contractor shall pay all fees associated with the additional submittal review. Payment of the fee shall be solely the contractor’s responsibility.

1.6 QUALITY ASSURANCE

A. The recommended practices stated in the manufacturer’s literature or documentation shall be considered as mandatory requirements.

B. Qualifications - Contractor: The contractor shall be an approved distributor/installer for Novec 1230 fire extinguishing systems and be an Arizona licensed contractor in possession of a valid special hazard extinguishing systems contractor’s license. The design and installation must be performed by a qualified contractor whose business is located within a 75-mile radius of the project site. The contractor shall have a minimum of 5 years of experience in the installation of special hazards systems in similar facilities.

C. Qualifications – Special Hazard System Design Services: Shop (working) drawings and calculations shall be prepared under the direction of and signed by a qualified registered Professional Engineer or a NICET Level III in special hazard systems. For the purposes of meeting this requirement, a qualified engineer is defined as an individual meeting one of the following conditions:

1. A registered professional engineer having passed the NCEES examination in fire protection engineering.

2. Registered professional engineer with verification of experience and at least 5 years of current experience in the design of the fire protection and detection systems.

D. Qualifications - Installer: A NICET Level III (minimum) in special hazards systems shall supervise the installation of the fire extinguishing system.
E. Qualifications – Releasing System Installer: Releasing system installer with a minimum of 2 years of experience shall be permitted to assist in the installation of releasing system devices, cabinets and panels. An electrician shall be permitted to install wire, cable, conduit and backboxes for the releasing system.

F. Qualifications - Test Personnel: Special hazards system technicians with a minimum of 8 years of experience shall be utilized to test and certify the installation of the fire extinguishing system. The special hazards system technicians testing the equipment shall be factory-trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

1.7 REGULATORY REQUIREMENTS

A. All system components shall be listed or approved for their intended use and shall be compatible with the system and its components. Where the terms "listed" or "approved" appear in this specification section, they shall mean UL-listed (UL Fire Prot Dir), FM-approved (FM App Guide), or listed by a nationally recognized testing laboratory (NRTL). The omission of these terms under the description of any item of equipment described shall not be construed as waiving the requirement for listing or approval. All listings or approvals shall be based on an existing ANSI or UL published standard.

B. Compliance with NFPA standards is mandatory. In the event of a conflict between specific provisions of this specification section and applicable standards, this specification section shall govern. Reference to "authority having jurisdiction" shall be interpreted to mean SRP or SRP’s Representative.

C. The fire protection installer and the contractor shall comply fully with all city, county and state laws, ordinances and regulations applicable to fire protection installations.

D. Should any change in plans or specification be required to comply with governmental regulations, the contractor shall notify the Engineer at the time of submitting his bid.

E. A Work Authorization is required for all Novec 1230 work. The SRP Project Manager (PM) shall apply for and receive the Work Authorization. The fire protection contractor will receive the Work Authorization from the SRP PM. The Work Authorization must be prominently displayed at the jobsite before any work, to include demolition, can begin. Upon completion of the work, a final inspection by the SRP Fire Marshal, and the satisfactory resolution of all issues identified by the Final Inspection, the SRP Fire Marshal shall sign and close out the Work Authorization which indicates acceptance of the permitted work.

1.8 VERIFYING ACTUAL FIELD CONDITIONS

A. Before commencing work, examine all adjoining work on which the contractor’s work is in any way dependent for perfect workmanship according to the intent of this specification section, and report to the SRP Representative any condition which prevents performance of first class work. No "waiver of responsibility" for incomplete, inadequate or defective adjoining work will be considered unless notice has been filed before submittal of a proposal.

B. The contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall advise the SRP Representative of any discrepancy before performing the work.

1.9 COORDINATION OF TRADES
A. The contract documents are not intended to serve as coordinated construction drawings showing all minor adjustments in locations required for a fully coordinated installation that respects the work of all trades.

B. Piping offsets, fittings, and any other accessories required shall be furnished as required to provide a complete installation and to eliminate interference with other construction.

C. Wherever the contractor’s work interconnects with work of other contractors, the contractor shall coordinate his work with other contractors to ensure that all contractors have the information necessary so that they may properly install all necessary connections and equipment. Identify all work items needing access (dampers, etc.) concealed above hung ceilings by permanent colored pins/tabs in the ceiling directly below the item.

D. Provide required supports and hangers for piping, conduit and equipment, so that loading will not exceed allowable loadings of structure. Submittal of a bid shall be a deemed representation that the contractor submitting such bid has ascertained allowable loadings and has included in his estimates the costs associated in furnishing required supports.

E. Field drilling and cutting of holes in structural decks, roofs, walls, etc., required for work under this section shall be coordinated through various trades in their respective materials and approved by the SRP Representative. All such drilling, cutting, and reinforcing costs shall be borne by the contractor.

F. Due to the type of installation, a fixed sequence of construction is required to properly install the complete systems. It shall be the responsibility of the contractor to coordinate, protect, and schedule his work with other trades in accordance with the construction sequence.

G. Cooperate with all other contractors and subcontractors to facilitate the completion of the work as a whole, subject to the direction of the SRP Representative.

1.10 SCHEDULING

A. Provide a schedule to SRP indicating the installation sequence and timeframe prior to beginning work. Provide weekly updates to SRP. All wiring, circuit testing and device installation shall be completed in time for the equipment supplier to make all final connections and to conduct all tests as outlined in this specification section.

B. Coordinate the Acceptance Test for each fire alarm system with the SRP Fire Marshal and other necessary parties identified by SRP.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Protect equipment delivered and placed in storage from the weather, humidity, and temperature variation, dirt and dust, and other contaminants in accordance with manufacturer’s instructions.

B. All pipes and fittings shall either be capped or plugged until installation.

C. Coordinate the storage arrangement and location with SRP.

D. Deliver and store products in shipping containers/boxes, with labeling in place.

1.12 WASTE REMOVAL
A. At the conclusion of each day's work, clean up and stockpile on site all waste, debris, and trash, which may have accumulated during the day as a result of work by the contractor and of his presence on the job.

B. Sidewalks and street adjoining the property shall be kept broom clean and free of waste, debris, trash and obstructions of any kind caused by work of the contractor, which will affect the condition and safety of streets, walks, utilities and property.

1.13 SPARE PARTS

A. Repair Service/Replacement Parts: During warranty period, the service technician shall be on-site within 24 hours after notification. All repairs shall be completed within 24 hours of arrival on-site.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Standard Products: Material and equipment shall be the standard products of a manufacturer, where possible, and not a combination of manufacturers for any particular classification of materials. Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 2 years prior to bid opening. All materials and equipment supplied shall be new, first quality and the manufacturer’s best type and latest model capable of complying with all requirements of this specification section and shall have been in continuous production and in continuous service in commercial applications for at least 1-year. Obsolete equipment shall not be used. All equipment furnished shall be new and listed for its intended application.

B. Nameplates: Major components of equipment shall have the manufacturer's name, model or serial number, and date of installation provided on a new plate permanently affixed to the item or equipment. Nameplates shall be etched metal or plastic, permanently attached by screws to panels or adjacent walls.

2.2 COMPONENTS

A. Piping: Pipe shall be steel conforming to ASTM 53, nonferrous drawn seamless copper tubing conforming to ASTM B88, and flexible metallic hose conforming to UL 536. Provide fittings for changes in direction of piping and for all connections. Reduce pipe sizes in the fitting. Do not use flush bushings. Fuse brazed joints, when used, with an alloy with a melting point above 1,000 degrees F. Provide pipe and fittings having a minimum bursting pressure of 5,000 per square inch (psi). For 1/2-inch and 3/4-inch iron pipe size (ips) provide schedule 40. For 1-inch or greater, use only schedule 80 pipe. Standard malleable iron banded fittings or ductile iron fittings through 2-inch ips. Use forged steel fittings in all sizes over 2 inches.

B. Discharge Nozzle: Permanently mark discharge nozzles to identify the nozzle and to show the equivalent single orifice diameter regardless of shape and number of orifices. Nozzles shall be available in NPT sizes 1/4-inch to 2.0-inch and shall be available in 180-degree and 360-degree distribution patterns.

C. Pipe Hangers and Supports: Provide pipe hangers and supports conforming to NFPA 2001 and manufacturer’s recommendations.

D. Pipe Sleeves: Provide where piping passes through masonry or concrete walls, floors, roofs, and partitions. Use standard weight zinc-coated steel pipe sleeves in outside walls below and above grade, in floor and in roof slabs. Zinc coat sheet steel sleeves in partitions having a nominal weight
of not less than 0.90 pounds per square foot. Ensure space between piping and the sleeve is not less than 1/2-inch. Use sleeves of sufficient length to pass through the entire thickness of walls, partitions and slabs. Pack space between the pipe and sleeve with asbestos-free insulation and approved sealant based on the material and the fire rating of the wall.

E. Escutcheons: Provide approved type escutcheons for piping passing through floors, walls and ceilings, consisting of one-piece or split-type. Provide chrome plated escutcheons where pipe passes through finished ceilings. Other escutcheons may be steel or cast-iron with aluminum paint finish. Securely fasten escutcheons in place with setscrews or other positive means.

F. Storage cylinders shall be constructed of high strength alloy steel, conforming to all applicable specifications of the Department of Transportation. Container design shall permit on-site reconditioning and refilling when required. Safety valves, manifolds, pressure gauges, and pressure switches shall be furnished and installed. Each container shall meet the following:

1. A pressure gauge to provide visual and electrical supervision of the container pressure. The pressure gauge shall be color-coded to provide an easy, visual indication of container pressure.

2. A pressure relief provision that automatically operates when the internal temperature exceeds 130 degrees F. Each container shall have a safety device to relieve excess pressure safely, in advance of the rated cylinder test pressure.

3. The requirements of the US Department of Transportation specifications if used as shipping containers. IF not used as a shipping container, each container shall be designed, fabricated, inspected, certified, and stamped in accordance with Section VIII of ASME BPVC.

4. Provided with support racks that anchor to walls and floors.

5. A permanent nameplate or other permanent marking that indicates the agent, tare and gross weights and super-pressurization level (where applicable) of the container.

2.3 LOW-PRESSURE ALARM SWITCH

A. The tanks shall have a low-pressure switch to warn of clean agent tank depressurization. The low-pressure switch shall be wired to the RCP to provide an audible and visual "Supervisory" signal in the event the container pressure drops 5 percent below normal operating pressure.

2.4 RELEASING CONTROL PANEL (RCP)

A. Provide an approved releasing control panel that is compatible with the system, devices, and functions specified. The control system and its components shall be UL-listed or FM-approved for use as a local fire alarm system with releasing device service. The control system shall perform all functions necessary to operate the system detection, actuation, and auxiliary functions. The control system shall be microprocessor-based utilizing distributed processing concept. A single microprocessor failure shall not impact operation of additional modules on the system. The control system shall be capable of supporting an air-aspirating smoke detection system. The control system shall have four initiating circuits that are capable of Class A or Class B operation. Each circuit shall be capable of monitoring contact devices configured for manual release, manual alarm, system abort, trouble input or auxiliary (non-fire) input. The control panel shall release circuits for activation of an extinguishing/supervision system(s). Each circuit shall be rated for 1.5 amp @ 24 VDC. The control panel shall contain at least two indicating appliance circuits for annunciation. Each circuit shall be capable of Class A or Class B operation. Each circuit shall be rated for 1.5 amp @ 24 VDC.
B. Primary Power Supply: Provide a system which operates from a power supply with 120 grounded VAC and 24 VDC output satisfactorily with power input voltage varying from 85 to 110 percent of nominal value. Ensure that the power supply output is capable of powering all initiation signaling, annunciation, and control devices during alarm condition with 25 percent minimum space capacity.

C. Secondary Power Supply: Provide batteries, charger, and power transfer equipment which supplies the means of automatically supplying the entire system with battery backup power in the event of a primary power system failure, and switches to battery power in the event of AC power failure, and switches back to AC power upon return of primary power. Provide a control panel which operates when the backup batteries are disconnected for any reason, and controls charging currents and floating voltage levels to maintain batteries in optimum condition. Provide capability to recharge batteries in event of discharge. Fuse wiring to protect against battery over-current and polarity reversal. The battery charger and battery shall comply with the relevant codes, standards or regulations. Typically, 24 hours standby battery backup is required followed by 5 minutes in an alarm condition, unless site specific standby battery criteria is required. Follow local power supply standards that may apply. UL 1481 listed (provided the power supply and standby batteries have been appropriately sized/rated to accommodate the system's power requirements).

D. Storage Batteries: Provide sealed and spill-proof battery modules (no corrosive fumes). Utilize only batteries which are listed.

2.5 MANUAL RELEASE STATIONS

A. Stations shall be of the type not subject to operation by jarring or vibration. Stations shall have a dual-action release configuration. Break-glass front stations are not permitted; however, a pull lever break-glass rod type is acceptable. Manual release stations shall be a different color (such as yellow or orange) from building fire alarm pull stations.

2.6 AIR SAMPLING SMOKE DETECTORS

A. Detector Assembly: The detector, filter, aspirator and relay outputs shall be housed in a mounting box and shall be arranged in such a way that air is drawn from the fire risk and a sample passed through the dual stage filter and detector by the aspirator. Detection units shall be compact type and provided with scanning to identify which sampling pipe is carrying smoke. The scanning mechanism shall:

1. Be integrated into the detector.
2. Begin to sample each pipe individually upon detection of smoke.
3. Be used to identify the level of smoke in each pipe.
4. Be used to indicate in which pipe an alarm was first detected.
5. Operate upon manual activation of the scan button on the display.
6. Be automatically tested daily to ensure uninterrupted protection.

B. The detector shall be laser-based type and shall have an obscuration sensitivity range of 0.0015 percent/obs/ft to 6 percent obs/ft. The detector shall have four independent field programmable smoke alarm thresholds per pipe (sector) and a programmable scan time delay.

C. The aspirator shall be a purpose-designed rotary vane air pump capable of allowing for multiple sampling pipe runs up to 600 feet in total (four pipe runs per detector).
D. The assembly must contain relays for alarm and fault conditions. The relays shall be software programmable to the required functions. The assembly shall be able to be surface-mounted to a wall or recessed in the wall cavity (the unit may be inverted in either option). The assembly shall have built-in events and smoke logging. It shall store smoke levels, alarm condition, operator actions and faults. The date and time of each event shall be recorded. Each detector (zone) shall be capable of storing up to 18,000 events and does not require the presence of a display in order to do so.

E. Display: The display shall provide the following features at a minimum:

1. A 20 segment bar graph display.
2. Four independent high intensity alarm indicators; Alert, Action, Fire 1 and Fire 2, corresponding to the four alarm thresholds of the indicated sector.
4. LED indication that the first alarm sector is established.

F. Detector Alarm Levels: The laser-based air sampling detection system shall have four alarm thresholds per pipe (sector). The four alarm levels may be used as follows:

1. Alarm Level 1 (Alert): 0.025% obsc/ft.
2. Alarm Level 2 (Action): 0.044% obsc/ft.
3. Alarm Level 3 (Fire 1): 0.062% obsc/ft.
4. Alarm Level 4 (Fire 2): 0.61% obsc/ft.

G. Fault Alarms: The detector fault relay shall be connected to the appropriate alarm zone on the RCP in such a way that a detector fault would register a fault condition on the FACU.

2.7 [SMOKE DETECTORS]

A. [Photoelectric Smoke Detectors: Provide addressable photoelectric smoke detectors as follows:]

1. Provide analog/addressable photoelectric smoke detectors utilizing the photoelectric light scattering principle for operation in accordance with UL 268. Smoke detectors shall be listed for use with the fire alarm control unit.
2. Provide self-restoring type detectors that do not require any re-adjustment after actuation at the RCP to restore them to normal operation.
3. Components shall be rust and corrosion resistant. Vibration shall have no effect on the detector's operation. Protect the detection chamber with a fine mesh metallic screen that prevents the entrance of insects or airborne materials. The screen shall not inhibit the movement of smoke particles into the chamber.
4. Provide twist lock bases constructed of white, high impact polycarbonate designed for mounting on a standard 3 1/2-inch or 4-inch octagonal or 4-inch square outlet box for detectors. The detectors shall maintain contact with their bases without the use of springs. Provide companion mounting base with screw terminals for each conductor. Terminate field wiring on screw terminals. The detector shall have a visual indicator to show actuation. Insertion of an incorrect detector type into the base shall cause a "Wrong Device" trouble.
condition at the RCP until the proper type of detector is installed, or the system is reprogrammed. The system program shall recognize the insertion of a wrong device and shall automatically default to the set point values corresponding to the inserted device and shall monitor alarm and trouble conditions according to the default parameters.

5. The detector address shall identify the particular unit, its location within the system, and its sensitivity setting. Detectors shall be of the low voltage type rated for use on a 24 VCD system.

6. An operator at the control unit, having the proper access level, shall have the capability to manually access the following information for each initiating device:
   a. Primary status.
   b. Device type.
   c. Present average value.
   d. Present sensitivity selected.
   e. Detector range (normal, dirty, etc.)

B. [Laser Smoke Detectors: Provide addressable laser smoke detectors as follows:
   1. Provide analog/addressable laser smoke detectors utilizing laser diode and patented smoke sensing chamber, designed to amplify signals from smoke but diminish stray internal reflections and shall, on command from the control panel, send data to the panel representing the analog level of smoke density. Smoke detectors shall be listed for use with the releasing control panel.
   2. Detector shall be able to achieve sensitivities from 0.02 percent per foot to 2 percent per foot obscuration. Laser smoke detector shall provide point identification of the fire location through addressability, shall experience no delay in response time due to smoke dilution or smoke transportation time, and shall offer complete supervision of wiring and detector.
   3. Provide self-restoring type detectors that do not require any re-adjustment after actuation at the releasing control panel to restore them to normal operation. Detectors shall be UL-listed as smoke-automatic fire detectors.
   4. Components shall be rust and corrosion resistant. Vibration shall have no effect on the sensor’s operation. Protect the detection chamber with a fine mesh metallic screen that prevents the entrance of insects or airborne materials. The screen shall not inhibit the movement of smoke particles into the chamber.
   5. Provide twist lock bases for detectors. The detectors shall maintain contact with their bases without the use of springs. Provide companion mounting base with screw terminals for each conductor. Terminate field wiring on the screw terminals. The sensor shall have a visual indicator to show actuation.
   6. The sensor address shall identify the particular unit, its location within the system, and its sensitivity type. Detectors shall be of the low voltage type rated for use on a 24 VDC system.
   7. An operator at the control panel, having the proper access level, shall have the capability to manually access the following information for each initiating device:
      a. Primary status.
      b. Device type.
      c. Present average value.
      d. Present sensitivity selected.
      e. Sensor range (normal, dirty, etc.).]
C. Duct Smoke Detectors: Duct-mounted photoelectric smoke detectors shall be furnished and installed where indicated and in accordance with NFPA 90A. Units shall consist of a smoke detector as specified in paragraph Photoelectric Smoke Detectors, mounted in a special housing fitted with duct sampling tubes. Detector circuitry shall be mounted in a metallic enclosure exterior to the duct. Detectors shall have a manual reset. Detectors shall be rated for air velocities that include air flows between 500 and 4000 fpm. Detectors shall be powered from RCP.

1. Sampling tubes shall run the full width of the duct. The control functions, operation, reset, and bypass shall be controlled from the RCP.

2. Lights to indicate the operation and alarm condition, and the test and reset buttons shall be visible and accessible with the unit installed and the cover in place. Remote indicators shall be provided where required by NFPA 72 and these shall be provided with key-operated test and reset switches.

3. Remote lamps and switches as well as the affected fan units shall be properly identified in etched plastic placards. Detectors shall provide for control of auxiliary contacts for shutdown. Auxiliary contacts provided for this function shall be located within 3 feet of the controlled circuit or appliance.

4. The detectors shall be compatible with the RCP to ensure complete system compatibility.

2.8 ABORT STATIONS

A. Abort station shall be guarded, spring-loaded type which operates only when pressure is manually applied to the switch. Upon release of manual pressure, switch de-activates allowing delayed functions to resume. After start of agent discharge switch has no effect. Activation of the abort switch during normal (non-alarm) conditions causes activation of system trouble signal.

2.9 ALARM SIGNALING DEVICES

A. Audible Alarms: Audible notification appliance shall be [surface][flush]-mounted, vibrating type alarm horns suitable for use in an electrically supervised circuit and having a sound output rating of at least 90 decibels at 10 feet.

B. Visual Alarms: [Surface][Flush]-mounted lamp assembly suitable for use in a electrically supervised circuit. Provide flashing strobe type lamps, powered from the releasing control panel alarm circuit. Provide lamps with a minimum 15 candela. Flash rate is between 60 and 120 flashes per minute. Protect lamps by a thermos-plastic lens, red for pre-discharge alarms and blue for discharge alarms. Visual alarms may be part of an audio-visual alarm assembly.

2.10 ELECTROMAGNETIC DOOR HOLDER RELEASE

A. Devices shall be designed to operate on 24 VDC and require not more than 3 watts of power to develop 25 psi of holding force. Under normal conditions, the magnets shall attract and hold the doors open. Operation shall be fail safe with no moving parts. Electromagnetic door hold-open devices shall not be required to be held open during building power failure. The device shall be listed based upon UL 228.

2.11 ELECTRICAL WORK

A. Wiring: Provide power, control, and fire alarm wiring, including connections to the fire alarm systems under this section and conform to NFPA 70. Wiring for 120 volt circuits is No. 12 AWG minimum. Wiring for low voltage DC circuits is No. 16 AWG minimum. Color code all wiring. Use rigid metal
conduit or intermediate metal conduit, except electrical metallic tubing may be used in dry locations not enclosed in concrete or where not subject to mechanical damage.

B. Conductor Identification: Identify all circuit conductors within each enclosure where a tap, splice, or termination is made. Conductor identification is by plastic coated self-sticking printed markers or by heat-shrink type sleeves. Attach the markers in a manner that does not permit accidental detachment. Properly identify control circuit terminations.

C. Alarm Wiring: The SLC wiring shall be [fiber optic] or [solid copper] cable in accordance with the manufacturer’s requirements. Copper signaling line circuits and initiating device circuit field wiring shall be No. [14][16][18][___] AWG size twisted and shielded solid conductors at a minimum. Visual notification appliance circuit conductors, that contain audible alarm appliances, shall be solid copper No. 14 AWG size twisted and shielded conductors at a minimum.[ Speaker circuits shall be copper No. 16][____] AWG size twisted and shielded conductors at a minimum.] Wire size shall be sufficient to prevent voltage drop problems. Circuits operating at 24 VDC shall not operate at less than the UL-listed voltages for the sensors and/or appliances. Power wiring, operating at 120 VAC minimum, shall be a minimum No 12 AWG solid copper having similar insulation. Acceptable power-limited cables are FPL, FPLR or FPLP as appropriate with red colored covering. Non-power-limited cables shall comply with NFPA 70.

PART 3 - EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. Install materials and equipment in accordance with NFPA 2001. Provide each system complete and ready for operation. Provide each system with an approved pressure relief device designed to operate between 2,000 and 3,300 psi and located between the storage cylinder manifolds and any normally closed valve.

B. The Work Authorization must be prominently displayed at the job site before any work, to include demolition, can begin.

C. Upon completion of the work, a final inspection by the SRP Fire Marshal, and the satisfactory resolution of all issues identified by the Final Inspection, the SRP Fire Marshal shall sign and close out the Work Authorization which indicates acceptance of the permitted work.

D. Distribution Piping and Fittings: Distribution piping and fittings shall be installed in accordance with the manufacturer’s requirements, NFPA 2001 and approved piping standards and guidelines. All distribution piping shall be installed by qualified individuals using good, accepted practices and quality procedures. All piping shall be adequately supported and anchored at all directional changes and nozzle locations. All piping shall be reamed, blown clear and swabbed with suitable solvents to remove burrs, mill varnish and cutting oils before assembly. All pipe threads shall be sealed with Teflon tape pipe sealant applied to the male threads ONLY.

E. Pipe Penetrations: Cutting structural members for passage of pipes or for pipe-hanger fastenings shall not be permitted. Pipes that must penetrate concrete or masonry walls or concrete floors shall be core-drilled and provided with pipe sleeves. Each sleeve shall be Schedule 40 galvanized steel, ductile-iron or cast-iron pipe shall extend through its respective wall or floor and be cut flush with each wall surface. The space between the sleeve and the pipe shall be firmly packed with mineral wool insulation. Where pipes penetrate fire walls, fire partitions, or floors, pipes shall be firestopped in accordance with Section 07 8400 FIRESTOPPING. In penetrations that are not fire-rated or not a floor penetration, the space between the sleeve and the pipe shall be sealed at both ends with plastic waterproof cement that will dry to a firm but pliable mass or with a mechanically adjustable segmented elastomer seal.
F. Escutcheons: Escutcheons shall be listed for piping passing through floors, walls, and ceilings, consisting of one-piece or split-type. Provide chrome plated escutcheons where pipe passes through walls and ceilings in finished areas. Other escutcheons may be steel or cast-iron, with aluminum paint finish. Securely fasten escutcheons in place with setscrews or other positive means.

G. Discharge Nozzle: Where clogging by external foreign material is likely, discharge nozzles shall be provided with frangible discs, blow-off caps, or other suitable devices.

H. Manual Release Stations: Provide manual release stations as indicated on the drawings. Mount stations so that their operating handles are 4 feet above the finished floor. Mount stations so they are located no farther than [5] feet from the exit door they serve, measured horizontally.

I. Smoke Detectors: Terminate field wiring on the screw terminals for all photoelectric and laser smoke detectors. Locate detectors [as required by NFPA 72 and their listings][as indicated] on a 4-inch mounting box. Locate smoke detectors on the ceiling. Smoke detectors are permitted to be on the wall no lower than 12 inches from the ceiling with no minimum distance from the ceiling. In raised floor spaces, install the smoke detectors to protect 225 square feet per detector. Install smoke detectors no close than 5 feet from air handing supply ducts.

J. Duct Smoke Detectors: Detectors mounted above 6 feet and those mounted below 6 feet that cannot be easily accessed while standing on the floor, shall be provided with a remote detector indicator panel containing test and reset switches. Auxiliary contacts provided for this function shall be located within 3 feet of a controlled circuit or appliance.

K. Electromagnetic Door Holder Release: Doors shall be held open at a minimum of 90 degrees so as not to impede egress from the space. Mount the armature portion on the door and have an adjusting screw for seating the angle of the contact plate. Wall-mount the electromagnetic release, with a total horizontal projection not exceeding 4 inches. Ensure all doors release to close upon first stage (pre-discharge) alarm. Electrical supervision of wiring external of control panel for magnetic door holding circuits is not required.

L. Releasing Control Panel (RCP): The RCP shall be located in a year round environmentally conditioned space and not in the hazard area served but adjacent to it. Locate the RCP [where indicated on the drawings][____]. [Recess][Semi-recess][Surface-mount] the enclosure with the top of the cabinet 6 feet above the finished floor or center the cabinet at [5] feet, whichever is lower. Conductor terminations shall be labeled and a drawing containing conductors, their labels, their circuits, and their interconnection shall be permanently mounted in the RCP.

M. Extinguishing System Saving/Disconnect Switch: Connect the positive and negative conductors of the Class B solenoid/actuator/electric release head circuitry in series to a lock switch. Provide and install the switch in an enclosure inside the facility. A clearly visible sign on the enclosure, or immediately adjacent, is to explicitly indicate its purpose as "FIRE EXTINGUISHING SYSTEM SAFING SWITCH".

N. Operating Instructions: Submit operating instructions for clean agent fire extinguishing systems consisting of raised or embossed white letter on red rigid plastic or enameled steel background and of adequate size to permit them to be easily read. Provide operating instructions at each remote control station. Instructions are to clearly indicate necessary steps for the operating of the system. Submit three copies of the Operation and Maintenance manuals 30 days prior to testing the clean agent fire extinguishing systems. Update and resubmit data for final approval no later than 30 days prior to contract completion.

O. Field Painting: Touch-up paint is to match equipment manufacturer’s original paint.
3.2 WARNING SIGNS

A. Provide three-layer red-white-red micarta engraved to show white letters on a red background, warning signs. Letters are to be uppercase. Warning signs are to be 1/8-inch thick with beveled edges.

B. Inside Control Room: Permanently affix a sign adjacent to every audible/visual alarm activated due to agent discharge reading:

WARNING

THIS SPACE IS PROTECTED BY A NOVEC 1230 CLEAN AGENT EXTINGUISHING SYSTEM. DO NOT ENTER WITHOUT AUTHORIZATION DURING OR AFTER DISCHARGE. THIS STROBE INDICATES DISCHARGE.

C. Manual Activation of Release Station: Place a sign at every locations where manual operation of the system may occur reading:

WARNING

ACTUATION OF THIS DEVICE WILL CAUSE FIRE EXTINGUISHING GAS TO DISCHARGE. BEFORE ACTUATING, ENSURE THAT PERSONNEL ARE CLEAR OF THE AREA.

3.3 FIELD QUALITY CONTROL

A. After the system installation has been completed, the entire system shall be checked out, inspected and functionally tested by qualified, trained personnel, in accordance with the manufacturer's recommended procedures and NFPA standards in the presence of SRP.

B. Test Procedure: At least 14 days [___] prior to functional testing, the installing contractor shall submit a Test Plan describing the procedures to be used to test the control system(s). The Test Plan shall include a step-by-step description of all tests to be performed and shall indicate the type and location of test apparatus to be employed. The tests shall demonstrate that the operational and installation requirements of this specification section have been met. All tests shall be conducted in the presence of the SRP Representative and shall not be conducted until the Test Plan has been approved by SRP.

C. Experienced technicians regularly employed by the contractor in the installation of the system and manufacturer’s representative referred to elsewhere in this section shall conduct the testing.

3.4 PRELIMINARY TESTS

A. Visual Inspection: Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals of Fire Alarm Systems" chapter.

B. Room Pressurization Test: After all construction is complete, conduct a room pressurization test in accordance with NFPA 2001 in each clean agent extinguishing system hazard area. Test shall conform enclosure’s ability to retain the agent concentration level for the required hold time. If the test fails, the extinguishing system contractor shall coordinate room sealing with the general contractor. Additional tests shall be conducted until successful test results are achieved. Include final test results with the final record drawings.
1. A room pressurization test shall be conducted, in each protected space, to determine the presence of openings, which would affect the agent system concentration levels. The test(s) shall be conducted using the Retro-Tec Corp. Door Fan system, or equivalent, with integrated computer program. All testing shall be in accordance with NFPA 2001.

2. If room pressurization testing indicates openings exist that would result in leakage and/or loss of clean agent fire extinguishing agent, the installing contractor shall be responsible for coordinating the proper sealing of the protected space(s) by the general contractor or his subcontractor or agent. The general contractor shall be responsible for adequately sealing all protected space(s) against agent loss or leakage. The installing contractor shall inspect all work to ascertain that the protected space(s) have been adequately and properly sealed. THE CLEAN AGENT FIRE EXTINGUISHING SYSTEM INSTALLING CONTRACTOR SHALL BE RESPONSIBLE FOR THE SUCCESS OF THE ROOM PRESSURIZATION TESTS. If the first room pressurization test is not successful, in accordance with this specification section, the installing contractor shall inform the general contractor to determine and correct the cause of the test failure. If, after inspection of the additional sealing performed, the installing contractor is satisfied that the protected space is ready for retesting, the installing contractor shall conduct additional room pressurization tests, at no additional cost, until a successful test is obtained. Copies of successful test results shall be submitted to the SRP Representative.

C. Operational Test: After electrical circuitry has been energized, apply power to control panel and confirm proper unit operation. Comply with "Test Methods" table in "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72. Test and adjust controls and safeties.

D. Clean Agent Fire Extinguishing Systems Test: Using nitrogen or other inert gas, perform a flow test on the piping network to verify that flow is continuous and unobstructed through piping and nozzles.

E. Pressure/Leak Test: Pneumatically test the piping in a closed circuit for a period of 10 minutes at 40 psi. At the end of 10 minutes, the pressure drop shall not exceed 20 percent of the test pressure. Repair leaks and retest until no leaks exist.

F. Test and Inspection Reports: Factory authorized service representative shall prepare the "Fire Alarm System Record of Completion" and the "Inspection and Testing" documents from NFPA 72.

3.5 FINAL TESTS

A. The system will be considered ready for acceptance testing only after the following have been accomplished:

1. Preliminary tests have been made and deficiencies corrected.

2. Testing reports have been submitted and approved.

B. Final acceptance testing shall be coordinated and performed by the contractor, in the presence of SRP. In order to assure attendance of the necessary representatives, each representative scheduled to witness the test shall be provided a minimum of 5 working days' notification of the proposed test date by the contractor. The test shall not be conducted until all parties agree on the scheduled test date. The contractor shall provide all the necessary personnel and equipment to conduct the tests.

C. The final acceptance test shall repeat 100 percent of preliminary tests.

D. If the Final Acceptance Test fails, the contractor shall pay all costs incurred to SRP for any and all retesting.
E. Upon satisfactory completion of the tests, the contractor shall leave the system in proper working order.

F. Warranty: Except as otherwise expressly provided in the contract documents, and excepting only items of routine maintenance, ordinary wear and tear or unusual abuse or neglect, contractor guarantees all work executed by the contractor and all supplies, materials, and devices of whatsoever nature incorporated in, or attached with the work, or otherwise delivered to SRP as part of the work pursuant to the contract to be absolutely free of all defects of workmanship and materials for a period of 2 years after final acceptance of the work by SRP. Include service directory with telephone numbers for 24-hour emergency service.

3.6 TRAINING

A. Instructor: Include in the project the services of an instructor, who has received specific training from the manufacturer for the training of other persons regarding the inspection, testing, and maintenance of the system provided. The instructor shall train the employees designated by SRP, in the care, adjustment, maintenance, and operation of the fire extinguishing system. Each instructor shall be thoroughly familiar with all parts of this installation. The instructor shall be trained in operating theory as well as in practical O&M work. Submit the instructor's information and qualifications including training history to SRP prior to training.

B. Required Instruction Time: Provide [4][8] hours of instruction after final acceptance of the system. The instruction shall be given during regular working hours on such dates and times as selected by SRP. The instruction may be divided into two or more periods at the discretion of SRP. The training shall allow for rescheduling for unforeseen maintenance and/or fire department responses.

END OF SECTION
SECTION 220513 - COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes general requirements for single-phase and poly-phase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on AC power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.2 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
   1. Motor controllers.
   2. Torque, speed, and horsepower requirements of the load.
   3. Ratings and characteristics of supply circuit and required control sequence.
   4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with requirements in this Section except when stricter requirements are specified in plumbing equipment schedules or Sections.

B. Comply with NEMA MG 1 unless otherwise indicated.

C. Motors larger than 5HP to be 277V or 480V, 3 Phase if available at site.

2.2 MOTOR CHARACTERISTICS

A. Indoor Duty: Continuous duty at ambient temperature of 40°C and at altitude of 3300 feet above sea level.

B. Outdoor duty: Continuous duty at ambient temperature of 50°C and at altitude of 3300 feet above sea level.

C. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.
2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Premium efficient, as defined in NEMA MG 1.

C. Service Factor: Minimum 1.15.

D. Multispeed Motors: Variable torque.
   1. For motors with 2:1 speed ratio, consequent pole, single winding.
   2. For motors with other than 2:1 speed ratio, separate winding for each speed.


F. Bearings: Regreasable, double-shielded, antifriction ball bearings suitable for radial and thrust loading.

G. Temperature Rise: Match insulation rating, unless otherwise indicated.

H. Insulation: Class F, unless otherwise indicated.

I. Code Letter Designation:
   1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
   2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T Insert number.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
   1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
   2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
   3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
   4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
   5. Measure shaft to ground voltage. If voltage exceeds 2v, install a shaft ground ring similar to “AEGIS SGR” on DE (driven end).
2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
   1. Permanent-split capacitor.
   2. Split phase.
   3. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Pre-lubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

2.6 MANUFACTURERS

A. Subject to compliance with the requirements included in this section, for motors not included as part of a listed assembly provide products by one of the following:
   1. General Electric
   2. Emerson
   3. A. O. Smith
   4. U. S. Motors
   5. WEG
   6. Baldor

PART 3 - EXECUTION

3.1 INSTALLATION

A. Termination – 5HP and above
   1. In peckerhead, mechanically terminate motor leads and conductors with crimped or compression “eyes”. Bolt eyes together with Grade 5 bolt, lock washer, and nut.
   2. Tape: First layer of tape is varnished Cambrick tape, tape over the Cambrick with self-sealing rubber wrap splicing tape. Finish with a wrap of #33 Scotch electrical tape (or equivalent).
   3. Terminal blocks: Mechanical connection terminal blocks for size, listing, and rating of motor conductors. Ample space required for insulated bushings and tape in terminal box.
      a. MANUFACTURERS
         1) Cooper Bussmann
         2) Burndy
PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Dielectric fittings.
3. Mechanical sleeve seals.
4. Sleeves.
5. Escutcheons.
7. Plumbing demolition.
8. Equipment installation requirements common to equipment sections.
9. Concrete bases.
10. Supports and anchorages.

1.2 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.3 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding:
1. Qualify processes and operators according to ASME B31.9 Building Services Piping.

2. Comply with provisions in ASME B31.9, "Building Services Piping."

3. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

D. Handle, store, and protect equipment and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations.

PART 2 - PRODUCTS

2.1 JOINING MATERIALS

A. Refer to individual Division 22 piping Sections for special joining materials and methods.

B. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

D. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

E. Brazing Filler Metals: AWS A5.8, BCuP Series or BAg1, unless otherwise indicated.


G. Solvent Cements for Joining Plastic Piping:

1. ABS Piping: ASTM D 2235.
2. CPVC Piping: ASTM F 493.
3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
4. PVC to ABS Piping Transition: ASTM D 3138.

2.2 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 °F.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly with dielectric bolt insulators or fully floating, powder-coated, plate-steel, companion flange with EPDM insulator to prevent contact with copper flange adapter, for 150- or 300-psig minimum working pressure as required to suit system pressures.

E. Dielectric Couplings: Galvanize-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 °F.

F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 °F.

2.3 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

B. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

C. Pressure Plates: Carbon steel above grade and stainless steel below grade. Include two for each sealing element.

D. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating above grade and stainless steel below grade of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.4 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Galvanized-Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with set screws.
2.5 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.

2.6 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 PLUMBING DEMOLITION

A. Refer to Division 1 Sections for general demolition requirements and procedures.

B. Disconnect, demolish, and remove plumbing systems, equipment, and components indicated to be removed.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping water and gas tight with same or compatible piping material.
2. Piping to Be Abandoned in Place (by Owner’s permission only): Drain piping and cap or plug piping water and gas tight with same or compatible piping material. Label “Abandoned in Place.”
3. Equipment to Be Removed: Disconnect and cap services water and gas tight, remove and discard equipment.
4. Equipment to Be Removed and Reinstalled: Disconnect and cap services water and gas tight and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational. Operational test to be witnessed by Owner.
5. Equipment to Be Removed and Salvaged: Disconnect and cap services water and gas tight and remove equipment and deliver to Owner.
C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved by Engineer.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping to conserve building space and not interfere with use of space.

F. Group piping wherever practical at common elevations and locations.

G. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

H. Install piping to permit servicing of valves and specialties.

I. Install piping at indicated slopes.

J. Install piping free of sags and bends.

K. Install fittings for changes in direction and branch connections.

L. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

M. Install piping to allow application of insulation.

N. Select system components with pressure rating equal to or greater than system test and operating pressures.

O. Install (one piece only) escutcheons for exposed penetrations of piping through walls, ceilings, and floors.

P. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs. Extend floor sleeves 2 inches above top of floors that are not slab on grade.
Q. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Install steel pipe for sleeves smaller than 6 inches in diameter.
2. Install cast-iron “wall pipes” for sleeves 6 inches and larger in diameter.
3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

R. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron “wall pipes” for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

S. Fire-BARRIER Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials as indicated on Drawings, or as required by authorities having jurisdiction.

T. Non-FIRE Barrier Penetration: seal the annular space around the outside of the pipe with caulk, foam sealant, or gasket system.

U. Verify final equipment locations for roughing-in.

V. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

W. See Section 220523 GENERAL DUTY VALVES FOR PLUMBING PIPING for valve requirements.

3.3 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.

3.4 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment, fixture, and serviceable assembly.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment, fixture, and serviceable assembly.

3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.

4. Wet Pipe Systems:
   a. NPS 2 and smaller: Install dielectric coupling or nipple fitting to connect piping materials of dissimilar metals.
   b. MPS 2-1/2 and larger: Install dielectric flange to connect piping materials of dissimilar metals.

3.5 TESTING OF PIPING SYSTEMS
   A. Test pipe and fittings according to the requirements in Division 22 Sections specifying piping systems.

3.6 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS
   A. Install equipment level and plumb, parallel and perpendicular to other building systems and components, unless otherwise indicated.

   B. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components without removal of any permanent construction as stated in the plumbing code. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

   C. Install equipment to allow right of way for piping installed at required slope.

3.7 CONCRETE BASES
   A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

      1. Construct concrete bases of dimensions indicated, but not less than 6 inches larger in both directions than supported unit.
      2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
      3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
      4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
      5. Install anchor bolts to elevations required for proper attachment to supported equipment.
      6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 3.

3.8 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 5 for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.9 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor plumbing materials and equipment.

B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.

C. Attach to structure as required to support applied loads.

D. Use of wood for these purposes is by permission (only) of the Owner.

3.10 GROUTING

A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Metal-bellows expansion joints.
   2. Flexible-hose expansion joints.
   3. Pipe bends and loops.
   4. Alignment guides and anchors.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Delegated-Design Submittal: For each anchor and alignment guide indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and bends.
   2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
   3. Alignment Guide Details: Detail field assembly and attachment to building structure.
   4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

C. Welding certificates.

D. Product certificates.

E. Maintenance data.

1.3 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:
   2. Welding to Piping: ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 EXPANSION JOINTS

A. Metal-Bellows Expansion Joints: ASTM F 1120, circular-corrugated-bellows type with external tie rods.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Flex-Hose Co., Inc.
   b. Flex-Weld, Inc.
   c. Hyspan Precision Products, Inc.
   d. Metraflex, Inc.
   e. Proco Products, Inc.

2. Metal-Bellows Expansion Joints for Copper Piping: Multiple-ply phosphor-bronze bellows, copper pipe end connections, and brass shrouds.


5. Minimum Pressure Rating: 150 psig, unless otherwise indicated.

6. Configuration: Double-bellows type with base, unless otherwise indicated.

7. End Connections: Flanged or weld.

B. Flexible-Hose Expansion Joints: Manufactured assembly of two flexible-metal-hose legs joined by a long radius, 180-degree return bend or center section of flexible hose with rigid elbows; with inlet and outlet elbow fittings, corrugated-metal inner hoses, and braided outer sheath.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Flex-Hose Co., Inc.
   b. Metraflex, Inc.

2. Flexible-Hose Expansion Joints for Copper Piping: Copper-alloy fittings with solder-joint end connections:
   a. NPS 2 and Smaller: Bronze hose and single-braid bronze sheath.

3. Flexible-Hose Expansion Joints for Steel Piping: Carbon-steel fittings, stainless-steel hose and single-braid, stainless steel-sheath:
   a. NPS 2 and Smaller: Threaded ends.
   b. NPS 2-1/2 to NPS 6: Flanged ends.

   a.  

2.2 ALIGNMENT GUIDES

A. Description: Steel, factory fabricated, with bolted two-section outer cylinder and base for alignment of piping and two-section guiding spider for bolting to pipe.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Flex-Hose Co., Inc.
   b. Flex-Weld, Inc.
   c. Hyspan Precision Products, Inc.
   d. Metraflex, Inc.

2.3 MATERIALS FOR ANCHORS

A. Steel Shapes and Plates: ASTM A 36/A 36M.

B. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel, hex head.

C. Washers: ASTM F 844, steel, plain, flat washers.
D. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, and tension and shear capacities appropriate for application.
   2. Expansion Plug: Zinc-coated steel.

E. Concrete: Portland cement mix, 3000 psi minimum. Comply with requirements in Division 3 for formwork, reinforcement, and concrete.

F. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink, nonmetallic grout; suitable for interior and exterior applications.
   2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 EXPANSION-JOINT INSTALLATION

A. Install manufactured, nonmetallic expansion joints according to FSA's "Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors."

B. Install expansion joints of sizes matching size of piping in which they are installed.

C. Install alignment guides to allow expansion and to avoid end-loading and torsional stress.

3.2 PIPE BEND AND LOOP INSTALLATION

A. Attach pipe bends and loops to anchors.
   2. Concrete Anchors: Attach by fasteners. Follow fastener manufacturer’s written instructions.

3.3 SWING CONNECTIONS

A. Connect risers and branch connections to mains with at least five pipe fittings, including tee in main.

B. Connect risers and branch connections to terminal units with at least four pipe fittings, including tee in riser.

C. Connect mains and branch connections to terminal units with at least four pipe fittings, including tee in main.

3.4 ALIGNMENT-GUIDE INSTALLATION

A. Install guides on piping adjoining pipe expansion fittings and loops.
B. Attach guides to pipe and secure to building structure.

3.5 ANCHOR INSTALLATION

A. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

B. Fabricate and install steel anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and AWS D1.1.

C. Construct concrete anchors of poured-in-place concrete of dimensions indicated and include embedded fasteners.

D. Install pipe anchors according to expansion-joint manufacturer's written instructions if expansion joints are indicated.

E. Use grout to form flat bearing surfaces for expansion fittings, guides, and anchors installed on or in concrete.

END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Thermometers.
   2. Gages.

1.2 SUBMITTALS
A. Product Data: For each type of product indicated, include materials and finishes, dimensions, and accuracies. For pressure gages, submit pressure gage range for each application. For thermometers, submit temperature range and scale divisions for each application.

PART 2 - PRODUCTS

2.1 METAL-CASE, LIQUID-IN-GLASS THERMOMETERS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Trerice, H. O. Co.
   2. Weiss Instruments, Inc.

B. Case: Die-cast aluminum or brass, 9 inches long in mechanical rooms, 7 inches long elsewhere.

C. Tube: Red or blue reading, organic-liquid filled, with magnifying lens.

D. Tube Background: Satin-faced, nonreflective aluminum with permanently etched scale markings.

E. Window: Glass.

F. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.

G. Stem: Copper-plated steel, aluminum, or brass for thermowell installation and of length to suit installation.

H. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.
I. Range: The maximum operating temperature should not exceed 75% of the full-scale range. The normal operating range should be in the middle half of the range (between 25% and 75% of the full-scale range); whenever possible.

2.2 THERMOWELLS

A. Manufacturers: Same as manufacturer of thermometer being used.

B. Description: Pressure-tight, threaded, socket-type metal fitting made for insertion into piping and of type, diameter, and length required to hold thermometer.

C. Materials: Brass in copper piping systems, Type 316 stainless steel in all other piping systems.

D. Lagging Extensions: Provide in insulated piping systems, length suitable for insulation thickness.

2.3 PRESSURE GAGES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2. Ernst Gage Co.
3. Palmer - Wahl Instruments Inc.

B. Direct-Mounting, Dial-Type Pressure Gages: Indicating-dial type complying with ASME B40.100.

1. Case: Dry type, drawn steel, stainless steel or cast aluminum, 4-1/2-inch diameter.
2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
3. Pressure Connection: Brass, NPS 1/4, bottom-outlet type unless back-outlet type is indicated.
4. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Pointer: Red or other dark-color metal.
7. Window: Glass.
8. Ring: Metal.
9. Accuracy: Grade A, plus or minus 1 percent of middle half scale.
10. Range: The maximum operating pressure should not exceed 75% of the full-scale range. The normal operating range should be in the middle half of the range (between 25% and 75% of the full-scale range); whenever possible.

C. Pressure-Gage Fittings:

1. Valves: NPS 1/4 brass gage cock with lever handles, or brass or stainless-steel needle type.
2. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.
PART 3 - EXECUTION

3.1 THERMOMETER APPLICATIONS

A. Install liquid-in-glass or digital thermometers in the following locations:
   1. Outlet of each domestic, hot-water storage tank.
   2. Outlet of each domestic water heater.
   3. Outlet of each hot water circulation pump.
   4. Outlet of each tempered water recirculation pump.

B. Provide the following temperature ranges for thermometers:
   1. Domestic Hot and Tempered Water: 30 to 180 deg F, with 2-degree scale divisions.

3.2 GAGE APPLICATIONS

A. Install dry-case-type pressure gages for discharge of each pressure-reducing valve.

3.3 INSTALLATIONS

A. Install direct-mounting thermometers and adjust vertical and tilted positions.

B. Install thermowells with socket extending a minimum of 2 inches into fluid, but not less than one-third of diameter of pipe and in vertical position in piping tees where thermometers are indicated.

C. Prime thermowells with an approved heat transfer medium such as graphite or heat transfer paste to provide optimal accuracy and response time.

D. Install direct-mounting pressure gages in piping tees with pressure gage located on pipe at most readable position.

E. Install needle-valve and snubber fitting in piping for each pressure gage.

F. Install thermometers and gages adjacent to machines and equipment to allow service and maintenance for thermometers, gages, machines, and equipment.

G. Adjust faces of thermometers and gages to proper angle for best visibility.

END OF SECTION
SECTION 220523 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following general-duty valves:
   1. Bronze ball valves.
   2. Bronze check valves.
   3. Iron swing check valves.
   4. Spring-loaded, lift-disc check valves.
   5. Bronze gate valves.
   6. Cast-iron gate valves.

B. See Division 21 fire-suppression piping and fire pump Sections for fire-protection valves.

C. See Division 23 piping Sections for specialty valves applicable to those Sections only.

1.2 SUBMITTALS

A. For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; furnished specialties; and accessories.

1.3 QUALITY ASSURANCE

A. ASME Compliance: ASME B31.9 Building Services Piping.

B. Potable Water: NSF 61 or NSF 72 certification for valve materials by a third party is required for potable-water service.

C. Source Limitations for Valves: Obtain each type of valve from single manufacturer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 VALVES, GENERAL

A. Refer to Part 3 "Valve Applications" Article for applications of valves.
B. Valves: NPS 2 and Smaller: Threaded or soldered ends, unless otherwise indicated.

C. Valves: NPS 2-1/2 and Larger: Flanged ends, unless otherwise indicated.

D. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system test pressures and temperatures.

E. Valve Sizes: Same as upstream pipe, unless otherwise indicated.

F. Valve Actuators:
   1. Handwheel: Non-heating style of cast, malleable iron or aluminum for gear-operated, quarter-turn valves and all valves other than quarter-turn types, located not more than 8 feet above walkway.
   2. Chainwheel Actuators: For gear-operated, quarter-turn valves and all valves other than quarter-turn types, located more than 8 feet above walkways. Adjust chain length to maintain 7 feet clearance above walkway.
   3. Lever Handle: For quarter-turn valves NPS 6 and smaller. Provide infinite-position handle with open-position memory stop in balancing applications, and where indicated on Drawings.

G. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
   1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

H. Solder Joint: With sockets according to ASME B16.18.
   a. Caution: Use solder with melting point below 840 deg F for angle, check, and gate valves; below 421 deg F for ball valves.

I. Threaded: With threads according to ASME B1.20.1.


2.3 BRONZE BALL VALVES

A. Manufacturers:
   1. Two-Piece, Bronze Ball Valves:
      a. Honeywell Braukmann.
      b. Milwaukee Valve Company.
   2. Safety-Exhaust, Bronze Ball Valves:
      a. Milwaukee Valve Company.
B. Bronze Ball Valves, General: MSS SP-110.

C. Two-Piece, Bronze Ball Valves: Bronze body with full-port, stainless steel ball; PTFE seats; and 600-psig minimum CWP rating, 0˚F to 400˚F range, and blowout-proof stem.

D. Safety-Exhaust, Bronze Ball Valves: Two-piece bronze body with exhaust vent opening, chrome-plated ball with vent, blowout-proof stem, locking handle, and working pressure rating of 400-psig CWP.

2.4 BRONZE SWING CHECK VALVES

A. Manufacturers:

1. Bronze, Swing Check Valves with Nonmetallic Disc:
   a. Milwaukee Valve Company.

2. Description: MSS SP-80, Type 4.
   a. Standard: MSS SP-80, Type 4.
   b. SWP Rating: 150 psig.
   c. Design: Horizontal flow.
   e. Ends: Threaded.
   f. Disc: PTFE.

2.5 IRON SWING CHECK VALVES

A. Manufacturers:

1. Iron Swing Check Valves with Metal Seats:
   a. Grinnell Corporation.
   b. Milwaukee Valve Company.
   c. Mueller Co.

2. Description:
   a. Standard: MSS SP-71, Type I.
   b. SWP Rating: 125 psig.
   c. Body Design: Clear or full waterway.
   d. Body Material: ASTM A 126, iron with bolted bonnet.
   e. Design: Horizontal flow.
   f. Trim: Bronze.
   g. Gasket: Asbestos free.
2.6 SPRING-LOADED, LIFT-DISC CHECK VALVES

A. Manufacturers:

1. Lift-Disc Check Valves:
   a. Milwaukee Valve Company.
   b. Mueller Steam Specialty.

2. Description:
   b. SWP Rating: 125 psig.
   c. Body Material: Bronze.
   d. Disc Holder: Bronze.
   e. Disc ring: PTFE.
   f. Spring: Bronze.

2.7 BRONZE GATE VALVES

A. Manufacturers:

1. Bronze, Rising-Stem, Solid-Wedge Gate Valves:
   a. Milwaukee Valve Company.

2. Description:
   a. Standard: MSS SP-80, Type 1.
   b. SWP Rating: 150 psig.
   d. Stem: Bronze.
   e. Disc: Solid wedge; bronze.
   f. Packing: Asbestos free.
   g. Handwheel: Malleable iron or bronze.

2.8 CAST-IRON GATE VALVES

A. Manufacturers:

1. Cast-Iron, Nonrising-Stem Gate Valves:
   a. Grinnell Corporation.
   b. Milwaukee Valve Company.

2. Description:
   a. Standard: MSS SP-70, Type I.
   b. SWP Rating: 150 psig.
   c. Body Material: ASTM A 126, gray iron with bolted bonnet.
d. Trim: Bronze.
e. Disc: Solid wedge.
f. Packing and Gasket: Asbestos free.

PART 3 - EXECUTION

3.1 VALVE APPLICATIONS

A. Refer to piping Sections for specific valve applications. If valve applications are not indicated, use the following:
   1. Shutoff Service: Ball or butterfly valves.
   2. Throttling Service: Ball valves.

B. If valves with specified CWP ratings are not available, the same types of valves with higher CWP ratings may be substituted.

C. Low-Pressure, Compressed-Air Piping:
   1. Ball Valves, NPS 2 and Smaller: Two-piece, 400-psig CWP rating, bronze.
   2. Equipment-Isolation Ball Valves, NPS 2 and Smaller: Safety-exhaust, bronze.
   3. Ball Valves, NPS 2-1/2 and Larger: Class 150, ferrous alloy.
   4. Swing Check Valves, NPS 2 and Smaller: Class 150, bronze.
   5. Swing Check Valves, NPS 2-1/2 and Larger: Class 250, gray iron.
   7. Spring-Loaded, Lift-Disc Check Valves, NPS 2-1/2 and Larger: Class 250, cast iron.

D. Domestic Water Piping: Use the following types of valves:
   1. Ball Valves, NPS 2 and Smaller: Two-piece, 400-psig CWP rating, bronze.
   2. Ball Valves, NPS 2-1/2: Class 150, ferrous alloy.
   3. Swing Check Valves, NPS 2 and Smaller: Class 125, bronze. (Horizontal only)
   4. Swing Check Valves, NPS 2-1/2 and Larger: Class 125, iron. (Horizontal only)
   5. Spring-Loaded, Lift-Disc Check Valves, NPS 2 and Smaller: Class 125 minimum.
   6. Spring-Loaded, Lift-Disc Check Valves, NPS 2-1/2 and Larger: Class 125, cast iron.
   7. Gate Valves, NPS 8 and Larger: Class 125, OS&Y, bronze-mounted cast iron.

E. Pumped Piping: Use the following types of valves:
   1. Ball Valves, NPS 2 and Smaller: Two-piece, 400-psig CWP rating, copper alloy.
   2. Ball Valves, NPS 2-1/2: Class 150, ferrous alloy.
   3. Swing Check Valves, NPS 2 and Smaller: Class 125, bronze. (Horizontal only)
   4. Swing Check Valves, NPS 2-1/2 and Larger: Class 125, gray iron. (Horizontal only)
   5. Gate Valves, NPS 6 and Larger: Class 125, OS&Y, bronze-mounted cast iron.
   6. Lift check valves: vertical position
3.2 VALVE INSTALLATION

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

C. Locate valves for safe access by personnel with both hands simultaneously and provide separate support where necessary. Access shall include repair and replacement of the valve, as well as actuation.

D. Install valves in horizontal piping with stem at or above center of pipe.

E. Install quarter-turn valves so handle in open position is downstream of valve.

F. Install valves in position to allow full stem movement.

G. Install check valves for proper direction of flow and as follows:
   1. Swing Check Valves: In horizontal position with hinge pin level.
   2. Lift Check Valves: With stem upright and plumb, vertical positions.

H. Install branch line isolation valves close to the branch connection.

3.3 JOINT CONSTRUCTION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for basic piping joint construction.

END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Steel pipe hangers and supports.
   2. Metal framing systems.
   3. Thermal-hanger shield inserts.
   4. Fastener systems.
   5. Equipment supports.

B. See Division 21 for fire-suppression piping.

C. [See Division 22 Section "Expansion Fittings and Loops for Plumbing Piping" for pipe guides and anchors.]

D. [See Division 22 Section "Vibration [and Seismic] Controls for Plumbing Piping and Equipment" for vibration isolation devices.]

1.2 DEFINITIONS

A. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.3 PERFORMANCE REQUIREMENTS

A. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. [Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.]

1.4 SUBMITTALS

A. Product Data: For the following:
   1. Steel pipe hangers and supports.
   2. Metal framing systems.
   3. Thermal-hanger shield inserts.
   4. Powder-actuated fastener systems.

B. Welding certificates.
1.5 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 STEEL PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

B. Manufacturers:
   2. Carpenter & Paterson, Inc.
   3. ERICO/Michigan Hanger Co.
   4. Grinnell Corp.
   5. Tolco Inc.

C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.3 METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.

B. Manufacturers:
   2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
   3. Tolco Inc.
   4. Unistrut Corp.; Tyco International, Ltd.

C. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.
2.4 THERMAL-HANGER SHIELD INSERTS

A. Description: 100-psig minimum, compressive-strength insulation insert encased in sheet metal shield.

B. Manufacturers:
1. Carpenter & Paterson, Inc.
2. ERICO/Michigan Hanger Co.
3. Pipe Shields, Inc.

C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass with vapor barrier.

D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass.

E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

G. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
   1. Manufacturers:
      a. Hilti, Inc.
      b. ITW Ramset/Red Head.
      c. Masterset Fastening Systems, Inc.
      d. MKT Fastening, LLC.
      e. Powers Fasteners.

B. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated or stainless steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
   1. Manufacturers:
      b. Hilti, Inc.
      c. ITW Ramset/Red Head.
      d. MKT Fastening, LLC.
      e. Powers Fasteners.

2.6 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.
2.7 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
   2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
   1. Contractor’s Option 1: Provide felt-lined pipe insulator or elastomeric pipe clamp cushion where ferrous attachments are in direct contact with copper tubing.
   2. Contractor’s Option 2: Wrap copper tubing with not less than two layers of 10 mil thick black plastic tape extending to a minimum of 1 inch on each side of clamp.

E. Use padded hangers for piping that is subject to scratching.

F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
   2. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
   3. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
   4. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
   5. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
   6. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
   7. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.

G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.

H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.

I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For support of pipes to NPS 4, under roof installations with bar-joist construction to attach to top flange of structural shape. Provide retainer strap.
3. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
4. C-Clamps (MSS Type 23): For support of pipes to NPS 4, attached to structural shapes. Provide retaining strap.
5. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
   a. Light (MSS Type 31): 750 lb.
   b. Medium (MSS Type 32): 1500 lb.
   c. Heavy (MSS Type 33): 3000 lb.
6. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

K. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

L. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

M. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

3.2 HANGER AND SUPPORT INSTALLATION

A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

D. Fastener System Installation:
1. Install powder-actuated fasteners in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual. Do not use in lightweight concrete or concrete slabs less than 4 inches thick.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions. Do not use in lightweight concrete or concrete slabs less than 4 inches thick.

E. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.


G. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

H. Install lateral bracing with pipe hangers and supports to prevent swaying.

I. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

J. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.

L. Insulated Piping: Comply with the following:
1. Attach clamps and spacers to piping.
   a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
   b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
   c. Do not exceed pipe stress limits according to ASME B31.9 for building services piping.
2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
4. Shield Dimensions for Pipe: Not less than the following:
   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
   b. NPS 4: 12 inches long and 0.06 inch thick.
   c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
   d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
   e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
5. Pipes NPS 8 and Larger: Include wood inserts.
6. Insert Material: Length at least as long as protective shield.
7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.
3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

3.6 PAINTING

A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION
SECTION 220548 - VIBRATION AND SEISMIC CONTROLS FOR PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Elastomeric isolation pads.
   2. Elastomeric isolation mounts.
   3. Restrained spring isolators.
   4. Elastomeric hangers.
   5. Spring hangers with vertical-limit stops.
   6. Pipe riser resilient supports.
   7. Resilient pipe guides.
   8. Restraining braces and cables.

1.2 SUBMITTALS

A. Product Data: For each product indicated. Include load deflection curves.

1.3 QUALITY ASSURANCE


PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Ace Mountings Co., Inc.
   2. Amber/Booth Company, Inc.
   4. Isolation Technology, Inc.
   7. Vibration Eliminator Co., Inc.
   8. Vibration Isolation.

B. Elastomeric Isolation Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
   1. Resilient Material: Oil- and water-resistant neoprene.
C. Elastomeric Isolation Mounts: Double-deflection type, with molded, oil-resistant, neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.
1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.

D. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with limit-stop restraint.
1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch- thick, neoprene isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
2. Restraint: Limit-stop as required for equipment.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

E. Elastomeric Hangers: Single or double-deflection type, fitted with molded, oil-resistant neoprene isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.

F. Spring Hangers with Vertical-Limit Stop: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.
1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant neoprene.
7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

G. Pipe Riser Resilient Support: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch- thick neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psig and for equal resistance in all directions.

H. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes or post and sleeve arrangement separated by a minimum of 1/2-inch- thick neoprene. Where clearances are not readily visible, a factory-set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction shall be fitted. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.
PART 3 - EXECUTION

3.1 APPLICATIONS

A. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits.

3.2 VIBRATION-CONTROL DEVICE INSTALLATION

A. Equipment Restraints:
   1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inches.

B. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

C. Drilled-in Anchors:
   1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
   2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
   3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
   4. Set anchors to manufacturer’s recommended torque, using a torque wrench.
   5. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

3.3 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust active height of spring isolators.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION
SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Valve tags.

1.2 SUBMITTAL

A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: Black anodized aluminum, for mechanical engraving, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number as directed by Owner.
2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.


C. Background Color: Red.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1 inch main lettering, 3/4 secondary lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information, plus emergency notification instructions, as indicated on drawings and specifications.

2.3 PIPE LABELS


B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Rigid Carrier Pipe Labels: Use only MS-995 Maxilar™ Rigid Carrier Pipe Markers strapped to pipe with Type 316 ssstl banding.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, and an arrow indicating flow direction.
   1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
   2. Lettering Size:
      3. Pipe: <2.5” Letters: 3/4” high      Pipe: 2.5 – 6”     Letters: 1.5” high
      4. Pipe: 8-10” Letters: 2.5” high     Pipe: >10”        Letters: 3.5” high

2.4 VALVE TAGS

A. Valve Tags: Stamped or engraved, minimum 2-inch size with 1/4-inch letters for piping system abbreviation and function, i.e., balance, drain, shutoff, stop. Include 1/2-inch identifying number. Provide 5/32-inch hole for fastener.
   1. Material: 0.032-inch-thick brass.
   2. Valve-Tag Fasteners: Brass wire-link or beaded chain; or S-hook.
PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of plumbing equipment.
B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.
   1. Pipes with OD, Including Insulation, Less Than 6 Inches: Pre-tensioned pipe markers. Use size to ensure a tight fit.
   2. Pipes with OD, Including Insulation, 6 Inches and Larger: MS-995 Maxilar™ Rigid Carrier Pipe Markers
B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
   1. Near each valve and control device.
   2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
   3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
   4. At access doors, manholes, and similar access points that permit view of concealed piping.
   5. Near major equipment items and other points of origination and termination.
   6. Spaced at maximum intervals of 20 feet along each run. Reduce intervals to 10 feet in areas of congested piping and equipment.
C. Pipe Label Color Schedule: Comply with ANSI A13.1

3.4 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems including piping within refrigeration machinery rooms, boiler rooms, mechanical equipment room, mechanical equipment yards, piping mains, and piping branches serving more than one piece of equipment. Tags are not required on check valves; valves within factory-fabricated equipment units; plumbing fixture supply stops; faucets; convenience and lawn-watering hose connections; and roughing-in connections of end-use fixtures and units.
B. Where the Engineer has produced a valve schedule, all controlled and manual valves shall have a valve tag installed.

C. List tagged valves in a valve schedule. Valve schedule shall indicate the following:

1. Valve Identification Number.
2. Piping System: e.g., CA, DCW.
3. Function: e.g., balance, drain, shut-off, stop.
4. Location: e.g., "Above ceiling in Corridor C-01 near Room 117."
5. Equipment/Area Served: e.g., AH-1, CH-1, West Wing.

D. Mount valve schedule under glass in main mechanical room, or elsewhere as directed by Owner. Include copy in O&M Manual.

3.5 ADJUSTING AND CLEANING

A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

B. Clean faces or mechanical identification devices and glass frames of valve schedules.

END OF SECTION
SECTION 220719 - PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulating the following plumbing piping services:
   1. Domestic hot-water piping.
   2. Domestic recirculating hot-water piping.
   3. Sanitary waste piping exposed to freezing conditions.
   4. Storm-water piping exposed to freezing conditions.
   5. Roof drains and rainwater leaders.

B. Related Sections:
   1. Section 220716 "Plumbing Equipment Insulation."

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
   2. Detail attachment and covering of heat tracing inside insulation.
   3. Detail insulation application at pipe expansion joints for each type of insulation.
   4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
   5. Detail removable insulation at piping specialties, equipment connections, and access panels.
   6. Detail application of field-applied jackets.
   7. Detail application at linkages of control devices.

C. Field quality-control reports.

1.3 QUALITY ASSURANCE

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. **Insulation Installed Outdoors:** Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

B. Comply with the following applicable standards and other requirements specified for miscellaneous components:


**PART 2 - PRODUCTS**

2.1 **INSULATION MATERIALS**

A. Comply with requirements in "Piping Insulation Schedule(s)" for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Pittsburgh Corning Corporation; Foamglas.
2. Special-Shaped Insulation: ASTM C 552, Type III.
3. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
4. Preformed Pipe Insulation with Factory-Applied [ASJ] [ASJ-SSL]: Comply with ASTM C 552, Type II, Class 2.
5. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

G. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Aeroflex USA, Inc.; Aerocel.
   b. Armacell LLC; AP Armaflex.
   c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.

H. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
a. Fibrex Insulations Inc.; Coreplus 1200.
b. Johns Manville; Micro-Lok.
c. Knauf Insulation; 1000-Degree Pipe Insulation.
d. Manson Insulation Inc.; Alley-K.
e. Owens Corning; Fiberglas Pipe Insulation.

2. Type I, 850 Deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

I. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Armacell LLC; Tubolit.
   b. Nomaco Insulation; IMCOLOCK and NOMALOCK.

2.2 INSULATING CEMENTS

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Aeroflex USA, Inc.; Aerosal.
   b. Armacell LLC; Armaflex 520 Adhesive.
d. K-Flex USA; R-373 Contact Adhesive.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
1. Products: Subject to compliance with requirements, [provide one of the following:
   b. Eagle Bridges - Marathon Industries; 225.
   d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

1. Products: Subject to compliance with requirements, provide one of the following:
   b. Eagle Bridges - Marathon Industries; 225.
   d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

F. PVC Jacket Adhesive: Compatible with PVC jacket.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Dow Corning Corporation; 739, Dow Silicone.
   d. Speedline Corporation; Polycy VP Adhesive.
2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services’ "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
   1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
   1. **Products**: Subject to compliance with requirements, provide one of the following:
      b. Vimasco Corporation; 749.
   2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
   3. Service Temperature Range: Minus 20 to plus 180 deg F.
   4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
   1. **Products**: Subject to compliance with requirements, provide one of the following:
      b. Eagle Bridges - Marathon Industries; 550.
      e. Vimasco Corporation; WC-1/WC-5.
   2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
   3. Service Temperature Range: Minus 20 to plus 180 deg F.
   4. Solids Content: 60 percent by volume and 66 percent by weight.

2.5 SEALANTS

A. Joint Sealants:
   1. **Joint Sealants for Cellular-Glass Products**: Subject to compliance with requirements, provide one of the following:
      b. Eagle Bridges - Marathon Industries; 405.
d. Mon-Eco Industries, Inc.; 44-05.
e. Pittsburgh Corning Corporation; Pittseal 444.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Permanently flexible, elastomeric sealant.
4. Service Temperature Range: Minus 100 to plus 300 deg F.
5. Color: White or gray.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. FSK and Metal Jacket Flashing Sealants:
1. Products: Subject to compliance with requirements, provide one of the following:
   b. Eagle Bridges - Marathon Industries; 405.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
   d. Mon-Eco Industries, Inc.; 44-05.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
1. Products: Subject to compliance with requirements, provide one of the following:

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
   1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
   2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
   3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.7 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for pipe.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      b. Vimasco Corporation; Elastafab 894.

2.8 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Johns Manville; Zeston.
      c. Proto Corporation; LoSmoke.
      d. Speedline Corporation; SmokeSafe.
   2. Adhesive: As recommended by jacket material manufacturer.
   3. Color: White or Color-code jackets based on piping system.
   4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
      a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

C. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
c. RPR Products, Inc.; Insul-Mate.
d.
2. Sheet and roll stock ready for shop or field sizing.
3. Finish and thickness are indicated in field-applied jacket schedules.
4. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper or 2.5-mil- thick polysurlyn.
5. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
6. Factory-Fabricated Fitting Covers:
   a. Same material, finish, and thickness as jacket.
   b. Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
   c. Tee covers.
   d. Flange and union covers.
   e. End caps.
   f. Beveled collars.
   g. Valve covers.
   h. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

D. Underground Direct-Buried Jacket: 125-mil- thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Pittsburgh Corning Corporation; Pittwrap.
   b. Polyguard Products, Inc.; Insulrap No Torch 125.

2.9 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. ABL, Ideal Tape Division; 428 AWF ASJ.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
   c. Compac Corporation; 104 and 105.
   d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
2. Width: 3 inches.
3. Thickness: 11.5 mils.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lb/ft in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. ABL, Ideal Tape Division; 491 AWF FSK.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
   c. Compac Corporation; 110 and 111.
d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.

2. Width: 3 inches.
3. Thickness: 6.5 mils.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. ABI, Ideal Tape Division; 370 White PVC tape.
   b. Compac Corporation; 130.
   c. Venture Tape; 1506 CW NS.
   d. <Insert manufacturer's name; product name or designation>.
2. Width: 2 inches.
3. Thickness: 6 mils.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. ABI, Ideal Tape Division; 488 AWF.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
   c. Compac Corporation; 120.
   d. Venture Tape; 3520 CW.
2. Width: 2 inches.
3. Thickness: 3.7 mils.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

2.10 SECUREMENTS

A. Aluminum Bands: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with closed seal.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. ITW Insulation Systems; Gerrard Strapping and Seals.
   b. RPR Products, Inc.; Insul-Mate Strapping and Seals.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

C. Wire: [0.080-inch nickel-copper alloy] [0.062-inch soft-annealed, stainless steel]
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
b. <Insert manufacturer’s name>.

2.11 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Engineered Brass Company.
   b. Insul-Tect Products Co.; a subsidiary of MVG Molded Products.
   c. McGuire Manufacturing.
   d. Plumberex.
   e. Truebro; a brand of IPS Corporation.
   f. Zurn Industries, LLC; Tubular Brass Plumbing Products Operation.

2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

B. Protective Shielding Piping Enclosures:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Truebro; a brand of IPS Corporation.
   b. Zurn Industries, LLC; Tubular Brass Plumbing Products Operation.

2. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples at edge 4 inches o.c.
      a. For below-ambient services, apply vapor-barrier mastic over staples.
   4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
   5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:
   1. Vibration-control devices.
   2. Testing agency labels and stamps.
   3. Nameplates and data plates.

3.3 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
   4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
   4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
   1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.
F. Insulation Installation at Floor Penetrations:
   1. Pipe: Install insulation continuously through floor penetrations.
   2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.4 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
   1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
   2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
   3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
   4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
   5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
   6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
   7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
   8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
   1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
   2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
   3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
   4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
   5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.5 INSTALLATION OF CELLULAR-GLASS INSULATION

A. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
   2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward clinched staples at 6 inches o.c.
   4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.

4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
   2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed sections of cellular-glass insulation to valve body.
   2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   3. Install insulation to flanges as specified for flange insulation application.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:
   1. Install pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
   4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install mitered sections of pipe insulation.
   2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed valve covers manufactured of same material as pipe insulation when available.
   2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 INSTALLATION OF MINERAL-FIBER PREFORMED PIPE INSULATION

A. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
   2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
   4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
   4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
   3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   4. Install insulation to flanges as specified for flange insulation application.

3.8 INSTALLATION OF POLYOLEFIN INSULATION

A. Insulation Installation on Straight Pipes and Tubes:
1. Seal split-tube longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:
   1. Install pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of same thickness as pipe insulation.
   4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install mitered sections of polyolefin pipe insulation.
   2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install cut sections of polyolefin pipe and sheet insulation to valve body.
   2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   3. Install insulation to flanges as specified for flange insulation application.
   4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.9 FIELD-APPLIED JACKET INSTALLATION

A. Where FSK jackets are indicated, install as follows:
   1. Draw jacket material smooth and tight.
   2. Install lap or joint strips with same material as jacket.
   3. Secure jacket to insulation with manufacturer's recommended adhesive.
   4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
   5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.
   1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.
3.10 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
   1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.11 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
   1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.12 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
   1. Drainage piping located in crawl spaces.
   2. Underground piping.
   3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.13 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Hot and Recirculated Hot Water: Insulation shall be the following:
1. Flexible Elastomeric: 3/4 inch thick.
2. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.

B. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities: Insulation shall be the following:
1. Flexible Elastomeric: 1/2 inch thick.
2. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.
3. Polyolefin: 1/2 inch thick.

3.14 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Domestic Water Piping: Insulation shall be one of the following:
1. Cellular Glass: 2 inches thick.
2. Flexible Elastomeric: 2 inches thick.
3. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.
4. Polyolefin: 2 inches thick.

B. Domestic Hot and Recirculated Hot Water: Insulation shall be one of the following:
1. Cellular Glass: 2 inches thick.
2. Flexible Elastomeric: 2 inches thick.
3. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.
4. Polyolefin: 2 inches thick.

3.15 OUTDOOR, UNDERGROUND PIPING INSULATION SCHEDULE

A. Not Applicable

3.16 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed or exposed:
1. PVC, Color-Coded by System: [20 mils] [30 mils] thick.

3.17 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:
1. [PVC] [PVC, Color-Coded by System]: [20 mils] [30 mils] thick.
2. Aluminum, Corrugated: [0.020 inch] [0.024 inch] thick.

D. Piping, Exposed:
   1. [PVC] [PVC, Color-Coded by System]: [20 mils] [30 mils] thick.
   2. Aluminum, Corrugated: [0.020 inch] [0.024 inch] thick.

3.18 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET

A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes water distribution piping and related components outside the building for water service and fire-service mains.

B. Utility-furnished products include water meters that will be furnished to the site, ready for installation.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Detail precast concrete vault assemblies and indicate dimensions, method of field assembly, and components.

C. Field quality-control test reports.

D. Operation and maintenance data.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.

2. Comply with standards of authorities having jurisdiction for potable-water-service piping, including materials, installation, testing, and disinfection.

3. Comply with standards of authorities having jurisdiction for fire-suppression water service piping, including materials, hose threads, installation, and testing.

B. Piping materials shall bear label, stamp, or other markings of specified testing agency.

C. Comply with ASTM F 645 for selection, design, and installation of thermoplastic water piping.

D. Comply with FMG's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.

E. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.

F. NSF Compliance:
1. Comply with NSF 14 for plastic potable-water-service piping. Include marking "NSF-pw" on piping.
2. Comply with NSF 61 for materials for water-service piping and specialties for domestic water.

1.4 COORDINATION

A. Coordinate connection to water main with utility company.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS – Domestic Water Service

A. Copper Tube:
   1. Soft Copper, ASTM B 88, Type K, water tube, annealed
   2. Hard Copper, ASTM B 88, Type K, water tube, drawn temper.
   4. Solder Filler Metals: ASTM B 32, lead-free alloy, Sterling Premium Grade or Silverbrite 100. Include water-flushable flux according to ASTM B 813.
   5. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

B. PVC Pipe:
   1. Pipe:
      a. PVC, AWWA C900, Class 165, with bell end with gasket, and with spigot end.
   2. Fittings:
      a. Ductile Iron, Mechanical Joint type, AWWA C110, ductile iron standard pattern or AWWA C153, ductile iron compact pattern.
      b. Mechanical Wedge Action Joint Restraints, Grade 65-45-12 ductile iron per ASTM A536, break-off torque control nuts, UL listed, FM approved
      c. Glands, Gaskets, and Bolts: AWWA C111, ductile iron glands, rubber gaskets, and steel bolts.

C. Ductile Iron Pipe:
   1. Pipe:
2. Ductile Iron, AWWA C151, with bell and spigot ends or flanged ends.

2.1 Fittings:
   a. Ductile Iron, Mechanical Joint type, AWWA C110, ductile iron standard pattern or AWWA C153, ductile-iron compact pattern.
   b. Mechanical Wedge Action Joint Restraints, Grade 65-45-12 ductile iron per ASTM A536, break-off torque control nuts, UL listed, FM approved.
   c. Glands, Gaskets, and Bolts: AWWA C111, ductile iron glands, rubber gaskets, and steel bolts.
   d. Flanges: ASME B16.1, Class 125, cast iron.

2.2 PIPE AND FITTINGS – Fire Service @City Water Pressure

A. Polyethylene Pipe:
   1. Pipe: ASTM F 714, AWWA C906, or equivalent for Polyethylene (PE) water pipe; FMG approved, with minimum thickness equivalent to FMG Class 150.
   2. Molded PE Fittings: ASTM D 3350, PE resin, socket- or butt-fusion type, made to match PE pipe dimensions and class.

B. PVC Pipe:
   1. Pipe:
      a. PVC, AWWA C900, Class 235, with bell end with gasket, and with spigot end.
   2. Fittings:
      a. Ductile Iron, Mechanical Joint type, AWWA C110, ductile iron standard pattern or AWWA C153, ductile iron compact pattern.
      b. Mechanical Wedge Action Joint Restraints, Grade 65-45-12 ductile iron per ASTM A536, break-off torque control nuts, UL listed, FM approved.
      c. Glands, Gaskets, and Bolts: AWWA C111, ductile iron glands, rubber gaskets, and steel bolts.

C. Ductile Iron Pipe:
   1. Pipe:
      a. Ductile Iron, AWWA C151, with bell and spigot ends or flanged ends.
   2. Fittings:
      a. Ductile Iron, Mechanical Joint type, AWWA C110, ductile iron standard pattern or AWWA C153, ductile iron compact pattern.
      b. Mechanical Wedge Action Joint Restraints, Grade 65-45-12 ductile iron per ASTM A536, break-off torque control nuts, UL listed, FM approved.
      c. Glands, Gaskets, and Bolts: AWWA C111, ductile iron glands, rubber gaskets, and steel bolts.
   3. Flanges:
      a. Cast iron, ASME B16.1, Class 125.
      b. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
         1) ASME B16.21, rubber, flat, asbestos free, 1/8-inch (3.2-mm) maximum thickness, unless otherwise indicated.
         2) Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
3) Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
4) AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
5) Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

2.3 PIPE AND FITTINGS – Fire Service @Booster Pump Pressure

A. PVC Pipe:
1. Pipe:
   a. Ductile Iron, AWWA C900, Class 305, with bell end with gasket, and with spigot end.
2. Fittings:
   a. Ductile Iron, Mechanical Joint type, AWWA C110, ductile iron standard pattern or AWWA C153, ductile iron compact pattern.
   b. Mechanical Wedge Action Joint Restraints, Grade 65-45-12 ductile iron per ASTM A536, break-off torque control nuts, UL listed, FM approved
   c. Glands, Gaskets, and Bolts: AWWA C111, ductile iron glands, rubber gaskets, and steel bolts.

B. Ductile Iron Pipe:
1. Pipe:
   a. Ductile Iron, AWWA C151, with bell and spigot ends or flanged ends.
2. Fittings:
   a. Ductile Iron, AWWA C110, ductile iron standard pattern or AWWA C153, ductile iron compact pattern.
   b. Mechanical Wedge Action Joint Restraints, Grade 65-45-12 ductile iron per ASTM A536, break-off torque control nuts, UL listed, FM approved
   c. FM approved Glands, Gaskets, and Bolts: AWWA C111, ductile iron glands, rubber gaskets, and steel bolts.
3. Flanges:
   a. Cast iron, ASME B16.1, Class 125.
   b. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
      1) ASME B16.21, rubber, flat, asbestos free, 1/8-inch (3.2-mm) maximum thickness, unless otherwise indicated.
      2) Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      3) Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
      4) AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
      5) Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
2.4 PIPING SPECIALTIES

A. Transition Fittings: Manufactured fitting or coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

B. Tubular-Sleeve Pipe Couplings:
   1. Description: Metal, bolted, sleeve-type, reducing or transition coupling, with center sleeve, gaskets, end rings, and bolt fasteners and with ends of same sizes as piping to be joined.

2.5 VALVES

A. Domestic Water, NPS 4 to NPS 8, AWWA, Cast-Iron Gate Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
      c. McWane, Inc.; Kennedy Valve Div.
      d. Mueller Co.; Water Products Div.
      e. Watts.
      f. Apollo.

2. Nonrising-Stem, Resilient-Seated Gate Valves:
   a. Description: Gray or ductile iron valve body and bonnet; with bronze, gray, or ductile iron valve gate, resilient seats, bronze stem, and stem nut.
      1) Standard: AWWA C509.
      2) Minimum Pressure Rating: 200 psig.
      3) End Connections: Mechanical joint or flanged.
      4) Interior Coating: Complying with AWWA C550.
      5) 2” square operating nut for below grade installations, hand wheel for above grade installations

B. Underground Domestic Water, NPS 3/4 to NPS 2, AWWA, Brass Corporation Stops:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Mueller
      b. A. Y. McDonald
      c. Ford Meter Box

2. Ball Type Corporation Stops
   a. Description: Brass body, coated ball.
1) Standard: AWWA C800

2) Minimum Pressure Rating: 300 psig

3) EPDM seats and gaskets

4) 2” square operating nut

C. Aboveground Domestic Water, NPS 3/4 to NPS 4, AWWA, Ball Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Mueller
   b. Watts
   c. Apollo.

2. Full Port Ball Valve
   a. Description: Copper alloy body, stainless steel or coated brass ball.
      1) Standard: NSF/ANSI 61
      2) Minimum Pressure Rating: 150 psig
      3) PTFE Seats
      4) Blowout proof stem

D. Fire Service, NPS 4 to NPS 8, UL/FMG, Cast-Iron Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
   c. McWane, Inc.; Kennedy Valve Div.
   d. Mueller Co.; Water Products Div.

2. UL/FMG, Nonrising-Stem Gate Valves:
   a. Description: Iron body and bonnet with flange for indicator post, bronze seating material, and inside screw.
      1) Standards: UL 262 and FMG approved.
      2) Minimum Pressure Rating: 175 psig.
      3) End Connections: Flanged.

3. OS&Y, Rising-Stem Gate Valves:
   a. Description: Iron body and bonnet and bronze seating material.
      1) Standards: UL 262 and FMG approved.
2) Minimum Pressure Rating: 175 psig.
3) End Connections: Flanged.

2.6 VALVE ACCESSORIES AND SPECIALTIES

A. Tapping-Sleeve Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. McWane, Inc.; Kennedy Valve Div.
   c. Mueller Co.; Water Products Div.

2. Description: Sleeve and valve compatible with drilling machine.
   a. Standard: MSS SP-60.
   b. Tapping Sleeve: Cast- or ductile-iron or stainless-steel, two-piece bolted sleeve with flanged outlet for new branch connection. Include sleeve matching size and type of pipe material being tapped and with recessed flange for branch valve.
   c. Valve: AWWA, cast-iron, nonrising-stem, resilient-seated gate valve with one raised face flange mating tapping-sleeve flange.

B. Valve Boxes: Comply with MAG Standard Detail No. 391-1 and 270, Type A with a Class C900 PVC sleeve instead of cast iron sleeve. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over valve and with a barrel approximately 5 inches in diameter.
   1. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.
   2. Valve Stem Extensions: Steel, centering ring, rock guard, 2" operating nut, 2" socket with two locking screws

C. Indicator Posts: UL 789, FMG-approved, vertical-type, cast-iron body with operating wrench, extension rod, and adjustable cast-iron barrel of length required for depth of burial of valve.

2.7 WATER METERS

A. Water meters will be furnished by utility company.

2.8 WATER METER BOXES

A. Installed by Municipal Water Department or their contractors

2.9 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers for water service:
Watts LF909

Wilkins 375RP

B. Double-Check, Backflow-Prevention Assemblies for fire service:

Wilkens 350A

2.8 CONCRETE VAULTS

A. Description: Precast, reinforced-concrete vault, designed for A-16 load designation according to ASTM C 857 and made according to ASTM C 858.

2. Manhole: ASTM A 48/A 48M Class No. 35A minimum tensile strength, gray-iron traffic frame and cover.
   a. Dimension: 36-inch minimum diameter, unless otherwise indicated.
3. Manhole: ASTM A 536, Grade 60-40-18, ductile-iron traffic frame and cover.
   a. Dimension: 36-inch minimum diameter, unless otherwise indicated.
4. Drain: ASME A112.6.3, cast-iron floor drain with outlet of size indicated. Include body anchor flange, light-duty cast-iron grate, bottom outlet, and integral or field-installed bronze ball or clapper-type backwater valve.

2.9 FIRE HYDRANTS

A. Dry-Barrel Fire Hydrants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   d. American Foundry Group, Inc.
   e. East Jordan Iron Works, Inc.
   f. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
   g. McWane, Inc.; Kennedy Valve Div.
   h. McWane, Inc.; M & H Valve Company Div.
   i. Mueller Co.; Water Products Div.
   j. Troy Valve; a division of Penn-Troy Manufacturing, Inc.
   k. U.S. Pipe and Foundry Company.

2. Description: Freestanding, with one NPS 4-1/2 and two NPS 2-1/2 outlets, 5-1/4-inch main valve, drain valve, and NPS 6 mechanical-joint inlet. Include interior
coating according to AWWA C550. Hydrant shall have cast-iron body, compression-type valve opening against pressure and closing with pressure.

b. Pressure Rating: 150 psig minimum.

B. Wet Barrel Fire Hydrants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   c. McWane, Inc.; Clow Valve Co. Div. (Corona).
   d. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
   e. Mueller Co.; Water Products Div.

2. Description: Freestanding, with one NPS 4-1/2 and two NPS 2-1/2 outlets, NPS 6 threaded or flanged inlet, and base section with NPS 6 mechanical-joint inlet. Include interior coating according to AWWA C550.
   b. Pressure Rating: 150 psig minimum.

2.10 FIRE DEPARTMENT CONNECTIONS

A. Fire Department Connections:

1. Manufacturers: Subject to compliance with requirements of the municipality where installed, provide products by one of the following:
   b. Fire End & Croker Corporation.
   c. Guardian Fire Equipment, Inc.
   d. Kidde Fire Fighting.
   e. Potter Roemer.
   f. Reliable Automatic Sprinkler Co., Inc.

2. Description: Freestanding, with cast-bronze body, thread inlets according to NFPA 1963 and matching local fire department hose threads, and threaded bottom outlet. Include lugged caps, gaskets, and chains; lugged swivel connection and drop clapper for each hose-connection inlet; 18-inch high brass sleeve; and round escutcheon plate.
   b. Connections: Two NPS 2-1/2 inlets and one NPS 4 outlet.
   c. Inlet Alignment: Inline, horizontal.
   d. Finish Including Sleeve: Polished bronze.
   e. Escutcheon Plate Marking: "[AUTO SPKR] [&] [STANDPIPE]."
2.11 DIELECTRIC FITTINGS

A. Dielectric Fittings, General: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature. These fittings are to be used only where necessary.

B. Dielectric Unions:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Central Plastics Company.
   b. Epco Sales, Inc.
   d. Watts Water Technologies, Inc.
   e. Zurn Plumbing Products Group; Wilkins Div.

C. Dielectric Flanges:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Central Plastics Company.
   b. Epco Sales, Inc.
   c. Watts Water Technologies, Inc.
   d. CTS Flange

D. Dielectric Couplings:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Calpico, Inc.
   b. Lochinvar Corporation.

E. Dielectric Nipples:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Matco-Norco.
b. Precision Plumbing Products, Inc.

c. Watts.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Refer to Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

A. Domestic Water Service – Underground
1. NPS 3/4 to NPS 3: Type K soft copper tube, cast copper alloy or wrought copper fittings, brazed joints
2. NPS 4 to NPS 8: C900 PVC pipe with push-on joints, ductile iron fittings with mechanical wedge action restraint connections
3. NPS 4 to NPS 8: Ductile iron pipe with push-on joints, ductile iron fittings with mechanical wedge action restraint connections

B. Domestic Water Service – Within Boxes and Vaults Below Grade
1. NPS 3/4 to NPS 3: Type K hard copper tube, cast copper alloy or wrought copper fittings, soldered joints, unions
2. NPS 4 to NPS 8: C900 PVC pipe with push-on joints, ductile iron fittings with mechanical wedge action restraint connections
3. NPS 4 to NPS 8: Ductile iron pipe with push-on joints, ductile iron fittings with mechanical wedge action restraint connections
4. NPS 4 to NPS 8: Ductile iron pipe, ductile iron fittings, flanged connections

C. Domestic Water Service – Above Grade
1. NPS 3/4 to NPS 3: Type K hard copper tube, cast copper alloy or wrought copper fittings, soldered joints, unions
2. NPS 4 to NPS 8: Ductile iron pipe, ductile iron fittings, flanged connections

D. Fire Service @City Water Pressure - Underground
1. Polyethylene water pipe, FMG approved Class 150, with molded PE fittings
2. PVC pipe, AWWA C900, Class 235, with bell end with gasket, and with spigot end, ductile iron fittings with mechanical wedge action restraint connections
3. Ductile iron pipe with push-on joints, ductile iron fittings with mechanical wedge action restraint connections

E. Fire Service @City Water Pressure – Above Grade
1. Ductile iron pipe, ductile iron fittings, flanged connections

F. Fire Service @Booster Pump Pressure - Underground
1. PVC pipe, AWWA C900, Class 305, with bell end with gasket, and with spigot end, ductile iron fittings with mechanical wedge action restraint connections
2. Ductile iron pipe with push-on joints, ductile iron fittings with mechanical wedge action restraint connections

G. Fire Service @Booster Pump Pressure – Above Grade
1. Ductile iron pipe, ductile iron fittings, flanged connections.

3.3 PIPING INSTALLATION

A. Install piping, valves, devices, and accessories in accordance with the manufacturer's published installation instructions.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on the Coordination Drawings.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping to permit valve servicing.

E. Install piping at indicated slopes.

F. Install piping free of sags and bends.

G. Install fittings for changes in direction and branch connections.

H. Select system components with pressure rating equal to or greater than system operating pressure and test pressures.

I. Permanent sleeves are not required for holes formed by removable PE sleeves.

J. Verify final equipment locations before roughing-in.

K. Refer to equipment specifications in other Sections for roughing-in requirements.

L. Water-Main Connection: Municipal water supplier shall make all taps.

M. Comply with NFPA 24 for fire-service-main piping materials and installation.

N. Install copper tube and fittings according to CDA’s "Copper Tube Handbook."

O. Install PE pipe according to ASTM D 2774 and ASTM F 645.

P. Install PVC, AWWA pipe according to ASTM F 645 and AWWA M23.

Q. Bury piping with a minimum of 6 inches of sand on all sides and at least 30 inches below grade.

R. Extend water-service piping and connect to water-supply source and building-water-piping systems at outside face of building wall in locations and pipe sizes indicated.

1. Terminate water-service piping at building wall until building-water-piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping
material. Make connections to building-water-piping systems when those systems are installed.

S. Sleeves are specified in Section 220515 "Common Work Results for Plumbing."

T. Mechanical sleeve seals are specified in Section 220515 "Common work Results for Plumbing."

U. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.

V. Copper tube, ductile iron pipe, fittings, and associated ferrous components installed underground shall be protected with 8 mil polyethylene wrap or 10 mil tape.

3.4 JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.


F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

G. Soldered Joints: Apply ASTM B 813 water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy (0.20 percent maximum lead content) complying with ASTM B 32.


I. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

J. Make pipe joints according to the following:
3. PE Piping Insert-Fitting Joints: Use plastic insert fittings and fasteners according to fitting manufacturer's written instructions.
4. PVC Piping Gasketed Joints: Use joining materials according to AWWA C900. Construct joints with elastomeric seals and lubricant according to ASTM D 2774 or ASTM D 3139 and pipe manufacturer's written instructions.
5. Dissimilar Materials Piping Joints: Use adapters compatible with both piping materials, with OD, and with system working pressure.

3.5 ANCHORAGE INSTALLATION

A. Anchorage, General: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:
   1. Concrete thrust blocks.
   2. Locking mechanical joints.
   4. Bolted flanged joints.
   5. Heat-fused joints.
   6. Pipe clamps and tie rods.
   7. Mechanical wedge action joints

B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:

C. Apply polyethylene wrap or tape to surfaces of installed ferrous anchorage devices.

3.6 VALVE INSTALLATION

A. AWWA Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.

B. UL/FMG, Gate Valves: Comply with NFPA 24. Install each underground valve and valves in vaults with stem pointing up and with vertical cast-iron indicator post.

3.7 BACKFLOW PREVENTER INSTALLATION

A. Install backflow preventers of type, size, and capacity indicated. Include valves and test cocks. Install according to requirements of plumbing and health department and authorities having jurisdiction.

B. Do not install backflow preventers in vault or in other spaces subject to flooding.

C. Do not install bypass piping around backflow preventers.
D. Support NPS 2-1/2 and larger backflow preventers, valves, and piping near floor and on pipe stands or cast in place concrete piers.

E. Provide a y-pattern strainer upstream of a backflow prevention valve assembly serving a domestic water service line.

3.8 CONCRETE VAULT INSTALLATION

A. Install precast concrete vaults according to ASTM C 891.

3.9 FIRE HYDRANT INSTALLATION

A. General: Install each fire hydrant with separate gate valve in supply pipe, anchor with restrained joints or thrust blocks, and support in upright position.

B. Wet-Barrel Fire Hydrants: Install with valve below frost line. Provide for drainage.

C. AWWA Fire Hydrants: Comply with AWWA M17.

D. UL/FMG Fire Hydrants: Comply with NFPA 24.

3.10 FIRE DEPARTMENT CONNECTION INSTALLATION

A. Install protective pipe bollards on three sides of each fire department connection. Pipe bollards are specified in Section 055000 "Metal Fabrications."

3.11 CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 3 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 3 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Install dielectric fittings at connections of dissimilar metal pipes.

B. Connect water-distribution piping to interior domestic water and fire-suppression piping.

3.12 QUALITY CONTROL

A. Piping Tests: Conduct hydrostatic piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.

B. Hydrostatic Tests: Test at not less than the following for two hours:

1. Water Service Piping – 120 psig.
2. Fire Service Piping exposed to city water pressure – 200 psig.

3. Fire Service Piping exposed to booster pump water pressure – 250 psig.

C. Prepare reports of testing activities.

3.13 IDENTIFICATION

A. Install continuous underground tracer wire and detectable warning tape during backfilling of trench for underground water-distribution piping. Locate below finished grade, directly over piping.

B. Permanently attach signage indicating plastic water-service piping has been provided for building, on main electrical meter panel.

3.14 CLEANING

A. Clean and disinfect water-distribution piping as follows:

1. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.

2. Use purging and disinfecting procedure as prescribed below:

   a. Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours.

   b. Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow to stand for 3 hours.

   c. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.

   d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination.

B. Prepare reports of purging and disinfecting activities.

END OF SECTION
SECTION 221116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes domestic water piping under and inside the building.

B. See Division 221113, Section “Facility Water Distribution Piping” for water-service piping and water meters outside the building from source to the point where water-service piping enters the building.

C. See Division 221119, Section "Domestic Water Piping Specialties" for water distribution piping specialties.

1.2 SUBMITTALS

A. Product Data: For each product indicated, include manufacturer’s name, materials of construction, and joining materials.

1.3 QUALITY ASSURANCE

A. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," for potable domestic water piping and components.

B. Piping materials shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Soft Copper Tube: ASTM B 88, Type K, water tube, annealed temper.


2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Furnish Class 300 flanges if required to match piping.

3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

B. Hard Copper Tube: ASTM B 88, Type L, water tube, drawn temper.
2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Furnish Class 300 flanges if required to match piping.
3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

2.2 VALVES
   A. Bronze and cast-iron, general-duty valves are specified in Section 220523 "General-Duty Valves for Plumbing Piping."
   B. Balancing and drain valves are specified in Section 221119 "Domestic Water Piping Specialties."

2.3 PIPING JOINING MATERIALS, SLEEVES, AND SLEEVE SEALS
   A. See Section 220515 Common Work Results for Plumbing

PART 3 - EXECUTION

3.1 EXCAVATION
   A. Excavating, trenching, and backfilling are specified in Section 312000 Earthmoving.

3.2 PIPE AND FITTING APPLICATIONS
   A. Flanges may be used on aboveground piping only.
   B. Under-Building-Slab, Domestic Water NPS 4 and Smaller: Soft copper tube, Type K, no joints below slabs. All underground copper tube shall be protected with 20 mil plastic sleeve.
   C. Aboveground Domestic Water Piping All Sizes: Hard copper tube, Type L; copper pressure fittings; soldered joints for NPS2 and smaller; brazed joints for NPS2-1/2 and larger.
   D. Non-potable Water Piping All Sizes: Same as Domestic Water Piping.
3.3 VALVE APPLICATIONS

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

2. Throttling Duty: Use bronze full port ball valves for piping NPS 4 and smaller.

B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, on each water supply to plumbing fixtures with integral stops, and on each water supply to plumbing fixtures that do not have supply stops. Use ball valves.

C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping.

1. Install hose-end drain valves at low points in water mains, risers, and branches.

D. Install calibrated balancing valves in each hot-water circulation return branch and discharge side of each pump and circulator. Set calibrated balancing valves partly open to restrict but not stop flow. Calibrated balancing valves are specified in Section 221119 "Plumbing Specialties."

3.4 PIPING INSTALLATION

A. Basic piping installation requirements are specified in Section 220515 "Common Work Results for Plumbing."

B. Install copper tubing according to CDA's "Copper Tube Handbook."

C. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Section 220515 "Common Work Results for Plumbing."

D. Install shutoff valve and wall hydrant at each domestic water service entrance.

E. Install domestic water piping level without pitch and plumb.

3.5 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Section 220515 "Common Work Results for Plumbing."
B. Soldered Joints 2” and Smaller: Use ASTM B 813, water-flushable, lead-free flux, Sterling, or approved equal; ASTM B 32, lead-free-alloy solder, Sterling premium grade or Silvabrite 100; and ASTM B 828 procedure, unless otherwise indicated.

C. Brazed Joints 2-1/2” and Larger: Use Silvaloy Silfos brazing rods which meet all ASTM, ASW, Federal and military specifications (BcuP-2) with melting temperature between 1350 degrees F and 1500 degrees F. Cored solder is not approved.

3.6 HANGER AND SUPPORT INSTALLATION

A. Pipe hanger and support devices are specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment." Install the following:

1. Vertical Piping: MSS Type 8 or Type 42, clamps.
2. Individual, Straight, Horizontal Piping Runs: According to the following:
   a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer than 100 Feet: MSS Type 43, adjustable roller hangers.
   c. Longer than 100 Feet: MSS Type 49, spring cushion rolls, if indicated.
3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Install supports according to Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced 1 size for double-rod hangers, to a minimum of 3/8 inch.

E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
2. NPS 1 and NPS 1-1/2: 72 inches with 3/8-inch rod.
3. NPS 2: 96 inches with 3/8-inch rod.
4. NPS 2-1/2: 108 inches with 1/2-inch rod.
5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
6. NPS 6: 10 feet with 5/8-inch rod.
7. NPS 8: 10 feet with 3/4-inch rod.

F. Install supports for vertical copper tubing every 10 feet.
3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties. All offsets are not shown.

B. Install piping adjacent to equipment and machines to allow service and maintenance.

C. Connect domestic water piping to exterior water-service piping.

D. Connect domestic water piping to water-service piping with shutoff valve, and extend and connect to the following:

1. Booster Pumps: Cold-water suction and discharge piping.
2. Water Heaters: Cold-water supply and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
3. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Refer to Section 224100 “Plumbing Fixtures” and Drawings.
4. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.8 FIELD QUALITY CONTROL

A. Inspect domestic water piping as follows:

1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
2. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
   a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
   b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
3. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

B. Test domestic water piping as follows:

1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.

4. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.

5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.

6. Perform final system test in presence of Owner.

7. Prepare reports for tests and required corrective action.

3.9 CLEANING

A. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

B. Swab all pipe, fittings, and valves just prior to installation with a 1% chlorine solution for small sections of piping not practical for cleaning per below instructions.

C. Clean and disinfect potable domestic water piping using purging and disinfecting procedures prescribed by the Municipality providing the water or, if methods are not prescribed, procedures described in AWWAC 651 or as described below shall be used:

1. Flush piping system with clean, potable water until dirty water does not appear at outlets.

2. Fill and isolate system according to either of the following:
   a. Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
   b. Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate with valves and allow to stand for 3 hours.

3. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.

D. Submit water samples in sterile bottles to SRP for testing. Repeat procedures if biological examination shows contamination.

E. Prepare and submit reports of purging and disinfecting activities.

END OF SECTION
SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following domestic water piping specialties:

1. Backflow preventers.
2. Water pressure-reducing valves.
4. Temperature-actuated water mixing valves.
5. Strainers.
6. Hose bibbs.
7. Wall hydrants.
8. Drain valves.

1.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

1.3 SUBMITTALS

A. Product Data: For each product indicated, include rated capacities, materials, finishes, dimensions, required clearances, methods of assembly of components, and piping and wiring connections.

B. Operation and maintenance data for the following:

   1. Backflow preventers.
   2. Water pressure-reducing valves.
   3. Temperature-actuated water mixing valves.

1.4 QUALITY ASSURANCE

A. Plumbing specialties shall bear label, stamp, or other markings of specified testing agency.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.


D. NSF Compliance:
2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

PART 2 - PRODUCTS

2.1 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers suitable for continuous pressure application, consisting of two positive-seating check valves with intermediate relief valve, and test locks:

3. Operation: Continuous-pressure applications.
4. Pressure Loss: 7 psig maximum, through middle 1/3 of flow range.
5. Pressure Loss at Design Flow Rate: 7 psig.
6. Body: Bronze for NPS 2 and smaller; cast iron or steel with interior lining complying with AWWA C550 or that is FDA approved, or stainless steel for NPS 2-1/2 and larger.
7. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
8. Configuration: Designed for horizontal, straight through, or vertical inlet, horizontal center section, and vertical outlet flow as indicated.
9. Accessories:
   a. Valves: Ball type with threaded ends on inlet and outlet of NPS 4 and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 6 and larger.

B. Double-Check Backflow-Prevention Assemblies:

1. Manufacturers: Provide Wilkins Model 350A.
3. Operation: Continuous-pressure applications, unless otherwise indicated.
4. Pressure Loss: 7 psig maximum, through middle 1/3 of flow range.
5. Pressure Loss at Design Flow Rate: 7 psig.
6. Body: Ductile iron
7. End Connections: Flanged
8. Configuration: Designed for horizontal, straight through flow.
9. Accessories:
   a. Valves: Outside screw and yoke gate-type with flanged ends on inlet and outlet of.

2.2 WATER PRESSURE-REDUCING VALVES

A. Water Regulators:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
b. Zurn Plumbing Products Group; Wilkins Div.

4. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and NPS 3.
5. Type: Single-seated, direct operated, unless otherwise indicated for NPS 2 and smaller. Pilot-operated, diaphragm controlled, single- or double-seated, cast-iron-body main valve, with bronze-body pilot valve for valves NPS 2-1/2 and larger where indicated.
8. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and NPS 3.

2.3 BALANCING VALVES

A. Bronze, Calibrated-Orifice, Balancing Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Armstrong Fluid Technology
      b. Bell & Gossett
      c. Griswold Controls.
   2. Body: Bronze, ball type with calibrated orifice or venture.
   3. Ball: Brass or stainless steel.
   4. Seat: PTFE.
   5. End Connections: Threaded or socket.
   7. Handle Style: Lever, with memory stop to retain set position.
   8. CWP Rating: Minimum 125 psig.
   9. Maximum Operating Temperature: 250 deg F.

2.4 TEMPERATURE-ACTUATED WATER MIXING VALVES

A. Primary, Thermostatic, Water Mixing Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Bradley.
      b. Lawler Manufacturing Company, Inc.
      c. Leonard Valve Company.
      d. Watts Industries Co.
      e. Symmons Industries, Inc.
   4. Type: Exposed-mounting or Cabinet-type, thermostatically-controlled, pressure-balanced, water mixing valve.
   5. Material: Bronze body with corrosion-resistant interior components.
   6. Connections: Threaded union inlets and outlet.
7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, outlet thermometer, and adjustable, temperature-control handle.
8. Valve Pressure Rating: 125 psig minimum, unless otherwise indicated.
10. Valve Finish: Rough bronze.
11. Piping Finish: Copper.
12. Cabinet: Factory-fabricated, stainless steel, for recessed or surface mounting and with hinged, stainless-steel door.

2.5 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum, unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating and for NPS 2-1/2 and larger. Screwed screen retainer and centered blowdown.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: ASTM A 666 Type 304 stainless steel with round perforations, unless otherwise indicated.
5. Perforation Size:
   a. Strainers NPS 2 and Smaller: 0.033 inch.
   b. Strainers NPS 2-1/2 to NPS 4: 0.045 inch.
   c. Strainers NPS 5 and Larger: 0.10 inch.

2.6 OUTLET BOXES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Acorn Engineering Company.
2. Guy Gray Manufacturing Co., Inc.
4. Zurn Industries, Inc.

B. General: Recessed-mounting outlet boxes with supply fittings complying with ASME A112.18.1M. Include box with faceplate, services indicated for equipment connections, and steel blocking reinforcement.

C. Clothes Washer Outlet Boxes: With hot- and cold-water hose connections, drain, and the following:

1. Box and Faceplate: Plastic.
2. Shutoff Fitting(s): Combination, single lever, or two quarter-turn ball valves with hose end connections.
3. Drain: NPS 2 standpipe, P-trap, and direct waste connection to drainage piping.

D. Icemaker and Coffee Machine Outlet Boxes: With hose connection and the following:

1. Box and Faceplate: Plastic.
2. Shutoff Fitting: Stop with compression end sized to match the equipment connection.

2.7 HOSE BIBBS

A. Non-freeze Wall Hydrants:
1. Basis-of-Design Product: Subject to compliance with requirements, provide Woodford Manufacturing Company model B65 or comparable product by one of the following:
   a. Acorn Products, Inc.
   b. Watts Industries, Inc.
   c. Zurn Industries, Inc.
2. Standard: ASSE 1019.B for concealed-outlet, self-draining wall hydrants and listed by IAPMO.
4. Operation: Loose key.
5. Casing and Operating Rod: Copper tube casing with stainless steel operating stem of length required to match wall thickness. Include wall clamp.
7. Outlet: Concealed, with integral vacuum breaker complying with ASSE 1011, and garden-hose thread complying with ASME B1.20.7.
8. Box: Brass or Anodized aluminum deep, flush mounting with tee-handle operated locking cover.
10. Operating Keys(s): One with each wall hydrant.

B. Wall Hydrants:
1. Basis-of-Design Product: Subject to compliance with requirements provide Woodford Manufacturing Company model B76 or comparable product by one of the following:
   a. Acorn Products, Inc.
   b. Watts Industries, Inc.
   c. Zurn Industries, Inc.
2. Standard: ASSE 1052 for concealed-outlet, self-draining wall hydrants and listed by IAPMO.
4. Operation: Loose key.
6. Outlet: Concealed, with non-removable hose-connection backflow preventer complying with ASSE 1052; and garden-hose thread complying with ASME B1.20.7.
7. Box: Brass, deep, flush mounting with tee-handle operated locking cover.
8. Box and Cover Finish: Chrome plated.
9. Operating Keys(s): One with each wall hydrant.

C. Wall Faucets:
1. Basis-of-Design Product: Subject to compliance with requirements provide Woodford Manufacturing Company model 24 or a comparable product by one of the following:
   a. Acorn Products, Inc.
   b. Watts Industries, Inc.
c. Zurn Industries, Inc.

8. Vacuum Breaker: Integral or field-installed, non-removable, drainable, hose-connection vacuum breaker complying with ASSE 1011 and listed by IAPMO; with garden hose threads complying with ASME B1.20.7 on outlet.
9. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
10. Finish for Service Areas: Chrome or nickel plated.
11. Operation for Equipment Rooms: Metal wheel handle or operating key.
12. Operation for Service Areas: Operating key.
13. Include operating key with each operating-key hose bibb.
14. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.8 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:
   2. Pressure Rating: 400-psig minimum CWP.
   4. Body: Copper alloy.
   5. Ball: Chrome-plated brass.
   7. Seats and Seals: Replaceable.
   9. Inlet: Threaded or solder joint.
  10. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

B. Ball-Valve-Type, Stop-and-Waste Drain Valves.
   1. Standard: MSS SP-110 for full-port, two-piece ball valves.
   2. Pressure Rating: 400-psig minimum CWP.
   3. Body: Copper alloy.
   4. Ball: Chrome-plated brass.
   5. Stem: Blowout-proof.
   8. Inlet: Threaded or solder-joint.
   9. Outlet: Threaded or solder-joint.

2.9 WATER HAMMER ARRESTERS

A. Water Hammer Arresters:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
c. Tyler Pipe; Wade Div.
d. Watts Drainage Products Inc.
e. Zurn Plumbing Products Group

3. Type: Metal bellows.
4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

2.10 TRAP-SEAL DEVICES

A. Trap-Seal Device:

1. Manufacturers: Provide the SureSeal by Rectorseal.
3. Body: ABS.
4. Diaphragm: EPDM.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All equipment and components shall be installed in accordance with their listing and manufacturer’s published installation instructions.

B. Refer to Section 220515 "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

C. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.

1. Locate backflow preventers in same room as connected equipment or system where indicated.
2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor sink. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
3. Do not install bypass piping around backflow preventers.

D. Install water regulators with inlet and outlet shutoff valves and bypass with memory-stop balancing valve. Install pressure gages on inlet and outlet.

E. Install balancing valves in locations where they can easily be adjusted.

F. Install temperature-actuated water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.

1. Install thermometers and water regulators if specified.
2. Install cabinet-type units recessed in or surface mounted on wall as specified.
G. Install Y-pattern strainers for water on supply side of each control valve, water pressure-reducing valve, solenoid valve, potable water backflow prevention assembly, and pump.

H. Install hose bibs where indicated on drawings per the following.
   2. Public Interior Locations: Wall hydrants.

I. Install water hammer arresters with shutoff valves in water piping according to PDI-WH 201 by the Plumbing & Drainage Institute.

J. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties.

K. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
   1. Primary, thermostatic, water mixing valves.

L. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 “Identification for Plumbing Piping and Equipment.”

3.2 FIELD QUALITY CONTROL

A. Perform the following tests and prepare test reports:
   1. Test each reduced-pressure-principle backflow preventer and double-check backflow-prevention assembly according to authorities having jurisdiction and the device’s reference standard.

B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.3 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.

B. Set field-adjustable flow of balancing valves.

C. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

END OF SECTION
SECTION 221313 - FACILITY SANITARY SEWERS

PART 1 - GENERAL

1.1 SUMMARY
   A. Section Includes:
      1. Pipe and fittings.
      2. Nonpressure and pressure couplings.
      3. Expansion joints.
      5. Encasement for piping.

1.2 ACTION SUBMITTALS
   A. Product Data: For expansion joints.
   B. Shop Drawings: For manholes. Include plans, elevations, sections, details, and frames and covers.

1.3 INFORMATIONAL SUBMITTALS
   A. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from sewer system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.
   B. Product Certificates: For each type of cast-iron soil pipe and fitting, from manufacturer.
   C. Field quality-control reports.

PART 2 - PRODUCTS

2.1 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS
   A. Not Permitted

2.2 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS
   A. Not Permitted
2.3 PVC PIPE AND FITTINGS

A. PVC Corrugated Sewer Piping:
   2. Fittings: ASTM F 949, PVC molded or fabricated, socket type.

B. PVC Type PSM Sewer Piping:
   1. Pipe: ASTM D 3034, SDR 35, PVC Type PSM sewer pipe with bell-and-spigot ends for gasketed joints.
   2. Fittings: ASTM D 3034, PVC with bell ends.

2.4 CONCRETE PIPE AND FITTINGS

A. Nonreinforced-Concrete Sewer Pipe and Fittings: ASTM C 14, [Class 1] [Class 2] [Class 3], with [bell-and-spigot] [or] [tongue-and-groove] ends for gasketed joints with ASTM C 443, rubber gaskets.

B. Reinforced-Concrete Sewer Pipe and Fittings: ASTM C 76.
   1. [Bell-and-spigot] [or] [tongue-and-groove] ends for gasketed joints, with ASTM C 443, rubber gaskets.
   2. Class II, [Wall A] [Wall B] [Wall C].
   3. Class III, [Wall A] [Wall B] [Wall C].
   4. Class IV, [Wall A] [Wall B] [Wall C].
   5. Class V, [Wall A] [Wall B].

2.5 NONPRESSURE-TYPE TRANSITION COUPLINGS

A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Sleeve Materials:
   1. For Concrete Pipes: ASTM C 443, rubber.
   2. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
   3. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

C. Unshielded, Flexible Couplings:
   1. Description: Elastomeric sleeve with corrosion-resistant-metal tension band and tightening mechanism on each end.
D. Ring-Type, Flexible Couplings: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

2.6 CLEANOUTS

A. Cast-Iron Cleanouts: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.

1. Top-Loading Classification(s): Light Duty, Medium Duty, Extra Heavy Duty
2. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.

2.7 MANHOLES

A. Standard Precast Concrete Manholes:

1. Description: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
2. Diameter: 48 inches minimum unless otherwise indicated.
3. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
4. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section; with separate base slab or base section with integral floor.
5. Riser Sections: 4-inch minimum thickness, of length to provide depth indicated.
6. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated; with top of cone of size that matches grade rings.
7. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
8. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.
9. Steps: Individual FRP steps, or ASTM A 615/A 615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP; wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 48 inches.
10. Adjusting Rings: Interlocking HDPE rings, with level or sloped edge in thickness and diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
11. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, with diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope.

B. Manhole Frames and Covers:

1. Description: Ferrous; 24-inch ID by 7- to 9-inch riser, with 4-inch- minimum-width flange and 26-inch- diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "SANITARY SEWER."

2.8 CONCRETE

A. General: Cast-in-place concrete complying with ACI 318, ACI 350/350R, and the following:
   1. Cement: ASTM C 150, Type II.

B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.
   2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.
   1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
      a. Invert Slope: Maximum 2 percent through manhole.
   2. Benches: Concrete, sloped to drain into channel.
      a. Slope: Maximum 4 percent.

D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water/cementitious materials ratio.
   2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section 312000 "Earth Moving."
3.2 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground sanitary sewer piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

F. Install gravity-flow, nonpressure, drainage piping according to the following:

1. Install piping pitched down in direction of flow, at minimum slope of 1 percent unless otherwise indicated.
2. Install piping NPS 6 and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
3. Install piping with 36-inch minimum cover.
4. Install PVC corrugated sewer piping according to ASTM D 2321 and ASTM F 1668.
5. Install PVC Type PSM sewer piping according to ASTM D 2321 and ASTM F 1668.
6. Install nonreinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."
7. Install reinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."

G. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure, drainage piping according to the following:

4. Join PVC corrugated sewer piping according to ASTM D 2321.
5. Join PVC Type PSM sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasket joints.
8. Join dissimilar pipe materials with nonpressure-type, flexible[or rigid] couplings.

B. Pipe couplings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
   1. Use nonpressure flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.
      a. Unshielded flexible couplings for pipes of same or slightly different OD.
      b. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.
      c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

3.4 MANHOLE INSTALLATION
A. General: Install manholes complete with appurtenances and accessories indicated.
B. Install precast concrete manhole sections with sealants according to ASTM C 891.
C. Install FRP manholes according to manufacturer's written instructions.
D. Form continuous concrete channels and benches between inlets and outlet.
E. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches above finished surface elsewhere unless otherwise indicated.
F. Install manhole-cover inserts in frame and immediately below cover.

3.5 CONCRETE PLACEMENT
A. Place cast-in-place concrete according to ACI 318.
3.6 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts, and use cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.

1. Use Light-Duty, top-loading classification cleanouts in earth or unpaved foot-traffic areas.
2. Use Medium-Duty, top-loading classification cleanouts in paved foot-traffic areas.
3. Use Extra Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.

B. Set cleanout frames and covers in earth in cast-in-place-concrete block, [18 by 18 by 12 inches] deep. Set with tops [1 inch] above surrounding grade.

C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.7 CONNECTIONS

A. Connect nonpressure, gravity-flow drainage piping to building's sanitary building drains specified in Section 221316 "Sanitary Waste and Vent Piping."

B. Make connections to existing piping and underground manholes.

1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye fitting plus 6-inch overlap with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.

2. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.

3. Make branch connections from side into existing piping, NPS 21 or larger, or to underground manholes by cutting opening into existing unit large enough to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe or manhole wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.

   a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi unless otherwise indicated.
   b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.
4. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

C. Connect to grease-oil-and-sand interceptors specified in Section 221323 "Sanitary Waste Interceptors."

3.8 IDENTIFICATION

A. Materials and their installation are specified in Section 312000 "Earth Moving." Arrange for installation of green warning tapes directly over piping and at outside edges of underground manholes.

1. Use warning tape or detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground manholes.

3.9 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.

1. Submit separate report for each system inspection.
2. Defects requiring correction include the following:
   a. Alignment: Less than full diameter of inside of pipe is visible between structures.
   b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
   c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
   d. Infiltration: Water leakage into piping.
   e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to requirements of authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate report for each test.
5. Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:
a. Fill sewer piping with water. Test with pressure of at least 10-foot head of water, and maintain such pressure without leakage for at least 15 minutes.
b. Close openings in system and fill with water.
c. Purge air and refill with water.
d. Disconnect water supply.
e. Test and inspect joints for leaks.

6. Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:

   a. Option: Test plastic gravity sewer piping according to ASTM F 1417.
   b. Option: Test concrete gravity sewer piping according to ASTM C 924.

7. Manholes: Perform hydraulic test according to ASTM C 969.

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.10 CLEANING

A. Clean dirt and superfluous material from interior of piping.

END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the following soil and waste, sanitary drainage and vent piping inside the building and to a point 5 feet outside the building:

1. Pipe, tube, and fittings.
2. Specialty pipe fittings.

B. Related Section:

1. Section 221313 "Facility Sanitary Sewers" for piping > 5 feet outside the building.

1.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Soil, waste, and vent piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For waste and vent piping, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" in Part 3 for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. Heavy-Duty, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ANACO-Husky.
   b. Clamp-All Corp.
   c. Tyler Pipe.
   d. Mission rubber Company; A Division of MCD Industries, Inc.

3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
4. NPS 1½ to NPS 4: 3-inch wide shield with 4 bands.
5. NPS 5 to NPS 10: 4-inch wide shield with 6 bands.

2.3 COPPER TUBE AND FITTINGS

A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.

B. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.

C. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.

   1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
   2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

D. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

2.4 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
B. Cellular-Core PVC Pipe: **Not permitted.**

C. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

D. Adhesive Primer: ASTM F 656.
   1. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. Solvent Cement: ASTM D 2564.
   1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.5 SPECIALTY PIPE FITTINGS

A. Transition Couplings:
   1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
   2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
   3. Unshielded, Nonpressure Transition Couplings:
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         2) Mission Rubber Company; a division of MCP Industries, Inc.
         3) Plastic Oddities; a division of Diverse Corporate Technologies, Inc.
      c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
      d. Sleeve Materials:
         2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
         3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
   4. Shielded, Nonpressure Transition Couplings:
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2) Mission Rubber Company; a division of MCP Industries, Inc.

c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.2 PIPING INSTALLATION

A. **Cast Iron pipe is for above ground installation only.** Use solid core PVC pipe for below ground installations and through slab up to 6 inches above finished floor. Provide a cast iron cleanout, or test tee if a cleanout is not required, at the transition to accommodate testing.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

J. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and medium-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to
back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

K. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer’s written instructions for use of lubricants, cements, and other installation requirements. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:

1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

L. Install cast-iron piping according to CISPI’s "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

M. Install aboveground copper tubing according to CDA’s "Copper Tube Handbook."

N. Install underground PVC piping according to ASTM D 2321.

O. Plumbing Specialties:

1. Install backwater valves where indicated in sanitary waste gravity-flow piping. Comply with requirements for backwater valves specified in Section 221319 "Sanitary Waste Piping Specialties."
2. Install cleanouts where indicated. The invert of wall cleanout openings shall be above the flood level rim of the highest fixture on the branch served by the cleanout. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Section 221319 "Sanitary Waste Piping Specialties."

P. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

Q. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220515 "Common Work Results for Plumbing."

R. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220515 "Common Work Results for Plumbing."

S. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220515 "Common Work Results for Plumbing."
3.3 JOINT CONSTRUCTION

A. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI’s "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

B. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.

C. Flanged Joints: Align bolt holes. Select appropriate rubber gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

D. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
   3. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.4 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:
   1. Install transition couplings at joints of piping with small differences in OD’s.
   2. In Drainage Piping: Unshielded or Shielded, non-pressure transition couplings.

3.5 VALVE INSTALLATION

A. Backwater Valves: Install backwater valves where indicated in piping subject to backflow.
   1. Horizontal Piping: Horizontal backwater valves. Use normally closed type unless otherwise indicated.
   2. Floor Drains: Drain outlet backwater valves unless drain has integral backwater valve.
   3. Install backwater valves in accessible locations.
   4. Comply with requirements for backwater valve specified in Section 221319 "Sanitary Waste Piping Specialties."

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
   1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
   2. Install stainless-steel or fiberglass pipe hangers for horizontal piping in corrosive environments.
3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
5. Install copper loop hangers for horizontal copper tubing.
6. Vertical Piping: MSS Type 8 or Type 42, clamps.
7. Install individual, straight, horizontal piping runs:
   a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer than 100 Feet: MSS Type 43, adjustable roller hangers.
8. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
B. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.
C. Support vertical piping and tubing at base and at each floor.
D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.
E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing without fittings, valves, or couplings; and minimum rod diameters:
   1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
   2. NPS 3: 60 inches with 1/2-inch rod.
   3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
   4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
   5. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
F. Install supports for vertical cast-iron soil piping every 15 feet, if pipe has not penetrated a floor.
G. Install hangers for copper tubing with the following maximum horizontal spacing without fittings, valves, or couplings; and minimum rod diameters:
   1. NPS 1-1/4: 72 inches with 3/8-inch rod.
   2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
   3. NPS 2-1/2: 108 inches with 1/2-inch rod.
   4. NPS 3 and NPS 5: 10 feet with 1/2-inch rod.
   5. NPS 6: 10 feet with 5/8-inch rod.
   6. NPS 8: 10 feet with 3/4-inch rod.
H. Install supports for vertical copper tubing every 10 feet.

3.7 CONNECTIONS
A. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:
1. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
2. Install horizontal backwater valves with cleanout cover flush with floor.
3. Comply with requirements for backwater valves, cleanouts, and drains specified in Section 221319 "Sanitary Waste Piping Specialties."
4. Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

E. Make connections according to the following unless otherwise indicated:
1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.8 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.9 FIELD QUALITY CONTROL

A. During installation, notify SRP PM & Construction Inspector 48 hours before inspection must be made. Perform tests specified below in presence of inspector.

1. Roughing-in Inspection: Before concealing or closing-in after roughing-in, before backfilling underground and before setting fixtures.
2. Final Inspection: Arrange for final inspection to ensure compliance with requirements.

B. All equipment and components shall be installed in accordance with their listing and manufacturer’s published installation instructions.

C. Reports: Obtain inspection report cards and have them signed by SRP’s Construction Inspector.

D. Test sanitary drainage and vent piping, as follows:
1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired
2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.

3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.

4. Below grade piping shall be exposed and dirt removed from around the full circumference of pipe joints during testing. The bottom of straight sections without joints may be bedded. The contractor is responsible for maintaining walkable trenches and removing excess dirt for safe access during the inspections.

5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

3.10 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

B. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.11 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, soil, waste, and vent piping shall be the following:
   1. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
   2. Copper DWV tube, copper drainage fittings, and soldered joints.
   3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints through slab on grade and up to 6 inches above finished floor. Provide a cast iron cleanout, or test tee if cleanout is not required, at transition for testing.

C. Underground, soil, waste, and vent piping shall be the following:
   1. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

END OF SECTION
SECTION 221319 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following sanitary drainage piping specialties:

1. Backwater valves.
2. Floor drains and floor sinks.
3. Roof flashing assemblies.
5. Grease traps (kitchens).
6. Sand/oil separators (vehicle wash).

1.2 SUBMITTALS

A. Product Data: For each type of product indicated, include rated capacities, materials, finishes, dimensions, required clearances, operating characteristics, and accessories.

B. Operation and maintenance data for the following:

1. Grease traps.
2. Grease interceptors.

1.3 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 BACKWATER VALVES

A. Horizontal, PVC Backwater Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Rectorseal
   b. Sioux Chief
   c. Oatey
   d. Zurn Plumbing Products Group

3. Size: Same as connected piping.
4. Body: PVC.
5. Cover: PVC.
7. Type Check Valve: Removable, swing check, factory assembled or field modified to hang closed.
8. Extension: Full-size, PVC, soil-pipe extension to field-installed cleanout at surface; replaces backwater valve cover.

2.2 FLOOR DRAINS AND FLOOR SINKS

A. Cast-Iron Floor Drains; Equipment Rooms and Unfinished Areas:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Watts Drainage Products, FD-320-5-7 or a comparable product by one of the following:
   a. Josam Company
   c. Tyler Pipe; Wade Div.
   d. Watts Drainage Products Inc.
   e. Zurn Plumbing Products Group

2. Standard: ASME A112.6.3.
5. Seepage Flange: Required.
6. Anchor Flange: Required.
8. Outlet: Bottom.
10. Sediment Bucket: Shallow-type.
11. Top or Strainer Material: Ductile Iron.
13. Top Shape: Round.
14. Dimensions of Top or Strainer: 8 inch diameter.
15. Top Loading Classification: Heavy Duty.
16. Funnel: Not required.
17. Inlet Fitting: Gray iron, with threaded inlet and threaded or spigot outlet.

B. Cast-Iron Floor Drains; Finished Areas:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Watts Drainage Products, FD-100-A5-7 or a comparable product by one of the following:
   a. Josam Company
   c. Tyler Pipe; Wade Div.
   d. Watts Drainage Products Inc.
   e. Zurn Plumbing Products Group

2. Standard: ASME A112.6.3.
5. Seepage Flange: Required.
6. Anchor Flange: Required.
8. Outlet: Bottom.
10. Sediment Bucket: Not required.
11. Top or Strainer Material: Nickel bronze.
13. Top Shape: Square.
14. Dimensions of Top or Strainer: 6 inch by 6 inch square.
15. Top Loading Classification: Medium Duty.
16. Funnel: Not required.
17. Inlet Fitting: Gray iron, with threaded inlet and threaded or spigot outlet.

C. Cast-Iron Floor Drains; ADA Floor Drain:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Watts Drainage Products, FD-100-RS-517-7 or a comparable product by one of the following:
   a. Josam Company
   c. Tyler Pipe; Wade Div.
   d. Watts Drainage Products Inc.
   e. Zurn Plumbing Products Group

2. Standard: ASME A112.6.3.
5. Seepage Flange: Required.
6. Anchor Flange: Required.
8. Outlet: Bottom.
10. Sediment Bucket: Not required.
11. Top or Strainer Material: Nickel bronze.
13. Top Shape: Rectangular.
14. Dimensions of Top or Strainer: 5 inch by 17 inch rectangular strainer.
15. Top Loading Classification: Medium Duty.
16. Funnel: Not required.
17. Inlet Fitting: Gray iron, with threaded inlet and threaded or spigot outlet.

D. Cast-Iron Shower Drain:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Watts Drainage Products, FD-100-A6 or a comparable product by one of the following:
   a. Josam Company
   c. Tyler Pipe; Wade Div.
   d. Watts Drainage Products Inc.
   e. Zurn Plumbing Products Group

2. Standard: ASME A112.6.3.
5. Seepage Flange: Required.
6. Anchor Flange: Required.
8. Outlet: Bottom.
10. Sediment Bucket: Not required.
11. Top or Strainer Material: Nickel bronze.
13. Top Shape: Round.
14. Dimensions of Top or Strainer: 6 inch diameter.
15. Top Loading Classification: Medium Duty.
16. Funnel: Not required.
17. Inlet Fitting: Gray iron, with threaded inlet and threaded or spigot outlet.

E. Cast-Iron Floor Sink; Equipment Rooms and Unfinished Areas:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Watts Drainage Products, FD-760-7-150 or a comparable product by one of the following:
   a. Josam Company
   c. Tyler Pipe; Wade Div.
   d. Watts Drainage Products Inc.
   e. Zurn Plumbing Products Group

4. Seepage Flange: Required.
6. Outlet: Bottom.
8. Strainer: Dome-type.
10. Grate Finish: Acid-resistant enamel.
11. Top Shape: Square.
13. Dimensions: 12 inch square top with 10 inch deep sump.
15. Outlet Fitting: Spigot outlet.

F. Cast-Iron Floor Sink; Finished Areas:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Watts Drainage Products, FD-710-7 or a comparable product by one of the following:
   a. Josam Company
   c. Tyler Pipe; Wade Div.
   d. Watts Drainage Products Inc.
   e. Zurn Plumbing Products Group

4. Seepage Flange: Required.
6. Outlet: Bottom.
8. Strainer: Dome-type.
10. Grate Finish: Acid-resistant enamel.
11. Top Shape: Square.
13. Dimensions: 8 inch square top with 6 inch deep sump.
15. Outlet Fitting: Spigot outlet, and trap-seal primer valve connection.

2.3 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:
   1. Manufacturers: Roof flashing shall be provided by the manufacturer’s representative maintaining the warranty on the roof.

2.4 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains:
   1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.
   2. Size: Same as connected waste piping with increaser fitting of size indicated.

B. Air-Gap Fittings:
   1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
   2. Body: Bronze or cast iron.
   3. Inlet: Opening in top of body.
   4. Outlet: Larger than inlet.
   5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

C. Sleeve Flashing Device:
   1. Description: Manufactured, cast-iron fitting, with clamping device, that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 2 inches above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
   2. Size: As required for close fit to riser or stack piping.

D. Stack Flashing Fittings:
   1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
   2. Size: Same as connected stack vent or vent stack.

E. Vent Caps:
   1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
   2. Size: Same as connected stack vent or vent stack.

F. Air-Admittance Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Sioux Chief Manufacturing Co., Inc.
   b. Studor, Inc.

2. Description: Plastic housing with mechanically-operated sealing diaphragm, designed to admit air into vent piping and to prevent transmission of sewer gas into building.

3. Stack Vent Valve:

4. Fixture Vent Valve:
   b. Application: Connection to a vent serving a single fixture.

2.5 GREASE TRAPS

A. Grease Traps:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Josam Company
   b. MIFAB, Inc.
   c. Rockford Sanitary Systems, Inc.
   e. Tyler Pipe; Wade Div.
   f. Watts Drainage Products Inc.
   g. Zurn Plumbing Products Group

2. Standard: ASME A112.14.3 and PDI-G101, for intercepting and retaining fats, oils, and greases from food-preparation or -processing wastewater.

3. Plumbing and Drainage Institute Seal: Required.

4. Body Material: Cast iron or steel.

5. Interior Lining: Corrosion-resistant enamel.


7. Flow Rate: See Drawings.


9. Inlet and Outlet Size: See Drawings.

10. End Connections: Flanged, hub, or threaded.


12. Mounting: Above floor or recessed, flush with floor as indicated on Drawings.

13. Flow-Control Fitting: Required.


B. Sand/oil Separators:

1. Manufacturers: Provide the product used as the basis of design or submit a substitution request.

3. **Body Material:** Concrete.
4. **End Connections:** Flanged, hub, or threaded.
5. **Cleanout:** Integral.

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

B. All equipment and components shall be installed in accordance with their listing and manufacturer’s published installation instructions.

C. Install backwater valves in building drain piping. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.

D. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
   1. Position floor drains for easy access and maintenance.
   2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to Architectural Drawings or to the following drainage area radii if not indicated otherwise:
      a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
      b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
      c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.

   3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
   4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

E. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.

F. Assemble open drain fittings and install with top of hub 2 inches above floor.

G. Install trap-seal devices on inlet to floor drains that require trap-seal.

H. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

I. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

J. Install vent caps on each vent pipe passing through roof.

K. Install grease traps, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing.
1. **Above-Floor Installation**: Set unit with bottom resting on floor, unless otherwise indicated.

2. **Flush with Floor Installation**: Set unit and extension, if required, with cover flush with finished floor.

L. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

M. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 **CONNECTIONS**

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. **Grease Trap**: Connect inlet and outlet to unit, and connect flow-control fitting and vent to unit inlet piping. Install valve on outlet of automatic draw-off type unit.

3.3 **LABELING AND IDENTIFYING**

A. **Equipment Nameplates and Signs**: Install engraved plastic-laminate equipment nameplate or sign on or near each grease trap.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 **PROTECTION**

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION
SECTION 221413 - STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY
   A. This Section includes the following storm drainage piping inside the building and to a point 5 feet outside of building:
      1. Pipe, tube, and fittings.
      2. Special pipe fittings.

1.2 PERFORMANCE REQUIREMENTS
   A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:
      1. Storm Drainage Piping: 10-foot head of water.

1.3 SUBMITTALS
   A. Product Data: For each product indicated, include manufacturer’s name, materials of construction and joining materials.

1.4 QUALITY ASSURANCE
   A. Piping materials shall bear label, stamp, or other markings of specified testing agency. Pipe shall be marked with Manufacturer’s name.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS
   A. Flexible Transition Couplings for Underground Nonpressure Piping: ASTM C 1173 with elastomeric sleeve. Include ends of same sizes as piping to be joined and include corrosion-resistant metal band on each end.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. AB & I.
   b. Tyler.

2. Gaskets: ASTM C 564, rubber.

C. Hubless Cast-Iron Pipe and Fittings: ASTM A 888 or CISPI 301.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. AB & I.
      b. Tyler.

2. Couplings:
   a. Manufacturers and Products: Subject to compliance with requirements, provide one of the following products:
      1) Clampall Model Hi Torque 125.
      2) Husky Model SD4000.
   b. Heavy-Duty, Couplings. ASTM C 1540 assembly consisting of Type 304, stainless-steel shield; stainless-steel bands; and ASTM C 564 rubber sleeve with integral center pipe stop. Listed by IAPMO and complying with FM1680 Class 1.
      1) NPS 1-1/2 to NPS 4: 3-inch wide shield with 4 bands.
      2) NPS 5 to NPS 10: 4-inch wide shield with 6 bands.

D. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
   1. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Transition and special fittings with pressure ratings at least equal to piping pressure ratings may be used in applications below, unless otherwise indicated.

B. Aboveground Storm Drainage Piping: Use any of the following piping materials for each size range:
1. NPS 2 to NPS 12: Service weight, cast-iron soil piping; gaskets; and gasketed joints.

2. NPS 2 to NPS 15: Hubless, cast-iron soil piping with heavy-duty, Type 304 Stainless steel couplings.

3. NPS 2 to NPS 6: PVC pipe, PVC socket fittings, and solvent-cemented joints.

C. Underground Storm Drainage Piping: Use any of the following piping materials for each size range:

1. NPS 2 and NPS 6: PVC pipe, PVC socket fittings, and solvent-cemented joints.

3.2 PIPING INSTALLATION

A. Storm sewer and drainage piping outside the building are specified in Division 2.

B. Basic piping installation requirement are specified in Division 15 Section “Common Work Results for Plumbing”.

C. Reduce pipe sizes using concentric reducer fittings. Bushings shall not be used.

D. Cast-iron pipe shall only be used above grade.

E. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall, Thunderline Link Seal or approved equal. Select number of interlocking rubber links required to make installation watertight. Refer to Division 22 Section "Common Work Results for Plumbing" for sleeves and mechanical sleeve seals.

F. Install cast-iron storm drainage piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

G. Make changes in direction for storm piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

H. Lay buried building drain piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer’s written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

I. Install below grade PVC pipe according to MAG Standard 601, with pipe layed in 6" sand or pea gravel bed and covered with 6" sand or pea gravel.

J. Install storm drainage piping at the following minimum slopes, unless otherwise indicated:
1. Building Storm Drain: Minimum 1 percent downward in direction of flow or as shown on Drawings.
2. Horizontal Storm-Drainage Piping: Minimum 1 percent downward in direction of flow, or as shown on Drawings.

K. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

L. Install PVC storm drainage piping according to ASTM D 2665.

M. Install underground PVC storm drainage piping according to ASTM D 2321.

N. Do not enclose, cover, or put piping into operation until it is inspected and approved by SRP’s Construction Inspector.

3.3 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Division 15 Section “Common Work Results for Plumbing”.

   1. Gasketed Joints: Make with rubber gasket matching class of pipe and fittings.

C. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.4 HANGER AND SUPPORT INSTALLATION

A. Seismic-restraint devices are specified in Division 22 Section “Vibration and Seismic Controls for Plumbing Piping and Equipment”.

B. Pipe hangers and supports are specified in Division 15 Section “Hangers and Supports for Plumbing Piping and Equipment”. Install the following:
   1. Vertical Piping: MSS Type 8 or Type 42, clamps.
   2. Individual, Straight, Horizontal Piping Runs: According to the following:
      a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
      b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
      c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.
   3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
   4. Base of Vertical Piping: MSS Type 52, spring hangers.
C. Install supports according to Division 15 Section "Hangers and Supports for Plumbing Piping and Equipment."

D. Support vertical piping and tubing at base and at each floor.

E. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

F. Install hangers for cast-iron storm drainage piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
4. NPS 6 through NPS 12: 60 inches with 3/4-inch rod.
5. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

G. Install supports for vertical cast-iron storm drainage piping every 15 feet.

H. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 2: 48 inches with 3/8-inch rod.
2. NPS 3: 48 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
4. NPS 6 through NPS 12: 48 inches with 3/4-inch rod.

I. Install supports for vertical PVC piping every 48 inches.

J. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.5 CONNECTIONS

A. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.

B. Connect storm drainage piping to roof drains and storm drainage specialties.

3.6 FIELD QUALITY CONTROL
A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection. Make corrections with new material.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test storm drainage piping according to procedures of authorities having jurisdiction.

3.7 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION
SECTION 221423 - STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Roof drains.
   2. Miscellaneous storm drainage piping specialties.
   3. Cleanouts.
   4. Backwater valves.
   5. Trench drains.
   6. Flashing materials.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

1.3 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 METAL ROOF DRAINS

A. Cast-Iron, General-Purpose Roof Drains:
   2. Body Material: Cast iron.
   3. Dimension of Body:
      a. For Large-Sump, Nominal 14-inch diameter.
      b. For Medium-Sump, Nominal 8- to 12-inch diameter.
   4. Combination Flashing Ring and Gravel Stop: Required.
   6. Outlet: Bottom.
   8. Underdeck Clamp: Required unless waived in writing by SRP PM.
   10. Sump Receiver Plate: Not required
   11. Dome Material: Aluminum or Cast iron.
   12. Perforated Gravel Guard: Not required on membrane roofs
14. Water Dam: Not required.

B. Metal, Parapet Roof Drains:
   1. Standard: ASME A112.6.4, for parapet roof drains.
   2. Size: To meet Municipal IPC supplement size requirements
   3. Body Material: [Cast iron] <Insert material>.
   5. Grate Material: [Bronze] [Cast iron] [Nickel-bronze alloy] <Insert material>.

2.2 DRAINAGE PIPING SPECIALTIES

A. Downspout Adaptors:
   1. Description: Manufactured, gray-iron casting, for attaching to horizontal-outlet, parapet roof drain and to exterior, sheet metal downspout.
   2. Size: Inlet size to match parapet drain outlet.

B. Downspout Boots:
   1. Description: Manufactured, ASTM A 48/A 48M, gray-iron casting, with strap or ears for attaching to building; NPS 4 outlet; and shop-applied bituminous coating.
   2. Size: Inlet size to match downspout and NPS 4 outlet.

C. Conductor Nozzles:
   1. Description: Bronze body with threaded inlet and bronze wall flange with mounting holes.
   2. Size: Same as connected conductor.

2.3 CLEANOUTS

A. Floor Cleanout:
   2. Size: Same as connected branch.
   3. Type: [Adjustable housing] [Cast-iron soil pipe with cast-iron ferrule] [Heavy-duty, adjustable housing] [Threaded, adjustable housing].
   4. Body or Ferrule Material: Cast iron.
   5. Clamping Device: Required.
   6. Outlet Connection: Inside calk or Threaded.
   7. Closure: [Brass plug with straight threads and gasket] [Brass plug with tapered threads].
   8. Adjustable Housing Material: [Cast iron] [Plastic] with threads.
   10. Frame and Cover Shape: [Round] [Square].
   11. Top-Loading Classification: Heavy Duty or Medium Duty.
12. **Riser:** ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

**B. Test Tees:**

1. **Standard:** ASME A112.36.2M and ASTM A 74, ASTM A 888, or CISPI 301, for cleanout test tees.
2. **Size:** Same as connected drainage piping.
3. **Body Material:** Hub-and-spigot, cast-iron soil-pipe T-branch or hubless, cast-iron soil-pipe test tee as required to match connected piping.
4. **Closure Plug:** Countersunk or raised head.
5. **Closure Plug Size:** Same as or not more than one size smaller than cleanout size.

**C. Wall Cleanouts:**

1. **Standard:** ASME A112.36.2M, for cleanouts. Include wall access.
2. **Size:** Same as connected drainage piping.
3. **Body Material:** Required to match connected piping.
4. **Closure:** Countersunk or raised-head, **[brass]** [cast-iron] plug.
5. **Closure Plug Size:** Same as or not more than one size smaller than cleanout size.
6. **Wall Access:** Round, flat, chrome-plated brass or stainless-steel cover plate with screw.

**2.4 BACKWATER VALVES**

**A. Cast-Iron, Horizontal Backwater Valves:**

1. **Standard:** ASME A112.14.1, for backwater valves.
2. **Size:** Same as connected piping.
3. **Body Material:** Cast iron.
4. **Cover:** Cast iron with **[bolted]** or **[threaded]** access check valve.
5. **End Connections:** Hubless.
6. **Check Valve:** Removable, bronze, swing check, factory assembled or field modified to hang closed.
7. **Extension:** ASTM A 74, Service class; full-size, cast-iron soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.

**2.5 TRENCH DRAINS**

**A. Trench Drains:**

1. **Standard:** ASME A112.6.3, for trench drains.
2. **Body Material:** Cast iron.
3. **Flange:** Not required.
4. **Clamping Device:** Optional.
5. **Outlet:** Bottom or End.
6. **Grate Material:** **[Gray iron]** [stainless steel].

2.6 FLASHING MATERIALS

A. Copper Sheet: ASTM B 152/B 152M, 12 oz./sq. ft..

B. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.


D. Fasteners: Metal compatible with material and substrate being fastened.

E. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

F. Solder: ASTM B 32, lead-free alloy.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions.

1. Install flashing collar or flange of roof drain to prevent leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
2. Install expansion joints, if indicated, in roof drain outlets.
3. Position roof drains for easy access and maintenance.

B. Install downspout adapters on outlet of back-outlet parapet roof drains and connect to sheet metal downspouts.

C. Install downspout boots at grade with top 6 inches above grade. Secure to building wall.

D. Install conductor nozzles at exposed bottom of conductors where they spill onto grade.

E. Install cleanouts in aboveground piping and building drain piping according to the following instructions unless otherwise indicated:

1. Use cleanouts the same size as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate cleanouts at each change in direction of piping greater than 45 degrees.
3. Locate cleanouts at minimum intervals of 75 feet for piping NPS 4 and smaller and 100 feet for larger piping.
4. Locate cleanouts at base of each vertical soil and waste stack.

F. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

G. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

H. Install horizontal backwater valves in floor with cover flush with floor.

I. Install test tees in vertical conductors and near floor.

J. Install wall cleanouts in vertical conductors. Install access door in wall if indicated.

K. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface unless otherwise indicated.

L. Install sleeve flashing device with each conductor passing through floors with waterproof membrane.

3.2 CONNECTIONS

A. Comply with requirements for piping specified in Section 221413 "Facility Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

3.3 FLASHING INSTALLATION

A. Fabricate flashing from single piece of metal unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:

1. Lead Sheets: Burn joints of 6.0-lb/sq. ft. lead sheets, 0.0938-inch thickness or thicker. Solder joints of 4.0-lb/sq. ft. lead sheets, 0.0625-inch thickness or thinner.
2. Copper Sheets: Solder joints of copper sheets.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe Flashing: Sleeve type, matching the pipe size, with a minimum length of 10 inches and with skirt or flange extending at least 8 inches around pipe.
2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

C. Set flashing on floors and roofs in solid coating of bituminous cement.
D. Secure flashing into sleeve and specialty clamping ring or device.
E. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 PROTECTION
A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION
SECTION 221513 - GENERAL-SERVICE COMPRESSED-AIR PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes piping and related specialties for general-service compressed-air systems operating at 150 psig or less.

B. See Division 22 Section "General-Service Packaged Air Compressors and Receivers" for general-service air compressors and accessories.

1.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Compressed-air piping and support and installation shall withstand effects of seismic events determined according to SEI/ASCE 7, "Minimum Design Loads for Buildings and Other Structures."

1.3 SUBMITTALS

A. Product Data: For the following:

1. Pressure regulators. Include rated capacities and operating characteristics.
2. Automatic drain valves.
3. Filters. Include rated capacities and operating characteristics.
4. Lubricators. Include rated capacities and operating characteristics.

B. Field quality-control test reports.

C. Operation and maintenance data.

1.4 QUALITY ASSURANCE


PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B, black or hot-dip zinc coated with ends threaded according to ASME B1.20.1.

4. Steel Flanges: ASME B16.5, Class 150 or 300, carbon steel, threaded.

B. Copper Tube: ASTM B 88, Type L seamless, drawn-temper, water tube.
   1. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, wrought copper with dimensions for brazed joints.
   2. Cast-Copper-Alloy Flanges: ASME B16.24, Class 150 or 300.
   3. Copper Unions: ASME B16.22 or MSS SP-123.

2.2 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for compressed-air piping system contents.
   1. ASME B16.21, nonmetallic, flat, full-face, asbestos free, 1/8-inch maximum thickness.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated.

2.3 VALVES

A. Metal Ball, Butterfly, Check and Gate Valves: Comply with requirements in Division 15 Section "General Duty Valves for Plumbing Piping."

2.4 FLEXIBLE PIPE CONNECTORS

A. Bronze-Hose Flexible Pipe Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
   2. End Connections, NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
   3. End Connections, NPS 2-1/2 and Larger: Flanged copper alloy.

B. Stainless-Steel-Hose Flexible Pipe Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
   2. End Connections, NPS 2 and Smaller: Threaded steel pipe nipple.
   3. End Connections, NPS 2-1/2 and Larger: Flanged steel nipple.
2.5 SPECIALTIES

A. Safety Valves: ASME Boiler and Pressure Vessel Code: Section VIII, “Pressure Vessels,” construction; National Board certified, labeled, and factory sealed; constructed of bronze body with poppet-type safety valve for compressed-air service.

   1. Pressure Settings: Higher than discharge pressure and same or lower than receiver pressure rating.

B. Air-Main Pressure Regulators: Bronze body, pilot-operated direct acting, spring-loaded manual pressure-setting adjustment, and rated for 300-psig inlet pressure, unless otherwise indicated.

C. Air-Line Pressure Regulators: [Diaphragm] [Diaphragm or pilot] [Pilot] operated, bronze body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for 300-psig minimum inlet pressure, unless otherwise indicated.

D. Automatic Drain Valves: Stainless-steel body and internal parts, rated for 300-psig minimum working pressure, capable of automatic discharge of collected condensate. Include mounting bracket if wall mounting is indicated.

E. Coalescing Filters: Coalescing type with activated carbon capable of removing water and oil aerosols; with color-change dye to indicate when carbon is saturated and warning light to indicate when selected maximum pressure drop has been exceeded. Include mounting bracket if wall mounting is indicated.

F. Mechanical Filters: Two-stage, mechanical-separation-type, air-line filters. Equip with deflector plates, resin-impregnated-ribbon-type filters with edge filtration, and drain cock. Include mounting bracket if wall mounting is indicated.

G. Air-Line Lubricators: Sizes and capacities indicated; equip with drip chamber and sight dome for observing oil drop entering airstream; with oil-feed adjustment screw and quick-release collar for easy bowl removal.

   1. Provide with automatic feed device for supplying oil to lubricator.

2.6 QUICK COUPLINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   1. Aeroquip Corporation; Eaton Corp.
   2. Bowes Manufacturing Inc.
   3. Foster Manufacturing, Inc.
   5. Parker Hannifin Corp.; Fluid Connectors Group; Quick Coupling Div.
   6. Rectus Corp.
   7. Schrader-Bridgeport; Amflo Div.
   9. Snap-Tite, Inc.; Quick Disconnect & Valve Division.
   10. TOMCO Products Inc.
   11. Tuthill Corporation; Hansen Coupling Div.
B. General Requirements for Quick Couplings: Assembly with locking-mechanism feature for quick connection and disconnection of compressed-air hose.

C. Automatic-Shutoff Quick Couplings: Straight-through brass body with O-ring or gasket seal and stainless-steel or nickel-plated-steel operating parts.
   1. Socket End: With one-way valve and threaded inlet for connection to piping or threaded hose fitting.

D. Valveless Quick Couplings: Straight-through brass body with stainless-steel or nickel-plated-steel operating parts.
   1. Socket End: With O-ring or gasket seal, without valve, and with barbed inlet for attaching hose.
   2. Plug End: With barbed outlet for attaching hose.

2.7 HOSE ASSEMBLIES

A. Description: Compatible hose, clamps, couplings, and splicers suitable for compressed-air service, of nominal diameter indicated, and rated for 300-psig minimum working pressure, unless otherwise indicated.
   2. Hose Clamps: Stainless-steel clamps or bands.
   3. Hose Couplings: Two-piece, straight-through, threaded brass or stainless-steel O-ring or gasket-seal swivel coupling with barbed ends for connecting two sections of hose.
   4. Hose Splicers: One-piece, straight-through brass or stainless-steel fitting with barbed ends for connecting two sections of hose.

PART 3 - EXECUTION

3.1 PREPARATION

A. Interruption of Existing Compressed-Air Service: Do not interrupt compressed-air service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary compressed-air service according to requirements indicated:
   1. Notify Owner not less than two days in advance of proposed interruption of compressed-air service.
   2. Do not proceed with interruption of compressed-air service without Owner’s written permission.

3.2 PIPING APPLICATIONS

A. Compressed-Air Piping between Air Compressors and Receivers: Use one of the following piping materials for each size range:
1. NPS 2 and Smaller: Steel pipe; threaded, malleable-iron fittings; and threaded joints. Use black or galvanized pipe and fitting inside building and galvanized pipe and fittings exterior of building.
2. NPS 2 and Smaller: Type L, copper tube; wrought-copper fittings; and brazed joints.

B. Low-Pressure Compressed-Air Distribution Piping: Use one of the following piping materials for each size range:

1. NPS 2 and Smaller: Steel pipe; threaded, malleable-iron fittings; and threaded joints. Use black or galvanized pipe and fitting inside building and galvanized pipe and fittings exterior of building.
2. NPS 2 and Smaller: Type K or L, copper tube; wrought-copper fittings; and brazed joints.

C. Drain Piping: Use the following piping materials:

1. NPS 2 and Smaller: Type L copper tube; wrought-copper fittings; and brazed or soldered joints.

3.3 VALVE APPLICATIONS

A. Comply with requirements in "Valve Applications" Article in Division 15 Section "General Duty Valves for Plumbing Piping."

B. Equipment Isolation Valves: Safety-exhaust, copper-alloy ball valve with exhaust vent and pressure rating at least as great as piping system operating pressure.

3.4 PIPING INSTALLATION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for basic piping installation.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of compressed-air piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved.

C. Install piping concealed from view and protected from physical contact by building occupants, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping at right angles or parallel to building walls. Diagonal runs are prohibited, unless otherwise indicated.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and to coordinate with other services occupying that space.

F. Install piping adjacent to equipment and machines to allow service and maintenance.

G. Install air and drain piping with 1 percent slope downward in direction of flow.

H. Install nipples, flanges, unions, transition and special fittings, and valves with pressure ratings same as or higher than system pressure rating, unless otherwise indicated.
I. Equipment and Specialty Flanged Connections:
   1. Use steel companion flange with gasket for connection to steel pipe.
   2. Use cast-copper-alloy companion flange with gasket and brazed joint for connection to copper tube.

J. Install branch connections to compressed-air mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.

K. Install thermometer and pressure gage on discharge piping from each air compressor and on each receiver. Comply with requirements in Division 15 Section "Meters and Gages for Plumbing Piping."

L. Install piping to permit valve servicing.

M. Install piping free of sags and bends.

N. Install fittings for changes in direction and branch connections.

O. Install seismic restraints on piping. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

P. Install unions, adjacent to each valve and at final connection to each piece of equipment and machine.

3.5 JOINT CONSTRUCTION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for basic piping joint construction.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from pipe and fittings before assembly.

D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Apply appropriate tape or thread compound to external pipe threads.

E. Brazed Joints for Copper Tubing: Join according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

F. Flanged Joints: Use asbestos-free, nonmetallic gasket suitable for compressed air. Join flanges with gasket and bolts according to ASME B31.9 for bolting procedure.

G. Dissimilar Metal Piping Material Joints: Use dielectric fittings.

3.6 VALVE INSTALLATION

A. Refer to Division 22 Section "Common work Results for Plumbing" for basic piping and valve installation.
B. General-Duty Valves: Comply with requirements in Division 15 Section "General-Duty Valves for Plumbing Piping."

C. Install shutoff valves and unions or flanged joints at compressed-air piping to air compressors.

D. Install shutoff valve at inlet to each automatic drain valve.

E. Install shutoff valve at inlet and outlet from each filter, lubricator, pressure regulator and other specialties.

F. Install check valves to maintain correct direction of compressed-air flow to and from compressed-air piping specialties and equipment.

3.7 DIELECTRIC FITTING INSTALLATION

A. Install dielectric unions in piping at connections of dissimilar metal piping and tubing.

3.8 FLEXIBLE PIPE CONNECTOR INSTALLATION

A. Install flexible pipe connectors in discharge piping[ and in inlet air piping from remote air-inlet filter] of each air compressor.

B. Install bronze-hose flexible pipe connectors in copper compressed-air tubing.

C. Install stainless-steel-hose flexible pipe connectors in steel compressed-air piping.

3.9 SPECIALTY INSTALLATION

A. Install safety valves on receivers in quantity and size to relieve at least the capacity of connected air compressors.

B. Install safety valves where recommended by specialty manufacturers.

C. Install air-main pressure regulators in compressed-air piping at or near air compressors.

D. Install air-line pressure regulators in branch piping to equipment.

E. Install automatic drain valves on aftercoolers, receivers, and dryers. Discharge condensate onto nearest floor drain.

F. Install coalescing filters in compressed-air piping at or near air compressors and upstream from mechanical filters.[ Mount on wall at locations indicated.]

G. Install mechanical filters in compressed-air piping at or near air compressors and downstream from coalescing filters.[ Mount on wall at locations indicated.]

H. Install quick couplings at piping terminals for hose connections.

I. Install hose assemblies at hose connections.
3.10 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.

B. Comply with requirements in Division 15 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices.

C. Vertical Piping: MSS Type 8 or 42, clamps.

D. Individual, Straight, Horizontal Piping Runs:
   1. 100 Feet or Less: MSS Type 1, adjustable, steel clevis hangers.
   2. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.

E. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

F. Base of Vertical Piping: MSS Type 52, spring hangers.

G. Support horizontal piping within 12 inches of each fitting and coupling.

H. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

I. Install hangers for Schedule 40, steel piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1/4 to NPS 1/2: 96 inches with 3/8-inch rod.
   2. NPS 3/4 to NPS 1-1/4: 84 inches with 3/8-inch rod.
   3. NPS 1-1/2: 12 feet with 3/8-inch rod.
   4. NPS 2: 13 feet with 3/8-inch rod.

J. Install supports for vertical, Schedule 40, steel piping every 15 feet.

K. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1/4: 60 inches with 3/8-inch rod.
   2. NPS 3/8 and NPS 1/2: 72 inches with 3/8-inch rod.
   4. NPS 1: 96 inches with 3/8-inch rod.
   6. NPS 1-1/2: 10 feet with 3/8-inch rod.
   7. NPS 2: 11 feet with 3/8-inch rod.

L. Install supports for vertical copper tubing every 10 feet.

3.11 LABELING AND IDENTIFICATION

A. Install identifying labels and devices for general-service compressed-air piping, valves, and specialties. Comply with requirements in Division 15 Section "Identification for Plumbing Piping and Equipment."
3.12 FIELD QUALITY CONTROL

A. Perform field tests and inspections.

B. Tests and Inspections:

1. Piping Leak Tests: Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry air or gaseous nitrogen to pressure of 50 psig above system operating pressure, but not less than 150 psig. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.

2. Repair leaks and retest until no leaks exist.

3. Inspect [filters] [lubricators] [and] [pressure regulators] for proper operation.

4. Test and adjust piping safety controls. Replace damaged and malfunctioning safety controls.

5. Report results in writing.

END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes:

1. Lubricated, reciprocating air compressors.
2. Oil-flooded, rotary-screw air compressors.
3. Oil-sealed, rotary, sliding-vane air compressors.
4. Inlet-air filters.
5. Air-cooled, compressed-air aftercoolers.
6. Refrigerant compressed-air dryers.

1.2 PERFORMANCE REQUIREMENTS
A. [Delegated Design: Design compressed-air equipment mounting, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.]
B. Seismic Performance: Compressed-air equipment shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.3 SUBMITTALS
A. Product Data: For each model indicated, provided dimensions, weights, capacities at scheduled conditions, electrical requirements, required clearances, methods for assembling components, accessories, and location and size of each field connection.
B. [Delegated-Design Submittal: For compressed-air equipment mounting indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.]

1. [Detail fabrication and assembly of supports.]
2. [Design Calculations: Calculate requirements for selecting vibration isolators[ and seismic restraints] and for designing vibration isolation bases.]
C. Seismic Qualification Certificates: For compressed-air equipment, accessories, and components, from manufacturers.
D. Operation and maintenance data.
1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASME Compliance: Fabricate and label receivers to comply with ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PACKAGED AIR COMPRESSORS AND RECEIVERS

A. General Description: Factory-assembled, -wired, -piped, and -tested; electric-motor-driven; air-cooled; continuous-duty air compressors and receivers that deliver air of quality equal to intake air.

B. Control Panels: Automatic control station with load control and protection functions. Comply with NEMA ICS 2 and UL 508.

1. Enclosure: NEMA ICS 6, Type 12 control panel unless otherwise indicated.
3. Control Voltage: 120-V ac or less, using integral control power transformer.
5. Starting Devices: Hand-off-automatic selector switch in cover of control panel, plus pilot device for automatic control.
6. Automatic control switches to [alternate lead-lag compressors for duplex] [sequence lead-lag compressors for multiplex] air compressors.
7. Instrumentation: Include discharge-air pressure gage, air-filter maintenance indicator, hour meter, compressor discharge-air and coolant temperature gages, and control transformer.
8. Alarm Signal Device: For connection to alarm system to indicate when backup air compressor is operating.

C. Receivers: Steel tank constructed according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

1. Pressure Rating: At least as high as highest discharge pressure of connected compressors, and bearing appropriate code symbols.
2. Interior Finish: Corrosion-resistant coating.
3. Accessories: Include safety valve, pressure gage, drain, and pressure-reducing valve.

D. Mounting Frame: Fabricate mounting and attachment to pressure vessel with reinforcement strong enough to resist packaged equipment movement during a seismic event when base is anchored to building structure.
2.2 LUBRICATED, RECIPROCATING AIR COMPRESSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2. CompAir, Ltd.
3. Curtis-Toledo.
5. General Air Products, Inc.
6. Ingersoll-Rand; Air Solutions Group.
7. Kaeser Compressors, Inc.
8. Powerex, Inc.
9. Quincy Compressor; an EnPro Industries company.
10. Saylor-Beall Manufacturing Company.

B. Compressor(s): Lubricated, reciprocating-piston type with lubricated compression chamber and crankcase.

1. Submerged gear-type oil pump.
2. Oil filter.
3. Combined high discharge-air temperature and low lubrication-oil pressure switch.
4. Belt guard totally enclosing pulleys and belts.

C. Characteristics:

1. [Provide intercooler between stages of two-stage units.]
2. Mounting: [Freestanding] [Tank mounted].
   a. Interior Finish: [Epoxy] [Epoxy or galvanized] [Galvanized] <Insert coating> coating.
   b. Pressure Rating: 300 psig minimum.
   c. Pressure Regulator Setting: [100 psig]<Insert psig>.
   d. Pressure Relief Valve Setting: 150 psig.

2.3 OIL-FLOODED, ROTARY-SCREW AIR COMPRESSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2. CompAir, Ltd.
4. Ingersoll-Rand; Air Solutions Group.
5. Kaeser Compressors, Inc.
6. Quincy Compressor; an EnPro Industries company.
7. Sullair Corporation.

B. Compressor(s): Oil-flooded, rotary-screw type with lubricated helical screws and lubricated gear box.
2. Cooling/Lubrication System: Unit-mounted, air-cooled exchanger package prepiped to unit; with air pressure circulation system with coolant stop valve, full-flow coolant filter, and thermal bypass valve.
3. Air Filter: Dry type, with maintenance indicator and cleanable replaceable filter element.
5. Capacity Control: Capacity modulation between zero and 100 percent air delivery, with operating pressures between 50 and 100 psig. Include necessary control to hold constant pressure. When air demand is zero, unload compressor by using pressure switch and blowdown valve.

C. Characteristics:

1. Receiver: ASME construction steel tank.
   a. Interior Finish: [Epoxy] [Epoxy or galvanized] [Galvanized] <Insert coating> coating.
   b. Pressure Rating: 300 psig minimum.
   c. Pressure Regulator Setting: [100 psig]<Insert psig>.
   d. Pressure Relief Valve Setting: [150 psig]

2. Enclosure: Steel with sound-attenuating material lining.

2.4 OIL-SEALED, ROTARY, SLIDING-VANE AIR COMPRESSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Becker Pumps Corp.
2. Davey Compressor Company.
3. Gast Manufacturing Inc.
4. CompAir, Ltd.

B. Compressor(s): Nonpulsating, rotary, sliding-vane type with oil-sealed sliding vanes.

1. Cleanable inlet screens.
2. Outlet silencers and oil-mist separators on discharge connections.

C. Characteristics:

1. Air Compressor(s): Single stage.
2. Receiver: ASME construction steel tank.
   a. Interior Finish: [Epoxy] [Epoxy or galvanized] [Galvanized] <Insert coating> coating.
   b. Pressure Rating: 200 psig minimum.
   c. Pressure Regulator Setting: [100 psig]<Insert psig>.
d. Pressure Relief Valve Setting: **[150 psig]**.

2.5 INLET-AIR FILTERS

A. **Description:** Combination inlet-air filter-silencer, suitable for remote installation, for each air compressor.

1. **Construction:** Weatherproof housing for replaceable, dry-type filter element, with silencer tubes or other method of sound reduction.
2. **Capacity:** Match capacity of air compressor, with filter having collection efficiency of 99 percent retention of particles larger than 10 micrometers.

2.6 AIR-COOLED, COMPRESSED-AIR AFTERCOOLERS

A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:

1. Air/Tak, Inc.
2. Arrow Pneumatics, Inc.
3. Curtis-Toledo.
5. Hankison International.
6. Ingersoll-Rand; Air Solutions Group.
7. Kaeser Compressors, Inc.
8. Pneumatech Inc.
10. Van Air Systems, Inc.
11. Zeks Compressed Air Solutions.

B. **Description:** Electric-motor-driven, fan-operation, finned-tube unit; rated at 250 psig and leak tested at 350-psig minimum air pressure; in capacities indicated. Size units to cool compressed air in compressor-rated capacities to 10 deg F above summertime maximum ambient temperature. Include moisture separator and automatic drain.

2.7 REFRIGERANT COMPRESSED-AIR DRYERS

A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:

1. Air/Tak, Inc.
2. Arrow Pneumatics, Inc.
4. Curtis-Toledo.
5. Domnick Hunter Limited; ZANDER, Inc.
8. Ingersoll-Rand; Air Solutions Group.
12. Pneumatech Inc.
13. SPX Air Treatment.
14. Van Air Systems, Inc.
15. Wilkerson Operations; Pneumatic Division.

B. Description: Noncycling, air-cooled, electric-motor-driven unit with steel enclosure and capability to deliver 35 deg F, 100-psig air at dew point. Include automatic ejection of condensate from airstream, step-down transformers, disconnect switches, inlet and outlet pressure gages, thermometers, automatic controls, and filters.

C. Characteristics:
   1. Inlet Filter: 0.1 microns.
   2. Outlet Filter: Particulate.

2.8 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 15 Section "Common Motor Requirements for Plumbing Equipment."

   1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 16 Sections.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Install units, level, plumb, and anchored to substrate in locations indicated. Maintain manufacturer's recommended clearances. Orient equipment so controls and devices are accessible for servicing.

B. Equipment Mounting: Install air compressors[ and aftercoolers] [ and air dryers] [ , aftercoolers, and air dryers] on concrete bases using [elastomeric pads] [elastomeric mounts] [restrained spring isolators] <Insert device>. Comply with requirements in Division 3. Comply with requirements for vibration isolation devices specified in Division 15 Section "Vibration [and Seismic] Controls for Plumbing Piping and Equipment."

   1. Minimum Deflection: [1/4 inch] [1 inch] <Insert dimension>.

C. Equipment Mounting: Install air compressors[ and aftercoolers] [ and air dryers] [ , aftercoolers, and air dryers] on vibration isolation inertia bases. Comply with requirements specified in Division 15 Section "Vibration [and Seismic] Controls for Plumbing Piping and Equipment."
D. Equipment Mounting: Install air compressors and aftercoolers and air dryers on concrete bases. Comply with requirements in Division 3.

E. Install compressed-air equipment anchored to substrate.

F. Install the following devices on compressed-air equipment:
   1. Thermometer, Pressure Gage, and Safety Valve: Install on each compressed-air receiver.
   2. Pressure Regulators: Install downstream from air compressors and dryers.
   3. Automatic Drain Valves: Install on aftercoolers, receivers, and dryers. Discharge condensate over nearest floor drain.

G. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.
   2. Check for lubricating oil in lubricated-type equipment.
   3. Check belt drives for proper tension.
   4. Verify that air-compressor inlet filters and piping are clear.
   5. Check for equipment vibration-control supports and flexible pipe connectors and verify that equipment is properly attached to substrate.
   6. Check safety valves for correct settings. Ensure that settings are higher than air-compressor discharge pressure but not higher than rating of system components.
   7. [Check for proper seismic restraints.]
   8. Drain receiver tanks.
   9. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   10. Test and adjust controls and safeties.

3.2 CONNECTIONS

A. Comply with requirements for piping specified in Division 15 Section "General-Service Compressed-Air Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Connect piping to air compressors and receivers, except safety relief valve connections, with flexible pipe connectors of materials suitable for service. Flexible pipe connectors and their installation are specified in Division 15 Section "General-Service Compressed-Air Piping."

D. Ground equipment according to Division 16.

E. Connect wiring according to Division 16.

3.3 IDENTIFICATION

A. Identify general-service air compressors and components. Comply with requirements for identification specified in Division 15 Section "Identification for Plumbing Piping and Equipment."
3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air compressors [and aftercoolers] [and air dryers] [, aftercoolers, and air dryers].

END OF SECTION
SECTION 223300 - ELECTRIC WATER HEATERS

PART 1 - GENERAL

1.1 SUMMARY

1. Section Includes:
   1. Commercial, electric, storage, water heaters.
   2. Commercial, light-duty, storage, electric, water heaters.
   3. Electric, tankless, water heaters.

1.2 PERFORMANCE REQUIREMENTS

1. Seismic Performance: Commercial domestic-water heaters shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.3 ACTION SUBMITTALS

1. Product Data: For each type and size of domestic-water heater indicated.

B. LEED Submittals:
   1. Product Data for Prerequisite EA 2: Documentation indicating that units comply with applicable requirements in ASHRAE/IESNA 90.1, Section 7, "Service Water Heating."

C. Shop Drawings:
   1. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

1. Seismic Qualification Certificates: For commercial domestic-water heaters, accessories, and components, from manufacturer.

B. Water Heater Labeling: Certified and visibly labeled by testing agency acceptable to authorities having jurisdiction.

C. Source quality-control reports.

D. Field quality-control reports.
1.5 CLOSEOUT SUBMITTALS

A. Installation, operation, and maintenance data.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

C. ASME Compliance: Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61, "Drinking Water System Components - Health Effects."

1.7 WARRANTY

A. Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components of electric, domestic-water heaters that fail in materials or workmanship within specified warranty period.

1. Warranty Periods: From date of Substantial Completion.
   a. Storage Tank: No less than three years.
   b. Controls and Other Components: Two years

PART 2 - PRODUCTS

2.1 COMMERCIAL, ELECTRIC, domestic-WATER HEATERS

A. Commercial, Electric, Storage, Water Heaters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Water Heaters – Heavy Duty Series
   b. Ruud – Heavy Duty Series
   c. A. O. Smith, Water Products Co. – Gold Series
   d. State Water Heaters – Heavy Duty Series


   a. Tappings: Factory fabricated of materials compatible with tank and piping connections. Attach tappings to tank before testing.
      1) NPS 2 and Smaller: Threaded ends.
      2) NPS 2-1/2 and Larger: Flanged ends.

   b. Pressure Rating: 150 psig.

223300-2
c. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.

4. Factory-Installed Storage-Tank Appurtenances:
   a. Anode Rod: Replaceable magnesium.
   b. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
   c. Insulation: Comply with ASHRAE/IESNA 90.1.
   d. Jacket: Steel with enameled finish.
   e. Heating Elements: Electric, screw-in or bolt-on immersion type arranged in multiples of three.
   f. Temperature Control: Adjustable thermostat.
   g. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
   h. Relief Valves: ASME rated and stamped for combination temperature-and-pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating.

5. Special Requirements:
   a. NSF 5 construction with legs for off-floor installation.
   b. Remove all factory provided steel/galvanized nipples and replace with brass nipples.

B. Commercial, Light-Duty, Storage, Electric, Domestic-Water Heaters:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. A. O. Smith Water Products Co. – DuraPower Series
   c. Ruud – Light Duty Series
   d. State Water Heaters – Light Duty Series


   b. Pressure Rating: 150 psig.
   c. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.

4. Factory-Installed Storage-Tank Appurtenances:
   a. Anode Rod: Replaceable magnesium.
   b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
   c. Drain Valve: ASSE 1005.
   d. Insulation: Comply with ASHRAE/IESNA 90.
   e. Jacket: Steel with enameled finish.
   f. Heating Elements: Two; electric, screw-in immersion type; wired for simultaneous operation unless otherwise indicated. Limited to 12 kW total.
   g. Temperature Control: Adjustable thermostat.
   h. Safety Control: High-temperature-limit cutoff device or system.
   i. Relief Valve: ASME rated and stamped for combination temperature-and-pressure relief valves. Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Retain subparagraph below if domestic-water heater is required for foodservice equipment. Verify that NSF compliance is available for selected domestic-water heater.

5. Special Requirements:
   223300-3
a. NSF 5 construction with legs for off-floor installation.
b. Remove all factory provided steel/galvanized nipples and replace with brass nipples.

C. The water heaters shall possess the Capacity and Characteristics at Design Conditions as specified on the drawings and in the submittals for the following parameters:

1. Tank Capacity (Gallons).
2. Recovery Rate (GPH-°F).
3. Temperature Rise (°F).
4. Power Demand (KW).
5. Heating Elements:
   a. Number of Elements.
   b. Kilowatts Each Element.
   c. Number of Stages.
6. Electrical Characteristics:
   a. Voltage.
   b. Phases.
   c. Frequency (Hertz).
   d. Full-Load Amperes (Amps).
   e. Minimum Circuit Ampacity (Amps).
   f. Maximum Overcurrent Protection (Amps).

2.2 ELECTRIC, TANKLESS, domestic-WATER HEATERS

A. Electric, Tankless, Domestic-Water Heaters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
   a. Eemax.
   b. Instant-Flow.
   c. Powerstream-Pro.
   d. Hot Aqua
2. Standard: UL 499 for electric heating appliances.
3. Construction: Copper piping or tubing complying with NSF 61 barrier materials for potable water, without storage capacity.
   b. Pressure Rating: 150 psig
   c. Heating Element: Resistance heating system.
   d. Temperature Control: Thermostat.
   e. Safety Control: High-temperature-limit cutoff device or system.
   f. Jacket: Aluminum or steel with enameled finish or plastic.
5. The water heaters shall possess the Capacity and Characteristics as specified on the drawings and in the submittals for the following parameters:
   a. Flow Rate (GPM).
   b. Supply Temperature (°F)
   c. Power Demand (KW).
   d. Electrical Characteristics:
      1) Volts
      2) Phases.

223300-4
3) Frequency (Hertz).
4) Full-Load Amperes (Amps).
5) Minimum Circuit Ampacity (Amps).
6) Maximum Overcurrent Protection (Amps).

2.3 SOURCE QUALITY CONTROL

A. Hydrostatically test domestic-water heaters to minimum of one and one-half times pressure rating before shipment.

B. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 014000 "Quality Requirements" for retesting and reinspecting requirements.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

A. Commercial, Electric, Domestic-Water Heater Mounting: Install commercial, electric, domestic-water heaters on concrete base. Comply with requirements for concrete bases specified in Division 3 Concrete.
   1. Exception: Omit concrete bases for commercial, electric, domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated on drawings.
   2. Maintain manufacturer's recommended clearances for maintenance, service, and replacement.
   3. Arrange units so controls and devices that require servicing are accessible.
   4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
   5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   7. Install anchor bolts to elevations required for proper attachment to supported equipment.
   8. Anchor domestic-water heaters to structure.

B. Electric, Tankless, Water Heater Mounting: Install at least 18 inches above floor on wall bracket.
   1. Maintain manufacturer's recommended clearances for maintenance, service, and replacement.
   2. Arrange units so controls and devices that require servicing are accessible.
   3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.
5. Anchor domestic-water heaters to structure.

C. Install electric, water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
   1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 220523 "General-Duty Valves for Plumbing Piping."

D. Install commercial, electric, domestic-water heaters with seismic-restraint devices. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

E. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

F. Install combination temperature and pressure relief valves in water piping for electric, domestic-water heaters without storage. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

G. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for electric, domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 221119 "Domestic Water Piping Specialties."

H. Install thermometers on outlet piping of electric, domestic-water heaters. Comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."

I. In non-recirculating systems, install piping-type heat traps on inlet and outlet piping of electric, domestic-water heater storage tanks without integral or fitting-type heat traps.

J. Fill electric, domestic-water heaters with potable water.

K. Provide an expansion tank in accordance with Section 232113 and the manufacturer's sizing recommendations. The expansion tank shall be located in the cold water supply line between the check valve and the water heater. Charge domestic-water compression tanks with air to match the cold water supply pressure.

L. Provide an antisiphon device (e.g., check valve) in the cold water supply line between the shut off valve and the expansion tank to prevent backflow of tank water into the cold water supply line per IPC.
3.2 CONNECTIONS

A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to electric, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping and valves for easy removal of domestic-water heaters while maintaining cold water service elsewhere in the building.

C. Replace existing nipples and install brass nipples to prevent any possible galvanic action

3.3 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
   2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 014000 "Quality Requirements" for retesting and reinspecting.

C. Provide test and inspection reports.

END OF SECTION
SECTION 224100 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Faucets for [lavatories] [bathtubs] [bathtub/showers] [showers] [and] [sinks].
   2. Flushometers.
   3. Toilet seats.
   4. Protective shielding guards.
   5. Fixture support.
   6. Disposers.
   7. Hot-water dispensers.
   8. Water closets.
   9. Urinals.
  10. Lavatories.
  12. Individual showers.
  15. Laundry tub.

B. Related Sections include the following:
   1. Division 22 Section “Domestic Water Piping.”
   2. Division 22 Section “Sanitary Waste Piping Specialties.”
   3. Division 22 Section “Emergency Plumbing Fixtures.”
   4. Division 22 Section “Drinking Fountains and Water Coolers.”

C. See drawings for “Plumbing Fixture Specification.”

1.2 DEFINITIONS


B. Accessible Fixture: Plumbing fixtures that can be approached, entered, and used by people with disabilities.

C. FRP: Fiberglass-reinforced plastic.

D. PMMA: Polymethyl methacrylate (acrylic) plastic.

E. PVC: Polyvinyl chloride plastic.

1.3 SUBMITTALS

A. Product Data: For each product indicated, include trim, fittings, accessories, appurtenances, supports, materials and finishes, dimensions, construction details, and flow rates.

B. Operation and maintenance data.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.


D. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

E. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

F. Comply with the following applicable standards and other requirements specified for plumbing fixtures:

1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
5. Porcelain-Enameled, Formed-Steel Fixtures: ASME A112.19.4M.
8. Vitreous-China Fixtures: ASME A112.19.2M.

G. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:

1. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M.
2. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.

H. Comply with the following applicable standards and other requirements specified for bathtub and shower faucets:

2. Combination, Pressure-Equalizing and Thermostatic-Control Antiscald Faucets: ASSE 1016.

I. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:

2. Brass and Copper Supplies: ASME A112.18.1M.
5. Tubular Brass Drainage Fittings and Piping: ASME A112.18.2.

J. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Disposers: ASSE 1008 and UL 430.
2. Grab Bars: ASTM F 446.
5. Off-Floor Fixture Supports: ASME A112.6.1M.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with the specific requirements shown on the Drawings or herein, provide products by the following manufacturers.
2. Faucets: Chicago, Kohler, Symmons, T&S Brass.
15. Disposers: In-Sink Erator; a div. of Emerson Co., KitchenAid, Maytag Co.

2.2 FIXTURE

A. Basis-of-Design Products: Subject to compliance with requirements, provide the product indicated on the Drawings or a comparable product by one of the listed manufacturers.

2.3 FIXTURE SUPPORTS

A. Water-Closet Support: Heavy Duty water-closet combination carrier designed for accessible or standard mounting height as applicable. Include single or double, vertical or horizontal, hub-and-spigot or hubless waste fitting as required for piping arrangement; faceplates; couplings with gaskets; feet; and fixture bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.

B. Urinal Support: Type I, urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture. Include steel uprights with feet. Accessible Fixture Support: Include rectangular steel uprights.

C. Lavatory Support: Type II, lavatory carrier with concealed arms and tie rod. Include steel uprights with feet. Accessible Fixture Support: Include rectangular steel uprights.

2.4 FLUSH VALVES

A. Valve body cover, tailpiece and control stop shall be in conformance with ASTM Alloy Classification for Semi-Red Brass.

B. Required maximum flow shall be factory set, field external adjustment is not acceptable.

C. At all ADA fixtures, handles shall conform to ADA requirements.
D. Valve will be in conformance with the applicable sections of ASSE 1037, ANSI/ASME 112.19.6 and Military Specification V-29193 Standards.

E. Triple seal packing at valve handle.

F. Skirted high back pressure vacuum breaker.

G. Non-hold open ADA handle.

H. UPC, ADA and IAPMO listed.

I. Chromo plated cover for flush valve body to have female thread.

2.5 PLASTER TRAPS

A. Plaster and Sediment Traps: Manufactured unit with removable screens or strainer and removable cover, and designed to trap and retain waste material.
   1. Material: Cast-iron or steel with acid-resistant lining and coating body.

2.6 NEUTRALIZATION TANK

A. Neutralization Tank: Rotationally molded, seamless, high density polyethylene tank, with welded cover, top mounted inlet and outlet, 3-inch front handhole.
   1. Provide limestone chips as recommended by manufacturer.

PART 3 - EXECUTION

3.1 FIXTURE INSTALLATION

A. Assemble fixtures, trim, fittings, and other components according to manufacturers’ written instructions.

B. Install off-floor supports affixed to building substrate, for wall-hanging fixtures.
   1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
   2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
   3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.

C. Install back-outlet, wall-hanging fixtures onto waste fitting seals and attach to supports.

D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.

E. Install wall-hanging fixtures with tubular waste piping attached to supports.
F. Install floor-mounting, back-outlet water closets attached to building floor substrate and wall bracket and onto waste fitting seals.

G. Install counter-mounting fixtures in and attached to casework.

H. Install fixtures level and plumb according to manufacturers' written instructions and roughing-in drawings.

I. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies in a rigid manner to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

J. Install chrome plated brass trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

K. Install chrome plated tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.

L. Install flushometer valves for accessible compliant water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.

M. Install tanks for accessible, compliant tank-type water closets with lever handle mounted on wide side of compartment.

N. Install toilet seats on water closets.

O. Install faucet-spout fittings with specified flow rates and patterns aerator in faucet spouts if faucets are not furnished with required rates and patterns.

P. Install shower head with flow-control with specified maximum flow rates.

Q. Install traps on fixture outlets.

   1. Exception: Omit trap on fixtures with integral traps.
   2. Exception: Omit trap on indirect waste piping.

R. Install disposer in outlet of sinks indicated to have disposer. Install switch where indicated or in wall adjacent to sink if location is not indicated.

S. Install escutcheons at piping for wall and ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings.

T. Set bathtubs, shower receptors, and service basins in leveling bed of cement grout. Seal joints between fixtures and walls, floors, and counters using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color.

U. Provide pre-insulated drains, off-set drains, p-traps, and drain pipe exposed for accessible compliant lavatories and sinks.

3.2 CONNECTIONS
A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Supply and Waste Connections to Plumbing Fixtures: Connect fixtures with water supplies, stops, risers, traps, and waste piping. Use size fittings required to match fixtures. Connect to plumbing piping.

C. Supply and Waste Connections to Fixtures and Equipment Specified in Other Sections: Connect fixtures and equipment with water supplies, stops, risers, traps, and waste piping specified. Use size fittings required to match fixtures and equipment. Connect to plumbing piping.

D. Ground equipment according to Division 26.

E. Connect wiring according to Division 26.

3.3 FIELD QUALITY CONTROL

A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.

B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

E. Install fresh batteries in sensor-operated mechanisms.

3.4 PROTECTION

A. Provide protective covering for installed fixtures and fittings. Replace any damaged fixture or fittings.

B. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION
SECTION 224500 - EMERGENCY PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Emergency showers.
2. Eyewash equipment.
3. Eye/face wash equipment.
4. Combination units.
5. Water-tempering equipment.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.
B. Shop Drawings: Diagram power, signal, and control wiring.
C. Field quality-control test reports.
D. Operation and maintenance data.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. ANSI Standard: Comply with ANSI Z358.1, "Emergency Eyewash and Shower Equipment."
C. NSF Standard: Comply with NSF 61, "Drinking Water System Components - Health Effects," for fixture materials that will be in contact with potable water.
PART 2 - PRODUCTS

2.1 EMERGENCY SHOWERS

A. Freestanding, Plumbed Emergency Showers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Encon Safety Products.
   c. Haws Corporation.

2. Capacity: Not less than 20 gpm for at least 15 minutes.
3. Supply Piping: NPS 1 galvanized steel or PVC with flow regulator and stay-open control valve.
4. Control-Valve Actuator: [Pull rod] [Foot treadle].
5. Shower Head: 8-inch minimum diameter, chrome-plated brass or stainless steel

2.2 EYEWASH EQUIPMENT

A. Standard, Freestanding, Plumbed Eyewash Units:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Encon Safety Products.
   c. Haws Corporation.

2. Capacity: Not less than 0.4 gpm for at least 15 minutes.
3. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
4. Control-Valve Actuator: [Paddle] [Treadle].
5. Spray-Head Assembly: Two receptor-mounted spray heads.
6. Receptor: [Chrome-plated brass or stainless-steel] bowl.
7. Drain Piping: NPS 1-1/4 minimum, chrome-plated brass, receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2/CSA B125.2 Include galvanized-steel indirect connection to drainage system.

B. Accessible, Freestanding, Plumbed Eyewash Units:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Encon Safety Products.
   c. Haws Corporation.
2. Capacity: Not less than 0.4 gpm for at least 15 minutes.
3. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
5. Spray-Head Assembly: Two receptor-mounted spray heads.
6. Receptor: [Chrome-plated brass or stainless-steel] bowl.
7. Drain Piping: NPS 1-1/4 minimum, chrome-plated brass, receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2/CSA B125.2 Include galvanized-steel indirect connection to drainage system.

2.3 EYE/FACE WASH EQUIPMENT

A. Standard, Freestanding, Plumbed, Eye/Face Wash Units:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Encon Safety Products.
   c. Haws Corporation.
2. Capacity: Not less than 3.0 gpm for at least 15 minutes.
3. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
4. Control-Valve Actuator: [Paddle] [Treadle].
5. Spray-Head Assembly: Two or four receptor-mounted spray heads.
6. Receptor: [Chrome-plated brass or stainless-steel] bowl.
7. Drain Piping: NPS 1-1/4 minimum, chrome-plated brass, receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2/CSA B125.2 Include galvanized-steel indirect connection to drainage system.

B. Accessible, Freestanding, Plumbed, Eye/Face Wash Units:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Acorn Safety; a division of Acorn Engineering Company.
   b. Bradley Corporation.
   c. Encon Safety Products.
   d. Guardian Equipment Co.
   e. WaterSaver Faucet Co.
2. Capacity: Not less than 3 gpm for at least 15 minutes.
3. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
5. Spray-Head Assembly: Two or four receptor-mounted spray heads.
6. Receptor: [Chrome-plated brass or stainless-steel] bowl.
7. Drain Piping: NPS 1-1/4 minimum, chrome-plated brass, receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2/CSA B125.2 Include galvanized-steel indirect connection to drainage system.


2.4 COMBINATION UNITS

A. Standard, Plumbed Emergency Shower with Eyewash Combination Unit:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Acorn Safety; a division of Acorn Engineering Company.
   b. Bradley Corporation.
   c. Encon Safety Products.
   d. Guardian Equipment Co.
   e. Haws Corporation.
   f. Sellstrom Manufacturing Company.
   g. Speakman Company.
   h. WaterSaver Faucet Co.

2. Piping:
   a. Material: [Galvanized steel] [Chrome-plated brass] [PVC].
   b. Unit Supply: NPS 1-1/4 minimum.
   c. Unit Drain: Outlet at back or side near bottom.

3. Shower:
   a. Capacity: Not less than 20 gpm for at least 15 minutes.
   b. Supply Piping: NPS 1 with flow regulator and stay-open control valve.
   c. Control-Valve Actuator: [Pull rod] [Treadle].
   d. Shower Head: 8-inch- minimum diameter, [chrome-plated brass or stainless steel].
   e. Mounting: Pedestal.

4. Eyewash Unit:
   a. Capacity: Not less than 0.4 gpm for at least 15 minutes.
   b. Supply Piping: NPS 1/2 with flow regulator and stay-open control valve.
   d. Spray-Head Assembly: Two receptor-mounted spray heads.
   e. Receptor: [Chrome-plated brass or stainless-steel] bowl.
   f. Mounting: Attached shower pedestal.
   g. Drench-Hose Option: May be provided instead of eyewash unit.

   1) Capacity: Not less than 0.4 gpm for at least 15 minutes.
   2) Drench Hose: Hand-held spray head with squeeze-handle actuator and hose.
3) Mounting: Bracket on shower pedestal.

B. Standard, Plumbed Emergency Shower with Eye/Face Wash Combination Units:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Acorn Safety; a division of Acorn Engineering Company.
   b. Bradley Corporation.
   c. Encon Safety Products.
   d. Guardian Equipment Co.
   e. Haws Corporation.
   f. Sellstrom Manufacturing Company.
   g. Speakman Company.
   h. WaterSaver Faucet Co.

2. Piping:

   a. Material: [Galvanized steel] [Chrome-plated brass or stainless steel] [PVC].
   b. Unit Supply: NPS 1-1/4 minimum
   c. Unit Drain: Outlet at back or side near bottom.

3. Shower:

   a. Capacity: Not less than 20 gpm for at least 15 minutes.
   b. Supply Piping: NPS 1 with flow regulator and stay-open control valve.
   c. Control-Valve Actuator: [Pull rod] [Treadle].
   d. Shower Head: 8-inch- minimum diameter, [chrome-plated brass or stainless steel].
   e. Mounting: Pedestal.

4. Eye/Face Wash Unit:

   a. Capacity: Not less than 3 gpm for at least 15 minutes.
   b. Supply Piping: NPS 1/2 with flow regulator and stay-open control valve.
   d. Spray-Head Assembly: Two or four receptor-mounted spray heads.
   e. Receptor: [Chrome-plated brass or stainless-steel] bowl.
   f. Mounting: Attached shower pedestal.
   g. Drench-Hose Option: May be provided instead of eye/face wash unit.

   1) Capacity: Not less than 3 gpm for at least 15 minutes.
   2) Drench Hose: Hand-held spray head with squeeze-handle actuator and hose.
   3) Mounting: Bracket on shower pedestal.

2.5 WATER-TEMPERING EQUIPMENT

A. Hot- and Cold-Water, Water-Tempering Equipment:
1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
   a. Acorn Safety; a division of Acorn Engineering Company.
   b. Bradley Corporation.
   c. Encon Safety Products.
   d. Guardian Equipment Co.
   e. Haws Corporation.
   f. Sellstrom Manufacturing Company.
   g. Speakman Company.
   h. WaterSaver Faucet Co.

2. **Description:** Factory-fabricated equipment with thermostatic mixing valve.
   a. **Thermostatic Mixing Valve:** Designed to provide 85 deg F tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus 5 deg F throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, controls, metal piping, and corrosion-resistant enclosure.
   b. **Supply Connections:** For hot and cold water.

2.6 **SOURCE QUALITY CONTROL**
   A. Certify performance of emergency plumbing fixtures by independent testing organization acceptable to authorities having jurisdiction.

PART 3 - EXECUTION

3.1 **EMERGENCY PLUMBING FIXTURE INSTALLATION**
   A. Insulate all outdoor fixtures and plumbing to prevent water from solar heating to an uncomfortable or dangerous level. Install outdoor fixtures under shade when possible.
   B. Install fixtures level and plumb and fasten to substrate.
   C. Install shutoff valves in water-supply piping to fixtures. Install valves chained in open position. Install valves in locations where they can easily be reached for operation. Comply with requirements for valves specified in Section 220523 "General-Duty Valves for Plumbing Piping."
   D. Install dielectric fitting in supply piping to emergency equipment if piping and equipment connections are made of different metals. Comply with requirements for dielectric fittings specified in Section 221116 "Domestic Water Piping."
   E. Install thermometers in supply and outlet piping connections to water-tempering equipment. Comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."
F. Install trap and waste piping on drain outlet of emergency equipment receptors that are indicated to be directly connected to drainage system.

G. Fill self-contained fixtures with flushing fluid.

3.2 CONNECTIONS

A. Connect hot- and cold-water-supply piping to hot- and cold-water, water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures. Comply with requirements for hot- and cold-water piping specified in Section 221116 "Domestic Water Piping."

B. Directly connect emergency plumbing fixture receptors with trapped drain outlet to sanitary waste and vent piping. Comply with requirements for waste piping specified in Section 221316 "Sanitary Waste and Vent Piping."

3.3 IDENTIFICATION

A. Install equipment nameplates or equipment markers on emergency plumbing fixtures and equipment and equipment signs on water-tempering equipment. Comply with requirements for identification materials specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities.

B. Tests and Inspections:
   1. Perform visual and mechanical inspection.
   2. Perform Leak Test after installation and charging.
   3. Perform Operational Test after electrical circuitry has been energized to test all safety features.
   4. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust or replace fixture flow regulators for proper flow.

B. Adjust equipment temperature settings.

END OF SECTION
SECTION 224713 - DRINKING FOUNTAINS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Freestanding drinking fountains.
2. Wall-mounting drinking fountains.
3. Wall-mounting refrigerated drinking fountains.
4. Fixture supports.

1.2 SUBMITTALS

A. Product Data: For each product indicated, include trim, fittings, accessories, appurtenances, supports, materials and finishes, dimensions, construction details, and flow rates.

B. Operation and maintenance data.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.


C. NSF Standard: Comply with NSF 61, "Drinking Water System Components—Health Effects," for fixture materials that will be in contact with potable water.

D. [ARI Standard: Comply with ARI's "Directory of Certified Drinking Water Coolers" for style classifications.]


F. [ASHRAE Standard: Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants" for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant unless otherwise indicated.]
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with the specific requirements shown on the Drawings or herein, provide products by the following manufacturers:


2.2 FIXTURE SUPPORTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2. Tyler Pipe; Wade Div.
3. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.

B. Description: ASME A112.6.1M, water cooler carriers. Include vertical, steel uprights with feet and tie rods and bearing plates with mounting studs matching fixture to be supported.

1. Type I: Hanger-type carrier with two vertical uprights.
2. Type II: Bilevel, hanger-type carrier with three vertical uprights.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Use carrier off-floor supports for wall-mounting fixtures, unless otherwise indicated.

B. Set freestanding and pedestal drinking fountains on floor or concrete pad.

C. Use chrome-plated brass or copper tube, fittings, and valves in locations exposed to view.

3.2 INSTALLATION

A. Install off-floor supports affixed to building substrate and attach wall-mounting fixtures, unless otherwise indicated.

B. Install fixtures level and plumb. For fixtures indicated for children, install at height indicated on Architectural Drawings.

C. Install water-supply piping with shutoff valve on supply to each fixture to be connected to water distribution piping. Use ball valve. Install valves in locations where they can be easily reached.
for operation. Valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

D. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.

E. Install pipe escutcheons at wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding pipe fittings. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."

F. Seal joints between fixtures and walls and floors using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 7.

3.3 CONNECTIONS

A. Connect fixtures with water supplies, traps, and risers, and with soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Ground equipment according to Division 26.

C. Connect wiring according to Division 26.

3.4 FIELD QUALITY CONTROL

A. Water Cooler Testing: After electrical circuitry has been energized, test for compliance with requirements. Test and adjust controls and safeties.

1. Remove and replace malfunctioning units and retest as specified above.
2. Report test results in writing.

3.5 ADJUSTING

A. Adjust fixture flow regulators for proper flow and stream height.

B. Adjust water cooler temperature settings.

END OF SECTION
SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR MECHANICAL EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY
A. Section includes general requirements for single-phase and poly-phase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on AC power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.2 COORDINATION
A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
   1. Motor controllers.
   2. Torque, speed, and horsepower requirements of the load.
   3. Ratings and characteristics of supply circuit and required control sequence.
   4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS
A. Comply with requirements in this Section except when stricter requirements are specified in plumbing equipment schedules or Sections.
B. Comply with NEMA MG 1 unless otherwise indicated.
C. Motors larger than 5HP to be 277V or 480V, 3 Phase if available at site.

2.2 MOTOR CHARACTERISTICS
A. Indoor Duty: Continuous duty at ambient temperature of 40°C and at altitude of 3300 feet above sea level.
B. Outdoor duty: Continuous duty at ambient temperature of 50°C and at altitude of 3300 feet above sea level.
C. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.
2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Premium efficient, as defined in NEMA MG 1.

C. Service Factor: Minimum 1.15.

D. Multispeed Motors: Variable torque.
   1. For motors with 2:1 speed ratio, consequent pole, single winding.
   2. For motors with other than 2:1 speed ratio, separate winding for each speed.


F. Bearings: Regreasable, double-shielded, antifriction ball bearings suitable for radial and thrust loading.

G. Temperature Rise: Match insulation rating, unless otherwise indicated.

H. Insulation: Class F, unless otherwise indicated.

I. Code Letter Designation:
   1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
   2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T Insert number.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
   1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
   2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
   3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
   4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
   5. Measure shaft to ground voltage. If voltage exceeds 2v, install a shaft ground ring similar to “AEGIS SGR” on DE (driven end).
2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
   1. Permanent-split capacitor.
   2. Split phase.
   3. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Pre-lubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

2.6 MANUFACTURERS

A. Subject to compliance with the requirements included in this section, for motors not included as part of a listed assembly provide products by one of the following:
   1. General Electric
   2. Emerson
   3. A. O. Smith
   4. U. S. Motors
   5. WEG
   6. Baldor

PART 3 - EXECUTION

3.1 INSTALLATION

A. Termination – 5HP and above
   1. In peckerhead, mechanically terminate motor leads and conductors with crimped or compression “eyes”. Bolt eyes together, with Grade 5 bolt, lock washer, and nut.
   2. Tape: First layer of tape is varnished Cambrick tape, tape over the Cambrick with self-sealing rubber wrap splicing tape. Finish with a wrap of #33 Scotch electrical tape (or equivalent).
   3. Terminal blocks: Mechanical connection terminal blocks for size, listing, and rating of motor conductors. Ample space required for insulated bushings and tape in terminal box.
      a. MANUFACTURERS
         1) Cooper Bussmann
         2) Burndy
SECTION 230515 – COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Dielectric fittings.
3. Mechanical sleeve seals.
4. Sleeves.
5. Escutcheons.
7. HVAC demolition.
8. Equipment installation requirements common to equipment sections.
9. Concrete bases.
10. Supports and anchorages.

1.2 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.3 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Building Services Piping Code: Chapter V, "Fabrication, Assembly, and Erection"

1. Comply with provisions in ASME B31.9 “Building Services Piping.”
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
C. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

PART 2 - PRODUCTS

2.1 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.

2.2 JOINING MATERIALS

A. Refer to individual Division 23 piping Sections for special joining materials.

2.3 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250 psig minimum working pressure at 180°F.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly with dielectric bolt insulators or fully floating, powder-coated, plate-steel, companion flange with EPDM insulator to prevent contact with copper flange adapter, for 150 or 300 psig minimum working pressure as required to suit system pressures.

E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300 psig minimum working pressure at 225°F.

F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300 psig minimum working pressure at 225°F.

2.4 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve. Thunderline Link Seal or approved equal.

B. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

C. Pressure Plates: Carbon steel above grade and stainless steel below grade. Include two for each sealing element.

D. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating above grade and stainless steel below grade of length required to secure pressure plates to sealing elements. Include one for each sealing element.
2.5 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   1. Under deck Clamp: Clamping ring with set screws.

2.6 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

2.7 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HVAC DEMOLITION

A. Refer to Division 1 Sections for general demolition requirements and procedures.

B. Disconnect, demolish, and remove HVAC systems, equipment, and components indicated to be removed.
   1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
   2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material. Label "Abandoned in Place."
   3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
   4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material. Label "Abandoned in Place."
5. Equipment to Be Removed: Disconnect and cap services, remove and discard equipment.

6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational. Operational test to be witnessed by Owner.

7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.

B. Install escutcheons for exposed penetrations of piping through walls, ceilings, and floors.

C. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs. In sprinklered buildings, extend floor sleeves 2 inches above top of floor.

D. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

   1. Install steel pipe for sleeves smaller than 6 inches in diameter.
   2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
   3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

E. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

F. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

G. Verify final equipment locations for roughing-in.

H. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

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3.3 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the Division 23 Sections specifying piping systems.

3.4 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
4. Wet Pipe Systems:
   a. NPS 4 and smaller: Install dielectric coupling or nipple fitting to connect piping materials of dissimilar metals.
   b. MPS 2-1/2 and larger: Install dielectric flange to connect piping materials of dissimilar metals.

3.5 TESTING OF PIPING SYSTEMS

A. Test pipe and fittings according to the requirements in Division 23 Sections specifying piping systems.

3.6 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components without the removal of any permanent construction as stated in the mechanical code. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

3.7 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 6 inches larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 3.

3.8 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 5 for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.9 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor HVAC materials and equipment.

B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.10 GROUTING

A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

END OF SECTION
SECTION 230519 - METERS AND GAGES FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Thermometers.
   2. Gages.
   3. Test plugs.
   5. Flowmeters.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated, include materials and finishes, dimensions, and accuracies. For pressure gages, submit pressure range for each application. For thermometers, submit temperature range and scale divisions for each application. For water and flow meters, submit performance curves.

B. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 METAL-CASE, LIQUID-IN-GLASS THERMOMETERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   1. Titrice, H. O. Co.
   2. Weiss Instruments, Inc.

B. Case: Die-cast aluminum or brass, 9 inches long in mechanical rooms, 7 inches long elsewhere.

C. Tube: Red or blue reading, organic-liquid filled, with magnifying lens.

D. Tube Background: Satin-faced, nonreflective aluminum with permanently etched scale markings.

E. Window: Glass.

F. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.

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G. Stem: Copper-plated steel, aluminum, or brass for thermowell installation and of length to suit installation.

H. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

I. Range: The maximum operating temperature should not exceed 75% of the full-scale range. The normal operating range should be in the middle half of the range (between 25% and 75% of the full-scale range); whenever possible.

2.2 DUCT-TYPE, LIQUID-IN-GLASS THERMOMETERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Palmer - Wahl Instruments Inc.
2. Weiss Instruments, Inc.

B. Case: Die-cast aluminum, 7 inches long.

C. Tube: Red or blue reading, organic filled, with magnifying lens.

D. Tube Background: Satin-faced, nonreflective aluminum with permanently etched scale markings.

E. Window: Glass.

F. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.

G. Stem: Metal, for installation in mounting bracket and of length to suit installation.

H. Mounting Bracket: Flanged fitting for attachment to duct and made to hold thermometer stem.

I. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

J. Range: The maximum operating temperature should not exceed 75% of the full-scale range. The normal operating range should be in the middle half of the range (between 25% and 75% of the full-scale range); whenever possible.

2.3 THERMOWELLS

A. Manufacturers: Same as manufacturer of thermometer being used.

B. Description: Pressure-tight, threaded, socket-type metal fitting made for insertion into piping and of type, diameter, and length required to hold thermometer.

C. Materials: Brass in copper piping systems, Type 316 stainless steel in all other piping
systems.

D. Lagging Extensions: Provide in insulated piping systems, length suitable for insulation thickness.

2.4 PRESSURE GAGES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2. Ernst Gage Co.
3. Palmer - Wahl Instruments Inc.
4. Winters Instruments

B. Direct-Mounting, Dial-Type Pressure Gages: Indicating-dial type complying with ASME B40.100.

1. Case: Dry type, drawn steel, stainless steel, or cast aluminum, 4-1/2-inch diameter.
2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
3. Pressure Connection: Brass, NPS 1/4, bottom-outlet type unless back-outlet type is indicated.
4. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Pointer: Red or other dark-color metal.
7. Window: Glass.
8. Ring: Metal.
9. Accuracy: Grade A, plus or minus 1 percent of middle half scale.
10. Range: The maximum operating pressure should not exceed 75% of the full-scale range. The normal operating range should be in the middle half of the range (between 25% and 75% of the full-scale range); whenever possible.

C. Pressure-Gage Fittings:

1. Valves: NPS 1/4 brass gage cock with lever handles, or brass or stainless-steel needle type.
2. Siphons: NPS 1/4 coil of brass tubing with threaded ends.
3. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.

2.5 TEST PLUGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Peterson Equipment Co., Inc.
2. Sisco Manufacturing Co.

B. Description: Corrosion-resistant brass or stainless-steel body with core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping.

C. Minimum Pressure and Temperature Rating: 500 psig at 200 degrees F.

D. Core Inserts: One or two self-sealing rubber valves.
   1. Insert material for air, water, oil, or gas service at 20 to 200 degrees F shall be CR.
   2. Insert material for air or water service at minus 30 to plus 275 degrees F shall be EPDM.

E. Test Kit: Furnish one test kit containing one pressure gage and adaptor, two thermometer(s), and carrying case. Pressure gage, adapter probes, and thermometer sensing elements shall be of diameter to fit test plugs and of length to project into piping.
   1. Pressure Gage: Small bourdon-tube insertion type with 2 to 3 inch diameter dial and probe. Dial range shall be 0 to 200 psig.
   2. Low-Range Thermometer: Small bimetallic insertion type with 1 to 2 inch diameter dial and tapered-end sensing element. Dial ranges shall be 25 to 125 degrees F.
   3. High-Range Thermometer: Small bimetallic insertion type with 1 to 2 inch diameter dial and tapered-end sensing element. Dial ranges shall be 0 to 220 degrees F.
   4. Carrying case shall have formed instrument padding.

2.6 WATER METERS

A. Positive Displacement Water Meters:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ABB Water Meters, Inc.
      b. Grinnell Corporation; Mueller Co.; Hersey Meters.
      c. Water Specialties Corp.
   2. Description: AWWA C700, nutating disc type, bronze main case. Register flow in gallons unless cubic feet are indicated.

2.7 VENTURI FLOWMETERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Armstrong Pumps, Inc.
2. Gerand Engineering Co.

B. Description: Differential-pressure design for installation in piping; with calibrated flow-measuring element, separate flowmeter, hoses or tubing, valves, fittings, and conversion chart compatible with flow-measuring element, flowmeter, and system fluid.

C. Construction: Bronze, brass, or factory-primed steel; with brass fittings and attached tag with flow conversion data. Pressure Rating: 250 psig.

D. Temperature Rating: 250 deg F.

E. End Connections for NPS 2 and Smaller: Threaded.

F. End Connections for NPS 2-1/2 and Larger: Flanged or welded.

G. Range: Flow range of flow measuring element and flowmeter shall cover operating range of equipment or system served.

H. Permanent Indicators: Suitable for wall or bracket mounting, calibrated for connected flowmeter element, and having 6-inch- diameter, or equivalent, dial with fittings and copper tubing for connecting to flowmeter element.

1. Scale: Gallons per minute.
2. Accuracy: Plus or minus 1 percent between 20 and 80 percent of range.
3. Range: The maximum operating flow should not exceed 75% of the full-scale range. The normal operating range should be in the middle half of the range (between 25% and 75% of the full-scale range); whenever possible.

I. Portable Indicators: Differential-pressure type calibrated for connected flowmeter element and having two 12-foot hoses in carrying case.

1. Scale: Gallons per minute.
2. Accuracy: Plus or minus 2 percent between 20 and 80 percent of range.
3. Range: The maximum operating flow should not exceed 75% of the full-scale range. The normal operating range should be in the middle half of the range (between 25% and 75% of the full-scale range); whenever possible.

J. Operating Instructions: Include complete instructions with each flowmeter.

2.8 PITOT-TUBE FLOWMETERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Dieterich Standard Inc.
2. Preso Meters Corporation.
3. Taco, Inc.

B. Description: Insertion-type, differential-pressure design for inserting probe into piping and measuring flow directly in gallons per minute.
C. Construction: Stainless-steel probe of length to span inside of pipe; with integral transmitter and direct-reading scale.

D. Pressure Rating: 150 psig minimum.

E. Temperature Rating: 250 degrees F minimum.

F. Display: Visual instantaneous rate of flow.

G. Integral Transformer: For low-voltage power connection.

H. Accuracy: Plus or minus 1 percent for liquids and gases.

2.9 FLOW INDICATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Dwyer Instruments.
2. Ernst Gage Co.
3. OPW Engineered Systems; Dover Corp.

B. Description: Instrument for installation in piping systems for visual verification of flow.

C. Construction: Bronze or stainless steel body; with sight glass and indicator, and threaded or flanged ends.

D. Pressure Rating: 125 psig.

E. Temperature Rating: 200 degrees F.

F. End Connections for NPS 2 and Smaller: Threaded.

G. End Connections for NPS 2-1/2 and Larger: Flanged.

PART 3 - EXECUTION

3.1 THERMOMETER APPLICATIONS

A. Install liquid-in-glass or solar-powered digital thermometers in the following locations:

1. Inlet and outlet of each hydronic zone.
2. Inlet and outlet of each hydronic boiler and chiller.
3. Inlet and outlet of each hydronic coil in air handling units and built-up central systems.
4. Inlet and outlet of each hydronic heat exchanger.
5. Inlet and outlet of each hydronic heat-recovery unit.
6. Inlet and outlet of each thermal storage tank.
7. Outside-air, return-air, and mixed-air ducts.

B. Provide the following temperature ranges for thermometers:

1. Heating Hot Water: 30 to 240 deg F, with 2-degree scale divisions.
2. Condenser Water: 0 to 160 deg F, with 2-degree scale divisions.
3. Chilled Water: 0 to 100 deg F, with 2-degree scale divisions.
4. Steam and Condensate: 30 to 300 deg F, with 5-degree scale divisions.

3.2 Air Ducts: Minus 40 to plus 110 deg F, with 2-degree scale divisions.

3.3 GAGE APPLICATIONS

A. Install pressure gages for discharge of each pressure-reducing valve.

B. Install pressure gages at chilled- and condenser-water inlets and outlets of chillers. Provide one gage across each tube bundle with gage cocks to permit independent measurement of inlet and outlet pressures.

C. Install pressure gages at heating-water inlets and outlets of boilers. Provide one gage across boiler with gage cocks to permit independent measurement of inlet and outlet pressures.

D. Install pressure gages at water inlets and outlets of heat exchangers. Provide one gage across each side of heat exchanger with gage cocks to permit independent measurement of inlet and outlet pressures.

E. Install pressure gages at suction and discharge of each pump. Provide one gage with gage cocks for each pump to permit independent measurement of suction, discharge, and strainer inlet pressures.

F. Provide the following pressure ranges for pressure gage:

1. Vacuum-Pressure Range: 30-in. Hg of vacuum to 15 psig of pressure.
2. Range for Fluids under Pressure: Two times operating pressure.

3.4 INSTALLATIONS

A. Install direct-mounting thermometers and adjust vertical and tilted positions.

B. Install thermowells with socket extending a minimum of 2 inches into fluid, but not less than one-third of diameter of pipe and in vertical position in piping tees where thermometers are indicated.

C. Prime thermowells with an approved heat transfer medium such as graphite or heat transfer paste to provide optimal accuracy and response time.

D. Duct Thermometer Support Flanges: Install in wall of duct where duct thermometers are indicated. Attach to duct with screws.

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E. Install direct-mounting pressure gages in piping tees with pressure gage located on pipe at most readable position.

F. Install gage cock and snubber fitting in piping for each pressure gage for fluids (except steam).

G. Install needle-valve and siphon fitting in piping for each pressure gage for steam.

H. Install test plugs in tees or Thread-o-lets in piping.

I. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters as prescribed by manufacturer's written instructions.

J. Install flowmeter elements in accessible positions in piping systems.

K. Install differential-pressure-type flowmeter elements with at least minimum straight lengths of pipe upstream and downstream from element as prescribed by manufacturer's written instructions.

L. Install permanent indicators on walls or brackets in accessible and readable positions.

M. Install connection fittings for attachment to portable indicators in accessible locations.

N. Install flowmeters where indicated on drawings.

3.5 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance for meters, gages, machines, and equipment.

B. Connect flowmeter system elements to meters.

3.6 ADJUSTING

A. Calibrate meters according to manufacturer's written instructions, after installation.

B. Adjust faces of meters and gages to proper angle for best visibility.

END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following general-duty valves:

1. Copper-alloy ball valves.
2. Ferrous-alloy butterfly valves.
4. Iron swing check valves.
5. Spring-loaded, lift-disc check valves.
7. Cast-iron gate valves.

B. See Division 21 fire-suppression piping and fire pump Sections for fire-protection valves.

C. See Section 230923 “Instrumentation and Controls for HVAC” for control valves and actuators.

D. See Section 230553 “Identification for HVAC piping and equipment” for valve tags and schedules.

1.2 SUBMITTALS

A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; furnished specialties; and accessories.

1.3 QUALITY ASSURANCE

A. ASME Compliance: ASME B31.9 for building services piping valves.

B. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.

C. NSF Compliance: NSF 61 for valve materials for potable-water service.

D. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 VALVES, GENERAL

A. Refer to Part 3 "Valve Applications" Article for applications of valves.

B. Brass or Bronze Valves: NPS 6 and Smaller: Threaded or soldered ends, unless otherwise indicated.

C. Ferrous Valves, NPS 2-1/2 and Larger: Flanged ends, unless otherwise indicated.

D. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

E. Valve Sizes: Same as upstream pipe, unless otherwise indicated.

F. Valve Actuators:

1. Handwheel: Non-heating style of cast, malleable iron or aluminum for gear-operated, quarter-turn valves and all valves other than quarter-turn types, located not more than 8 feet above walkways.

2. Chainwheel Actuators: For gear-operated, quarter-turn valves and all valves other than quarter-turn types, located more than 8 feet above walkways. Adjust chain length to maintain 7 feet clearance above walkway.

3. Lever Handle: For quarter-turn valves NPS 6 and smaller, except plug valves. Provide infinite-position handle with open-position memory stop in balancing applications, and where indicated on Drawings.

4. Gear Operators: For quarter-turn valves larger than NPS 6, except plug valves.

G. Valves in Insulated Piping: With 2-inch stem extensions and the following features:

1. Gate Valves: With rising stem.

2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.


I. Solder Joint: With sockets according to ASME B16.18.

1. Caution: Use solder with melting point below 840 deg F for angle, check and gate valves; below 421 deg F for ball valves.
J. Threaded: With threads according to ASME B1.20.1.

2.3 COPPER-ALLOY BALL VALVES

A. Manufacturers:

1. Two-Piece, Copper-Alloy Ball Valves:
   a. Honeywell Braukmann.
   b. Milwaukee Valve Company.

B. Copper-Alloy Ball Valves, General: MSS SP-110.

C. Two-Piece, Copper-Alloy Ball Valves: Brass or bronze body with full-port, chrome-plated bronze ball; PTFE or TFE seats; and 400-psig minimum CWP rating and blowout-proof stem.

2.4 FERROUS-ALLOY BUTTERFLY VALVES

A. Manufacturers:

1. Single-Flange, Ferrous-Alloy Butterfly Valves:
   a. Bray Controls; a division of Bray International
   b. Milwaukee Valve Company.
   c. Mueller Steam Specialty.

2. Description:
   a. Standard: MSS SP-67, Type I.
   b. SWP Rating: minimum of 150 psig.
   c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
   d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
   e. Seat: EPDM.
   f. Stem: One- or two-piece stainless steel.
   g. Disc: Aluminum-bronze bronze.
   h. Shaft: one or two pieces with type 316 or 416 stainless steel.

2.5 BRONZE SWING CHECK VALVES

A. Manufacturers:

1. Bronze, Swing Check Valves with Nonmetallic Disc:
   a. Grinnell Corporation.
b. Milwaukee Valve Company.

2. Description:

a. Standard: MSS SP-80, Type 4.
b. SWP Rating: 150 psig.
c. Body Design: Horizontal flow.
e. Ends: Threaded.
f. Disc: PTFE or TFE.

2.6 IRON SWING CHECK VALVES

A. Manufacturers:

1. Iron Swing Check Valves with Metal Seats:

a. Grinnell Corporation.
b. Milwaukee Valve Company.
c. Mueller Co.

2. Description:

a. Standard: MSS SP-71, Type I.
b. SWP Rating: 125 psig.
c. Body Design: Clear or full waterway.
d. Body Material: ASTM A 126, iron with bolted bonnet.
e. Ends: Flanged.
f. Trim: Bronze.
g. Gasket: Asbestos free.

2.7 SPRING-LOADED, LIFT-DISC CHECK VALVES

A. Manufacturers:

1. Lift-Disc Check Valves:

a. Milwaukee Valve Company.
b. Mueller Steam Specialty.

2. Description:

b. SWP Rating: 125 psig.
c. Body Material: Bronze.
d. Ends: Threaded or solder joint.
e. Disc Holder: Bronze.
2.8 BRONZE GATE VALVES

A. Manufacturers:

1. Bronze, Rising-Stem, Solid-Wedge Gate Valves:
   a. Grinnell Corporation.
   b. Milwaukee Valve Company.

2. Description:
   a. Standard: MSS SP-80, Type 1.
   b. SWP Rating: 150 psig.
   d. Ends: Threaded or solder joint.
   e. Stem: Bronze.
   f. Disc: Solid wedge; bronze.
   g. Packing: Asbestos free.
   h. Handwheel: Malleable iron or bronze.

2.9 CAST IRON GATE VALVES

A. Manufacturers:

1. Type I, Cast-Iron, Nonrising-Stem or Rising-Stem Gate Valves:
   a. Grinnell Corporation.
   b. Milwaukee Valve Company.

2. Description:
   a. Standard: MSS SP-70, Type I.
   b. SWP Rating: 150 psig.
   c. Body Material: ASTM A 126, gray iron with bolted bonnet.
   d. Ends: Flanged.
   e. Trim: Bronze.
   f. Disc: Solid wedge.
   g. Packing and Gasket: Asbestos free.

2.10 BRONZE GLOBE VALVES

A. Bronze Globe Valves with Nonmetallic Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Grinnell Corporation.
b. Milwaukee Valve Company.

2. Description:

a. Standard: MSS SP-80, Type 2.
b. SWP Rating: 150 psig.
d. Ends: Threaded or solder joint.
e. Stem: Bronze.
f. Disc: PTFE or TFE.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron or bronze.

2.11 IRON GLOBE VALVES

A. Iron Globe Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Grinnell Corporation.
   b. Milwaukee Valve Company.

2. Description:

   a. Standard: MSS SP-85, Type I.
   b. SWP Rating: 200 psig.
   c. Body Material: ASTM A 126, gray iron with bolted bonnet.
   d. Ends: Flanged.
   e. Trim: Bronze.
   f. Packing and Gasket: Asbestos free.

PART 3 - EXECUTION

3.1 VALVE APPLICATIONS

A. Refer to piping Sections for specific valve applications. If valve applications are not indicated, use the following:

   1. Shutoff Service: Ball or butterfly.
   2. Throttling Service: Ball or butterfly.
   3. Pump Discharge: Triple-duty valve

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.

C. Chilled-Water Piping: Use the following types of valves:
1. Ball Valves, NPS 3 and Smaller: Two-piece, 600-psig CWP rating, copper alloy.
3. Swing Check Valves, NPS 2 and Smaller: Type 4, Class 125, bronze. (Horizontal piping only)
4. Swing Check Valves, NPS 2-1/2 and Larger: Type I, Class 125, gray iron. (Horizontal piping only)
5. Spring-Loaded, Lift-Disc Check Valves, NPS 2 and Smaller: Type IV, Class 125 minimum.
6. Spring-Loaded, Lift-Disc Check Valves, NPS 2-1/2 and Larger: Type III, Class 125, cast iron.

D. Condenser Water Piping: Use the following types of valves:

1. Ball Valves, NPS 3 and Smaller: Two-piece, 600-psig CWP rating, copper alloy.
3. Swing Check Valves, NPS 2 and Smaller: Type 4, Class 125, bronze. (Horizontal piping only)
4. Swing Check Valves, NPS 2-1/2 and Larger: Type I, Class 125, gray iron. (Horizontal piping only)
5. Spring-Loaded, Lift-Disc Check Valves, NPS 2 and Smaller: Type IV, Class 125 minimum.
6. Spring-Loaded, Lift-Disc Check Valves, NPS 2-1/2 and Larger: Type III, Class 125, cast iron.

E. Select valves, except wafer and flangeless types, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Solder-joint or threaded ends
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged or threaded ends.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged or threaded ends.
6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.2 VALVE INSTALLATION

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown. [Exception: Unions and flanges may be omitted on valves installed with pre-approved grooved-mechanical-joint couplings, ie. pipe connections to chillers]

C. Locate valves for easy access and provide separate support where necessary.

D. Install valves in horizontal piping with stem at or above center of pipe.

E. Install quarter-turn valves so handle in open position is downstream of valve.

F. Install valves in position to allow full stem movement.
G. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.
2. Lift Check Valves: With stem upright and plumb.

3.3 JOINT CONSTRUCTION

A. Refer to Division 23 Section "Common Work Results for HVAC" for basic piping joint construction.

B. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

C. Grooved Joints (pre-approved): Assemble joints with keyed coupling housing, gasket lubricant, and bolts, according to coupling and fitting manufacturer’s written instructions.

3.4 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

END OF SECTION
1.1 SUMMARY

A. This Section includes the following:
   1. Steel pipe hangers and supports.
   2. Metal framing systems.
   3. Thermal-hanger shield inserts.
   4. Fastener systems.
   5. Equipment supports.

B. See Division 5 for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.

C. See Division 13 for fire protection piping.

D. See Division 23 Section "Vibration [and Seismic] Controls for HVAC Piping and Equipment" for vibration isolation devices.

E. [See Division 23 Section "Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.]

F. See Division 23 Section(s) "[Metal Ducts] [Metal Ducts]" and "Nonmetal Ducts] [Nonmetal Ducts]" for duct hangers and supports.

1.2 DEFINITIONS

A. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.3 PERFORMANCE REQUIREMENTS

A. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. [Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.]
1.4 SUBMITTALS

A. Product Data: For the following:
   1. Steel pipe hangers and supports.
   2. Metal framing systems.
   3. Thermal-hanger shield inserts.
   4. Powder-actuated fastener systems.

B. Welding certificates.

1.5 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 STEEL PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

B. Manufacturers:
   2. Carpenter & Paterson, Inc.
   3. ERICO/Michigan Hanger Co.
   4. Grinnell Corp.
   5. Tolco Inc.

C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.
2.3 METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.

B. Manufacturers:
2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
3. Tolco Inc.
4. Unistrut Corp.; Tyco International, Ltd.

C. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.4 THERMAL-HANGER SHIELD INSERTS

A. Description: 100-psig- minimum, compressive-strength insulation insert encased in sheet metal shield.

B. Manufacturers:
1. Carpenter & Paterson, Inc.
2. ERICO/Michigan Hanger Co.
3. Pipe Shields, Inc.

C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass with vapor barrier.

D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass.

E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

G. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers:
   a. Hilti, Inc.
   b. ITW Ramset/Red Head.
   c. Masterset Fastening Systems, Inc.
d. MKT Fastening, LLC.
e. Powers Fasteners.

B. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated or stainless steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
   1. Manufacturers:
      b. Empire Industries, Inc.
      c. Hilti, Inc.
      d. ITW Ramset/Red Head.
      e. MKT Fastening, LLC.
      f. Powers Fasteners.

2.6 EQUIPMENT SUPPORTS
   A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.7 MISCELLANEOUS MATERIALS
   A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

   B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
      2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS
   A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.

   B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.

   C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.

   D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
      1. Contractor’s Option 1: Provide felt-lined pipe insulator or elastomeric pipe clamp cushion where ferrous attachments are in direct contact with copper tubing.
2. Contractor’s Option 2: Wrap copper tubing with not less than two layers of 10 mil thick black plastic tape extending to a minimum of 1 inch on each side of clamp.

E. Use padded hangers for piping that is subject to scratching.

F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
   2. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
   3. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
   4. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
   5. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
   6. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
   7. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.

G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
   2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.

H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
   2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.

I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
   2. Top-Beam C-Clamps (MSS Type 19): For support of pipes to NPS4, under roof installations with bar joist construction to attach to top flange of structural shape. Provide retaining strap.
   3. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
   4. C-Clamps (MSS Type 23): For support of pipes to NPS 4, attached to structural shapes. Provide retaining strap.
5. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
   a. Light (MSS Type 31): 750 lb.
   b. Medium (MSS Type 32): 1500 lb.
   c. Heavy (MSS Type 33): 3000 lb.

6. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
   2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
   3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

K. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

L. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

M. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

3.2 HANGER AND SUPPORT INSTALLATION

A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.

C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

D. Fastener System Installation:
   1. Install powder-actuated fasteners in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual. Do not use in lightweight concrete or concrete slabs less than 4 inches thick.
   2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions. Do not use in lightweight concrete or concrete slabs less than 4 inches thick.

E. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

G. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

H. Install lateral bracing with pipe hangers and supports to prevent swaying.

I. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

J. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.

L. Insulated Piping: Comply with the following:
   1. Attach clamps and spacers to piping.
      a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
      b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
      c. Do not exceed pipe stress limits according to ASME B31.1 for power piping and ASME B31.9 for building services piping.
   2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
   3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
   4. Shield Dimensions for Pipe: Not less than the following:
      a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
      b. NPS 4: 12 inches long and 0.06 inch thick.
      c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
      d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
      e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
   5. Pipes NPS 8 and Larger: Include wood inserts.
   6. Insert Material: Length at least as long as protective shield.
   7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

3.6 PAINTING

A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION
SECTION 230548 - VIBRATION CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Elastomeric Isolation pads.
   2. Elastomeric Isolation mounts.
   3. [Freestanding] [Restrainted] [Freestanding and restrained] spring isolators.
   4. Elastomeric hangers.
   5. Spring hangers.
   7. Pipe riser resilient supports.
   8. Resilient pipe guides.

1.2 PERFORMANCE REQUIREMENTS

A. Wind-Restraint Loading:
   1. Basic Wind Speed: \(<\text{Insert value}\>.
   2. Building Classification Category: \([\text{I}] [\text{II}] [\text{III}] [\text{IV}]\).
   3. Minimum 10 lb/sq. ft. multiplied by the maximum area of the HVAC component
      projected on a vertical plane that is normal to the wind direction, and 45 degrees
      either side of normal.

1.3 SUBMITTALS

A. Product Data: For each product indicated. Include load deflection curves.

1.4 QUALITY ASSURANCE

A. Field Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M,
   "Structural Welding Code - Steel."

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of
   the following:
   1. Ace Mountings Co., Inc.
   2. Amber/Booth Company, Inc.
4. Isolation Technology, Inc.
7. Vibration Eliminator Co., Inc.
8. Vibration Isolation.

B. Elastomeric Isolation Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
   1. Resilient Material: Oil- and water-resistant neoprene.

C. Elastomeric Isolation Mounts: Double-deflection type, with molded, oil-resistant, neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.
   1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
   2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.

D. Spring Isolators: Freestanding, laterally stable, open-spring isolators.
   1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
   5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
   6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

E. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with limit-stop restraint.
   1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch thick, neoprene isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
   2. Restraint: Limit stop as required for equipment.
   3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
F. Elastomeric Hangers: Single or double-deflection type, fitted with molded, oil-resistant neoprene isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.

G. Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.
1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

H. Spring Hangers with Vertical-Limit Stop: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.
1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant neoprene.
7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

I. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression and with a load stop. Include rod and angle-iron brackets for attaching to equipment.
1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant neoprene.
7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

J. Pipe Riser Resilient Support: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch thick neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psig and for equal resistance in all directions.

K. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes or post and sleeve arrangement separated by a minimum of 1/2-inch thick neoprene. Where clearances are not readily visible, a factory-set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction shall be fitted. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits.

3.2 VIBRATION-CONTROL DEVICE INSTALLATION

A. Comply with requirements in Division 7 for installation of roof curbs, equipment supports, and roof penetrations.

B. Equipment Restraints:
   1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
   2. Install thrust limits at centerline of thrust, symmetrical on either side of equipment.

C. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

D. Drilled-in Anchors:
   1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Set anchors to manufacturer's recommended torque, using a torque wrench.
5. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.3 ADJUSTING

A. Adjust isolators after piping system is at operating weight.
B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
C. Adjust thrust limits to a maximum of 1/4-inch movement during start and stop.
D. Adjust active height of spring isolators.
E. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION
SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Equipment labels.
   2. Warning signs and labels.
   3. Pipe labels.
   4. Duct labels.
   5. Valve tags.
   6. Refrigeration Machinery Room identification.

1.2 SUBMITTAL

A. Product Data: For each type of product indicated.

B. Valve Schedule: Electronic version of valve schedule for approval.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:
   1. Material and Thickness: Black anodized aluminum for mechanical engraving, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
   2. Minimum Label Size: Length and width vary, but not less than 2-1/2 by 3/4 inch.
   5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:
   1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
   4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
   5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
   7. Fasteners: Stainless-steel rivets or self-tapping screws.
   8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number as directed by Owner.
2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.


C. Background Color: Red.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1 inch main lettering, 3/4 inch secondary lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information, plus emergency notification instructions as indicated on drawings and specifications.

2.3 PIPE COLORS

A. Paint HVAC water pipe with Pittsburgh Paint as required below.
1. Chilled Water Supply: Safety Blue 90-311
2. Chilled Water Return: Light Blue 2708 (White) + Pastel base
3. Condenser Water Inside Plant: Green 90-311
4. Condenser Water Outside Plant: Beige/Sand No color # available

2.4 PIPE LABELS


B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Rigid Carrier Pipe Labels: Use only MS-995 Maxilar™ Rigid Carrier Pipe Markers strapped to pipe with Type 316 sstl banding.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, and an arrow indicating flow direction.
1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size(minimum):
3. Pipe: <2.5" Letters: 3/4" high Pipe: 2.5 D 6" Letters: 1.5" high
4. Pipe: 8-10" Letters: 2.5" high Pipe: >10" Letters: 3.5" high

2.5 VALVE TAGS
A. Valve Tags: Stamped or engraved, minimum 2-inch size with 1/4-inch letters for piping system abbreviation and function, i.e., balance, drain, shutoff, stop. Include 1/2-inch identifying number. Provide 5/32-inch hole for fastener.
   1. Material: 0.032-inch-thick brass.
   2. Valve-Tag Fasteners: Brass wire-link or beaded chain; or S-hook.

2.6 AS-BUILT MECHANICAL "FLOOR PLAN" DRAWING
A. Provide an as-built drawing that shows the major equipment and all valves with Valve ID

PART 3 - EXECUTION

3.1 PREPARATION
A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION
A. Install or permanently fasten labels on each major item of HVAC equipment.

B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION
A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.
   2. Pipe OD, incl. Insulation, 6 Inches and Larger: MS-995 Maxilar™ Rigid Carrier Pipe Markers

B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
   1. Near each valve and control device.
   2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
   3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
   4. At access doors, manholes, and similar access points that permit view of concealed piping.
   5. Near major equipment items and other points of origination and termination.
   6. Spaced at maximum intervals of 20 feet along each run. Reduce intervals to 10 feet in areas of congested piping and equipment.

3.4 VALVE-TAG INSTALLATION
A. Install tags on valves and control devices in piping systems including piping within
refrigeration machinery rooms, boiler rooms, mechanical equipment room, mechanical equipment yards, piping mains, and piping branches serving more than one piece of equipment. Tags are not required on check valves; valves within factory-fabricated equipment units; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units.

B. Identify tagged valves as follows
1. System: e.g., SEC, COND, CHW, CTW-1, CHL-B2
2. Subsystem: e.g. PMP-B2, COND,
3. Component: e.g. VLV, FC
4. Number: e.g. 1, 2, 3

3.5 VALVE SCHEDULE

A. Created a Valve Schedule in spreadsheet or table form. Valve schedule shall indicate the following:
1. System: e.g., SEC, COND, CHW, CTW-1, CHL-B2
2. Subsystem: e.g. PMP-B2, COND,
3. Component: e.g. VLV, FC
4. Number: e.g. 1, 2, 3
5. Mode of Operation: e.g. Auto, Man, A/M
6. Description (Function): e.g., Cooling Tower B2 By-Pass Valve
7. Location: e.g., "Above ceiling in Corridor C-01 near Room 117."

B. Mount valve schedule under plastic in main mechanical room, or elsewhere as directed by Owner. Include copy in O&M Manual.

C. Acronyms

<table>
<thead>
<tr>
<th>AUTO</th>
<th>Automatic Control</th>
<th>MAN</th>
<th>Manual Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHL</td>
<td>Chiller</td>
<td>PLNT</td>
<td>Central Plant</td>
</tr>
<tr>
<td>CHM</td>
<td>Chemical Treatment System</td>
<td>PMPX</td>
<td>Pump (X=number)</td>
</tr>
<tr>
<td>COND</td>
<td>Condenser Water Loop</td>
<td>PRI</td>
<td>Primary Chilled Water Loop</td>
</tr>
<tr>
<td>CTW</td>
<td>Cooling Tower</td>
<td>SEC</td>
<td>Secondary Chilled Water Loop</td>
</tr>
<tr>
<td>EQ</td>
<td>Equalizing Line</td>
<td>SEP</td>
<td>Centrifugal Separator</td>
</tr>
<tr>
<td>FC</td>
<td>Fan Coil</td>
<td>VLV</td>
<td>Valve</td>
</tr>
<tr>
<td>HX</td>
<td>Heat Exchanger</td>
<td></td>
<td>(X)-PLNT (Number)-Plant</td>
</tr>
</tbody>
</table>

3.6 AS-BUILT MECHANICAL "FLOOR PLAN" DRAWING UNDER PLASTIC

A. Place this under plastic next to the Valve Schedule.

3.7 REFRIGERATION MACHINERY ROOM IDENTIFICATION

A. Mount general information placard on wall in refrigeration machinery room adjacent to main entry.

B. Securely mount control device labels adjacent to each control device.
3.8 ADJUSTING AND CLEANING

A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

B. Clean faces or mechanical identification devices and glass frames of valve schedules.

END OF SECTION
SECTION 230593 - TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes Testing, Adjusting, and Balancing, (TAB) to produce design objectives for the following:

1. Air Systems:
   a. Constant-volume air systems.
   b. Variable-air-volume systems.
   c. Multizone systems.

2. Hydronic Piping Systems:
   a. Constant-flow systems.
   b. Variable-flow systems.

3. HVAC equipment quantitative-performance settings.
5. Existing systems TAB.
6. Verifying that duct-mounted smoke detectors, smoke dampers, combination fire/smoke dampers are installed per the manufacturer’s instructions and are operating correctly.
7. [Witnessing and Certifying the Operational Test of the Refrigerant Monitoring System.]
8. Reporting results of activities and procedures specified in this Section.

B. The form that provides TAB services shall be under contract directly with the General Contractor and shall not be a subcontractor to the Mechanical Contractor, nor an affiliate of the Mechanical Contractor.

1.2 DEFINITIONS

C. CTI: Cooling Tower Institute.
E. SMACNA: Sheet Metal and Air Conditioning Contractors’ National Association.
F. TAB: Testing, Adjusting, and Balancing.
1.3 SUBMITTALS

A. Certified TAB Reports: Submit copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.

B. Engineers Report: Submit copies of the Professional Mechanical Engineer’s report, as specified in this Section, certifying the proper operation of smoke control devices and air-moving device shut-downs.

C. Warranties specified in this Section.

1.4 QUALITY ASSURANCE

A. TAB Firm Qualifications: Engage a TAB firm certified by AABC, NEBB, or TABB.

B. Approved TAB firms:

1. Arizona Air Balance.
3. Environmental Test and Balancing, Inc.
4. General Air Control
6. Precisionaire, Inc.
7. QC Analytical.
8. TAB Technology, Inc.

C. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.


E. Instrumentation Type, Quantity, and Accuracy: As described in AABC national standards or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification", or TABB’s "National Standards for Environmental Systems Balance."

F. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by the instrument manufacturer.

1.5 PROJECT CONDITIONS
A. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.6 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.7 WARRANTY

A. Special Guarantee: Provide a guarantee on AABC, NEBB, or TABB forms stating that AABC, NEBB, or TABB will assist in completing the requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee includes the following provisions:

1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
2. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

1. Verify that air balancing devices, such as manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.
2. Verify that hydronic balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, and balancing valves, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.

B. Examine approved submittal data of HVAC systems and equipment.

C. Examine Project Record Documents described in Division 1 Section "Project Record Documents."
D. Examine air-systems equipment performance data including fan curves. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce performance ratings of HVAC air-systems equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.

E. Examine hydronic equipment performance data including pump curves. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce performance ratings of HVAC hydronic equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. Compare this data with the design data and installed conditions.

F. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and start-up specified in individual Sections have been performed.

G. Examine system and equipment test reports.

H. Examine HVAC air systems and equipment installations to verify that indicated balancing devices, such as manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

I. Examine HVAC hydronic system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, and balancing valves, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

J. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

K. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

L. Examine [fan coil units] [terminal units, such as variable-air-volume boxes, ] to verify that they are accessible and their controls are connected and functioning.

M. Visually examine underfloor plenums used for supply air to verify that pipe penetrations and other holes not required for airflow are sealed.

N. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

O. [Examine strainers for clean screens and proper perforations.]

P. [Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.]
Q. [Examine open-loop-system pumps to ensure absence of entrained air in the suction piping.]

R. Examine equipment for installation and for properly operating safety interlocks and controls.

S. Examine Smoke Control Devices:

1. Duct mounted smoke detectors:
   a. Verify sensor length and mounting location is per the manufacturer’s instructions.
   b. Verify the detector is installed per the manufacturer’s instructions.
   c. Verify the velocity of the air in the duct at the sensor tube location is within the manufacturer’s recommended range.
   d. Verify pressure drop across the detector is within the manufacturer’s recommended range.

2. Smoke dampers and combination fire/smoke dampers:
   a. Verify the dampers are installed per the manufacturer’s instructions.
   b. Verify that power and control wiring has been connected to the damper per the manufacturer’s instructions.
   c. Verify the damper opens and closes smoothly and completely.

T. Report deficiencies discovered before and during performance of TAB procedures to Engineer and Contractor. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system readiness checks and prepare system readiness reports. Verify the following:

1. Permanent electrical power wiring is complete.
2. Hydronic systems are filled, clean, and free of air.
3. Automatic temperature-control systems are operational.
4. Equipment and duct access doors are securely closed.
5. Balance, smoke, and fire dampers are open.
6. Isolating and balancing valves are open and control valves are operational.
7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC’s "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems", NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems", or TABB’s “HVAC Systems-Testing, Adjusting, and Balancing” and this Section.
B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.

C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, [valve position indicators,] fan-speed-control levers, and similar controls and devices, to show final settings.

D. Close or plug all probe holes and test ports after testing and balancing.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. For variable-air-volume systems, develop a plan to simulate diversity.

C. Determine the best locations in main and branch ducts for accurate duct airflow measurements.

D. Check airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.

E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

F. Verify that motor starters are equipped with properly sized thermal protection.

G. Check dampers for proper position to achieve desired airflow path.

H. Check for airflow blockages.

I. Check condensate drains for proper connections and functioning.

J. Check for proper sealing of air-handling unit components.

K. Check for proper sealing of air duct system.

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure fan static pressures to determine actual static pressure as follows:

   a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.

   b. Measure static pressure directly at the fan outlet or through the flexible connection.

   c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

2. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
   a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.

3. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers, under final balanced conditions.

4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.

5. Adjust fan speed using adjustable pulleys, VFD’s, or other motor speed control devices, where provided, to achieve design airflows.

6. If equipment modifications are required, e.g., sheave changes to adjust fan speed, obtain approval from Architect prior to making such modifications. Recommend adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.

7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full cooling, full heating, economizer, and any other operating modes to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.

1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.
   a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

2. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure terminal outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or outlet manufacturer’s written instructions and calculating factors.

D. Adjust terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values.

1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.

2. Adjust patterns of adjustable outlets for proper distribution without drafts.
3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a maximum set-point airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.

B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Set outside-air dampers at minimum, and return- and exhaust-air dampers at a position that simulates full-cooling load.
2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
3. Measure total system airflow. Adjust to within indicated airflow.
4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow as described for constant-volume air systems.

   a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.

6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.
7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
8. Record the final fan performance data.

C. Pressure-Dependent, Variable-Air-Volume Systems without Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Balance systems similar to constant-volume air systems.
2. Set terminal units and supply fan at full-airflow condition.
3. Adjust inlet dampers of each terminal unit to indicated airflow and verify operation of the static-pressure controller. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
4. Readjust fan airflow for final maximum readings.
5. Measure operating static pressure at the sensor that controls the supply fan, if one is installed, and verify operation of the static-pressure controller.
6. Set supply fan at minimum airflow if minimum airflow is indicated. Measure static pressure to verify that it is being maintained by the controller.
7. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow as described for constant-volume air systems.
a. If air outlets are out of balance at minimum airflow, report the condition but leave the outlets balanced for maximum airflow.

8. Measure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.

D. Pressure-Dependent, Variable-Air-Volume Systems with Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Set system at maximum indicated airflow by setting the required number of terminal units at minimum airflow. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.
2. Adjust supply fan to maximum indicated airflow with the variable-airflow controller set at maximum airflow.
3. Set terminal units at full-airflow condition.
4. Adjust terminal units starting at the supply-fan end of the system and continuing progressively to the end of the system. Adjust inlet dampers of each terminal unit to indicated airflow. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
5. Adjust terminal units for minimum airflow.
6. Measure static pressure at the sensor.
7. Measure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.

3.7 PROCEDURES FOR MULTIZONE SYSTEMS

A. Set unit at full flow through the cooling coil if coil has that capacity.

B. Adjust each zone damper to indicated airflow.

3.8 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare hydraulic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow.
2. Check rating of system relief valve(s).
3. Check makeup-water-station pressure gage for adequate pressure for highest vent.
4. Check flow-control valves for specified sequence of operation and set at indicated flow.
5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
6. Set system controls so automatic valves are wide open to heat exchangers.
7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.9 PROCEDURES FOR HYDRONIC SYSTEMS

A. Measure water flow at pumps. Use the following procedures, except for positive-displacement pumps:

1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer’s pump curve at zero flow and verify that the pump has the intended impeller size.

2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer’s head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.

3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer’s performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.

B. Set calibrated balancing valves, if installed, at calculated presettings.

C. Measure flow at all stations and adjust, where necessary, to obtain first balance.

1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

D. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.

E. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:

1. Determine the balancing station with the highest percentage over indicated flow.

2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.

3. Record settings and mark balancing devices.

F. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems’ pressures and temperatures including outdoor-air temperature.

G. Measure the differential-pressure control valve settings existing at the conclusions of balancing.

3.10 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

3.11 PROCEDURES FOR MOTORS
A. Motors, 1/6 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer.
4. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

3.12 PROCEDURES FOR CHILLERS

A. Balance water flow through each evaporator and condenser to within specified tolerances of indicated flow with all pumps operating. With only one chiller operating in a multiple chiller installation, do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design conditions:

1. Evaporator-water entering and leaving temperatures, pressure drop, and water flow.
2. If water-cooled chillers, condenser-water entering and leaving temperatures, pressure drop, and water flow.
3. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by chiller manufacturer.
4. Power factor if factory-installed instrumentation is furnished for measuring kilowatt.
5. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatt.
7. If air-cooled chillers, verify condenser-fan rotation and record fan and motor data including number of fans and entering- and leaving-air temperatures.

3.13 PROCEDURES FOR COOLING TOWERS

A. Balance condenser-water flow to each tower cell. Adjust make-up water level control device. Verify that makeup and blowdown systems are fully operational after tests and before leaving the equipment. Measure and record the following data for each cooling tower:

1. Condenser-water flow to each cell of the cooling tower.
2. Entering- and leaving-water temperatures.
3. Wet- and dry-bulb temperatures of entering air.
4. Wet- and dry-bulb temperatures of leaving air.
5. Tower-water flow rate recirculating through closed-circuit cooling towers.
6. Pump discharge pressure on closed-circuit cooling towers.
7. Adjust water level and feed rate of makeup-water system.

3.14 PROCEDURES FOR CONDENSING/OUTDOOR UNITS
A. Verify proper rotation of fans.
B. Measure entering- and leaving-air temperatures.
C. Record compressor and fan motor data.

3.15 PROCEDURES FOR BOILERS
A. If hydronic, measure entering- and leaving-water temperatures and water flow.
B. If steam, measure entering-water temperature and flow and leaving steam pressure, and temperature.
C. If forced draft, record blower motor data.

3.16 PROCEDURES FOR ELECTRIC HUMIDIFIERS
A. Record nameplate and measured voltage, each phase, under full load conditions.
B. Record nameplate and measured amperage, each phase, under full load conditions.
C. Verify operation of blower, if equipped.
D. Verify operation of makeup water and blowdown valves.

3.17 PROCEDURES FOR HEAT-TRANSFER COILS
A. Water Coils: Measure and record the following data for each coil:
   1. Entering- and leaving-water temperature.
   2. Water flow rate.
   3. Water pressure drop.
   4. Dry-bulb temperature of entering and leaving air.
   5. Wet-bulb temperature of entering and leaving air for cooling coils.
   6. Airflow.
   7. Air pressure drop.

B. Electric-Heating Coils: Measure and record the following data for each coil:
   1. Airflow.
   2. Entering- and leaving-air temperature at full load.
   3. Nameplate voltage and amperage input of each phase.
   4. Voltage and amperage input of each phase at full load and at each incremental stage.
   5. Calculated kilowatt at full load.
   6. Fuse or circuit-breaker rating for overload protection.

C. Refrigerant Coils: Measure and record the following data for each coil:
   1. Dry-bulb temperature of entering and leaving air.
   2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Refrigerant suction pressure and temperature.

3.18 PROCEDURES FOR HEAT-EXCHANGERS
A. Water to Water: Measure and record the following data for each side of the heat exchanger:
   1. Entering- and leaving-water temperature.
   2. Water flow rate.
   3. Water pressure drop.

3.19 PROCEDURES FOR TEMPERATURE MEASUREMENTS
A. During TAB, report the need for adjustment in temperature regulation within the automatic temperature-control system.
B. Measure outside-air, wet- and dry-bulb temperatures.

3.20 PROCEDURES FOR COMMERCIAL KITCHEN HOODS
A. Measure, adjust, and record the airflow of each kitchen hood. For kitchen hoods designed with integral makeup air, measure and adjust the exhaust and makeup airflow. Measure airflow by duct Pitot-tube traverse. If a duct Pitot-tube traverse is not possible, provide an explanation in the report of the reason(s) why and also the reason why the method used was chosen.
   1. Install welded test ports in the sides of the exhaust duct for the duct Pitot-tube traverse. Install each test port with a threaded cap that is liquid tight.
B. After balancing is complete, do the following:
   1. Measure and record the static pressure at the hood exhaust-duct connection.
   2. Measure and record the hood face velocity. Make measurements at multiple points across the face of the hood. Perform measurements at a maximum of 12 inches between points and between any point and the perimeter. Calculate the average of the measurements recorded. Verify that the hood average face velocity complies with the Contract Documents and governing codes.
   3. Check the hood for capture and containment of smoke using a smoke emitting device. Observe the smoke pattern. Make adjustments to room airflow patterns to achieve optimum results.
C. Report deficiencies.

3.21 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS
A. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished.
   1. New filters are installed.
2. Coils are clean and fins combed.
3. Drain pans are clean.
4. Fans are clean.
5. Bearings and other parts are properly lubricated.
6. Strainers are clean.
7. Deficiencies noted in the preconstruction report are corrected.

B. Perform testing and balancing of existing systems as directed in preceding Articles.

3.22 PROCEDURES FOR TESTING SMOKE CONTROL DEVICES

A. Record manufacturer and model number for each smoke detector, smoke damper, combination fire/smoke damper, and damper actuator.

B. Duct Mounted Smoke Detectors:
   1. Verify the proper operation of the smoke detector using a test gas, “canned smoke”, acceptable to the Authorities Having Jurisdiction. (Magnets are not acceptable.)
   2. Verify activation of the smoke detector closes the appropriate smoke or combination fire/smoke damper and/or de-energizes the appropriate air-moving device(s).
   3. Verify activation of the smoke detector is shown by the fire alarm system where monitoring of the detector is required.

C. Smoke and Combination Fire/Smoke Dampers: Verify dampers controlled by a Total Coverage Smoke Detection System operate correctly on a signal from the system.

D. Air-Moving Device Shut-down: Verify air-moving device(s) that are to be de-energized by a Total Coverage Smoke Detection System de-energize on a signal from the system.

E. After all smoke control devices have been installed, the TAB firm shall engage the services of a Professional Mechanical Engineer, registered in the State of Arizona, to witness the operation of each smoke control device and air-moving device shut-down. The Professional Mechanical Engineer shall submit a signed and sealed report attesting to the proper operation of the smoke control devices and air-moving device shut-downs.

3.23 [PROCEDURES FOR TESTING REFRIGERANT MONITORS]

A. Witness the Operational Test of the refrigerant monitor.

B. Verify the system performs the actions listed in the Sequence of Control.

C. Provide a signed statement on company letterhead in the Certified TAB Report that the Operational Test was completed successfully. Include the following:
   1. Name and company of person conducting the test.
   2. Time and date of the test(s).
   3. Concentrations and type of refrigerant used.
   4. Statement that the test was completed and the system operates as specified.
   5. Name and signature of witness.
3.24 TOLERANCES

A. Set HVAC system airflow and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 10 to minus 5 percent.
2. Air Outlets and Inlets: Plus 10 to minus 10 percent.
3. Heating-Water Flow Rate: Plus 10 to minus 10 percent.
4. Cooling-Water Flow Rate: Plus 10 to minus 5 percent.
5. Hydronic Pumps: Plus 10 to minus 5 percent.

3.25 CERTIFIED TAB REPORT

A. General: Typewritten, or computer printout, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.

B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing supervisor.

C. Include a list of instruments used for procedures, along with proof of calibration.

D. Report Contents: In addition to certified field report data, include the following:

1. Pump curves.
2. Fan curves.
3. Manufacturers’ test data.
4. Field test reports prepared by system and equipment installers.
5. Manufacturer’s installation instructions for smoke and combination fire/smoke dampers, and duct mounted smoke detectors.
6. Other information relative to equipment performance, but do not include Product Data.

E. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:

1. Title page.
2. Name and address of TAB firm.
3. Project name.
4. Project location.
5. Architect’s name and address.
6. Engineer’s name and address.
7. Contractor’s name and address.
9. Signature of TAB firm who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report.
    Number each page in the report.
11. Summary of contents including the following:
    a. Indicated versus final performance.
    b. Notable characteristics of systems.
12. Nomenclature sheets for each item of equipment.
13. Data for HVAC equipment, including manufacturer, model number, serial number, type and size.
14. Notes to explain why certain final data in the body of reports varies from indicated values.
15. Test conditions including the following:
   a. Settings for outside-, return-, and exhaust-air dampers.
   b. Conditions of filters.
   c. Face and bypass damper settings at coils.
   d. Sheave and belt sizes for belt-driven equipment.
   e. Settings for supply-air, static-pressure controller.
   f. Other system operating conditions that affect performance.

F. System Diagrams: Include schematic layouts or reduced scale plans of air and hydronic distribution systems. Include the following:
   1. Quantities of outside, supply, return, and exhaust airflows.
   2. Duct, outlet, and inlet sizes.
   4. Pipe and valve sizes and locations.
   5. Terminal units.

G. TAB Data:
   1. Results of TAB procedures on standard forms. Indicate “NA” (Not Applicable) in unused fields of standard forms. Do not delete unused fields.

H. System Diagrams: Include reduced-scale plans with mechanical equipment and air outlet designations corresponding to those in the TAB Data.

END OF SECTION
SECTION 230713 - DUCT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulating the following duct services:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return located in unconditioned space.
4. Indoor, exposed return located in unconditioned space.
5. Indoor, concealed, Type I, commercial, kitchen hood exhaust.
6. Indoor, exposed, Type I, commercial, kitchen hood exhaust.
7. Indoor, concealed oven and warewash exhaust.
8. Indoor, exposed oven and warewash exhaust.
9. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
10. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
11. Outdoor, concealed supply and return.
12. Outdoor, exposed supply and return.

B. Related Sections:

1. Section 230716 "HVAC Equipment Insulation."
2. Section 230719 "HVAC Piping Insulation."
3. Section 233113 "Metal Ducts" for duct liners.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
3. Detail application of field-applied jackets.
4. Detail application at linkages of control devices.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.
1.4 QUALITY ASSURANCE

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS


B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, [Type I-unfaced] [Type II with factory-applied vinyl vapor retarder jacket] [Type III with factory-applied reflective vapor retarder jacket]. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. CertainTeed Corp.; SoftTouch Duct Wrap.
   b. Johns Manville; Microlite.
   c. Knauf Insulation; Friendly Feel Duct Wrap.
   d. Manson Insulation Inc.; Alley Wrap.
   e. Owens Corning; SOFTR All-Service Duct Wrap.

G. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation [without factory-applied jacket] [with factory-applied
ASJ [with factory-applied FSK jacket]. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. **Products**: Subject to compliance with requirements, provide one of the following:
   a. CertainTeed Corp.; Commercial Board.
   b. Fibrex Insulations Inc.; FBX.
   c. Johns Manville; 800 Series Spin-Glas.
   d. Knauf Insulation; Insulation Board.
   e. Manson Insulation Inc.; AK Board.
   f. Owens Corning; Fiberglas 700 Series.

2.2 FIRE-RATED INSULATION SYSTEMS

A. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a [1] -hour fire rating by an NRTL acceptable to authorities having jurisdiction.

1. **Products**: Subject to compliance with requirements, provide one of the following:
   a. CertainTeed Corp.; FlameChek.
   b. Johns Manville; Firetemp Wrap.
   c. Nelson Fire Stop Products; Nelson FSB Flameshield Blanket.
   d. Thermal Ceramics; FireMaster Duct Wrap.
   e. 3M; Fire Barrier Wrap Products.
   f. Unifrax Corporation; FyreWrap.

2.3 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.

1. **Products**: Subject to compliance with requirements available products that may be incorporated into the Work include, but are not limited to, the following:
   b. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   b. Eagle Bridges - Marathon Industries; 550.
   e. Vimasco Corporation; WC-1/WC-5.

2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.

3. Service Temperature Range: Minus 20 to plus 180 deg F.

4. Solids Content: 60 percent by volume and 66 percent by weight.


2.4 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   b. Eagle Bridges - Marathon Industries; 405.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
   d. Mon-Eco Industries, Inc.; 44-05.

2. Materials shall be compatible with insulation materials, jackets, and substrates.

3. Fire- and water-resistant, flexible, elastomeric sealant.

4. Service Temperature Range: Minus 40 to plus 250 deg F.

5. Color: Aluminum.

6. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. ASJ Flashing Sealants, and Vinyl and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services’ "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.5 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
5. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.6 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for ducts.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   b. Vimasco Corporation; Elastafab 894.
   c. <Insert manufacturer's name; product name or designation>.
2.7 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Johns Manville; Zeston.
   c. Proto Corporation; LoSmoke.
   d. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer.

3. Color: [White].

D. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
   c. RPR Products, Inc.; Insul-Mate.
   d. <Insert manufacturer's name; product name or designation>.

2. Sheet and roll stock ready for shop or field sizing.

3. Finish and thickness are indicated in field-applied jacket schedules.

4. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper

5. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.

E. Self-Adhesive Outdoor Jacket: 60-mil- thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with [white] aluminum-foil facing.
3.1 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
   a. For below ambient services, apply vapor-barrier mastic over staples.
4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

### 3.3 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
   4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
   4. Seal jacket to wall flashing with flashing sealant.
C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

E. Insulation Installation at Floor Penetrations:

1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.4 INSTALLATION OF MINERAL-FIBER INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer’s recommended coverage rates per unit area, for 50\% coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

   a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
   b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
   c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
   d. Do not overcompress insulation during installation.
   e. Impale insulation over pins and attach speed washers.
   f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end.
of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.

6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for [50] percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.

b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.

c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.

d. Do not overcompress insulation during installation.

e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end
of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.

b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.5 FIELD-APPLIED JACKET INSTALLATION

A. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.
3.6 FIRE-RATED INSULATION SYSTEM INSTALLATION

A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.

B. Insulate duct access panels and doors to achieve same fire rating as duct.

C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Section 078413 "Penetration Firestopping."

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
   1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.8 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:
   1. Indoor, concealed supply and outdoor air.
   2. Indoor, exposed supply and outdoor air.
   3. Indoor, concealed return located in unconditioned space.
   4. Indoor, exposed return located in unconditioned space.
   5. Indoor, concealed, Type I, commercial, kitchen hood exhaust.
   6. Indoor, exposed, Type I, commercial, kitchen hood exhaust.
   7. Indoor, concealed oven and warewash exhaust.
   8. Indoor, exposed oven and warewash exhaust.
   9. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
   10. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
   11. Outdoor, concealed supply and return.
   12. Outdoor, exposed supply and return.

B. Items Not Insulated:
   1. Fibrous-glass ducts.
   2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
   3. Factory-insulated flexible ducts.
5. Flexible connectors.
7. Factory-insulated access panels and doors.

3.9 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, Supply-Air Duct and Plenum Insulation: Mineral-fiber [blanket] [board], [1-1/2 inches] [2 inches] [3 inches] <Insert dimension> thick and [0.75-lb/cu. ft.] [1.5-lb/cu. ft.] [3-lb/cu. ft.] nominal density.

B. Concealed, Return-Air Duct and Plenum Insulation: Mineral-fiber [blanket] [board], [1-1/2 inches] [2 inches] [3 inches] <Insert dimension> thick and [0.75-lb/cu. ft.] [1.5-lb/cu. ft.] [3-lb/cu. ft.] nominal density.

C. Concealed, Outdoor-Air Duct and Plenum Insulation: Mineral-fiber [blanket] [board], [1-1/2 inches] [2 inches] [3 inches] <Insert dimension> thick and [0.75-lb/cu. ft.] [1.5-lb/cu. ft.] [3-lb/cu. ft.] nominal density.

D. Concealed, Exhaust-Air Duct and Plenum Insulation: Mineral-fiber [blanket] [board], [1-1/2 inches] [2 inches] [3 inches] <Insert dimension> thick and [0.75-lb/cu. ft.] [1.5-lb/cu. ft.] [3-lb/cu. ft.] nominal density.

E. Concealed, Type I, Commercial, Kitchen Hood Exhaust Duct and Plenum Insulation: Fire-rated [blanket] [or] [board]; thickness as required to achieve 2-hour fire rating.

F. Exposed, Supply-Air Duct and Plenum Insulation: Mineral-fiber [blanket] [board], [1-1/2 inches] [2 inches] [3 inches] <Insert dimension> thick and [0.75-lb/cu. ft.] [1.5-lb/cu. ft.] [3-lb/cu. ft.] nominal density.

G. Exposed, Return-Air Duct and Plenum Insulation: Mineral-fiber [blanket] [board], [1-1/2 inches] [2 inches] [3 inches] <Insert dimension> thick and [0.75-lb/cu. ft.] [1.5-lb/cu. ft.] [3-lb/cu. ft.] nominal density.

H. Exposed, Outdoor-Air Duct and Plenum Insulation: Mineral-fiber [blanket] [board], [1-1/2 inches] [2 inches] [3 inches] <Insert dimension> thick and [0.75-lb/cu. ft.] [1.5-lb/cu. ft.] [3-lb/cu. ft.] nominal density.

I. Exposed, Exhaust-Air Duct and Plenum Insulation: Mineral-fiber [blanket] [board], [1-1/2 inches] [2 inches] [3 inches] <Insert dimension> thick and [0.75-lb/cu. ft.] [1.5-lb/cu. ft.] [3-lb/cu. ft.] nominal density.

J. Exposed, Type I, Commercial, Kitchen Hood Exhaust Duct and Plenum Insulation: Fire-rated [blanket] [or] [board]; thickness as required to achieve 2-hour fire rating.

3.10 ABOVEGROUND, OUTDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a duct system, selection from materials listed is Contractor's option.
B. Concealed, Supply-Air Duct and Plenum Insulation: Mineral-fiber [blanket] [board], [1-1/2 inches] [2 inches] [3 inches] <Insert dimension> thick and [0.75-lb/cu. ft.] [1.5-lb/cu. ft.] [3-lb/cu. ft.] nominal density.

C. Concealed, Return-Air Duct and Plenum Insulation: Mineral-fiber [blanket] [board], [1-1/2 inches] [2 inches] [3 inches] <Insert dimension> thick and [0.75-lb/cu. ft.] [1.5-lb/cu. ft.] [3-lb/cu. ft.] nominal density.

D. Concealed, Outdoor-Air Duct and Plenum Insulation: Mineral-fiber [blanket] [board], [1-1/2 inches] [2 inches] [3 inches] <Insert dimension> thick and [0.75-lb/cu. ft.] [1.5-lb/cu. ft.] [3-lb/cu. ft.] nominal density.

E. Exposed, Supply-Air Duct and Plenum Insulation: Mineral-fiber [blanket] [board], [1-1/2 inches] [2 inches] [3 inches] <Insert dimension> thick and [0.75-lb/cu. ft.] [1.5-lb/cu. ft.] [3-lb/cu. ft.] nominal density.

F. Exposed, Return-Air Duct and Plenum Insulation: Mineral-fiber [blanket] [board], [1-1/2 inches] [2 inches] [3 inches] <Insert dimension> thick and [0.75-lb/cu. ft.] [1.5-lb/cu. ft.] [3-lb/cu. ft.] nominal density.

3.11 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Ducts and Plenums, Concealed:
   1. None.
   2. [PVC] [PVC, Color-Coded by System]: [20 mils] [30 mils] thick.
   3. Aluminum, Smooth or Corrugated: [0.016 inch] [0.020 inch] [0.024 inch] [0.032 inch] [0.040 inch] thick.

D. Ducts and Plenums, Exposed:
   1. None.
   2. [PVC] [PVC, Color-Coded by System]: [20 mils] [30 mils] thick.
   3. Aluminum, Smooth or Corrugated: [0.016 inch] [0.020 inch] [0.024 inch] [0.032 inch] [0.040 inch] thick.

3.12 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Ducts and Plenums, Concealed:
1. None.
2. [PVC, Color-Coded by System]: [20 mils] [30 mils] thick.
3. Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: [0.016 inch] [0.020 inch] [0.024 inch] [0.032 inch] [0.040 inch] thick.
4. <Insert jacket type>.

D. Ducts and Plenums, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:

1. Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: [0.016 inch] [0.020 inch] [0.024 inch] [0.032 inch] [0.040 inch] thick.
2. <Insert jacket type>.

E. Ducts and Plenums, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:

1. [Painted] Aluminum, [Smooth] [Stucco Embossed] with [1-1/4-Inch-Deep Corrugations] [2-1/2-Inch-Deep Corrugations] [4-by-1-Inch Box Ribs]: [0.032 inch] [0.040 inch] thick.
2. <Insert jacket type>.

END OF SECTION
SECTION 230719 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulating the following HVAC piping systems:

1. Chilled-water piping.
2. Refrigerant suction and hot-gas piping.

B. Related Sections:

1. Section 230713 "Duct Insulation."
2. Section 230716 "HVAC Equipment Insulation."
3. Section 232113.13 "Underground Hydronic Piping" for loose-fill pipe insulation in underground piping outside the building.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Products shall not contain asbestos, lead, mercury, or mercury compounds.

B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

E. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

1. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

   a. Aeroflex USA, Inc.; Aerocel.
   b. Armacell LLC; AP Armaflex.
   c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.

F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 1290, Type I.

1. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

   a. CertainTeed Corp.; SoftTouch Duct Wrap.
   b. Johns Manville; Microlite.
   c. Knauf Insulation; Friendly Feel Duct Wrap.
   d. Manson Insulation Inc.; Alley Wrap.
   e. Owens Corning; SOFTR All-Service Duct Wrap.

G. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

   a. Fibrex Insulations Inc.; Coreplus 1200.
   b. Johns Manville; Micro-Lok.
   c. Knauf Insulation; 1000-Degree Pipe Insulation.
   d. Manson Insulation Inc.; Alley-K.
   e. Owens Corning; Fiberglas Pipe Insulation.
2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

H. Mineral-Fiber, Pipe Insulation Wicking System: Preformed pipe insulation complying with ASTM C 547, Type I, Grade A, with absorbent cloth factory-applied to the entire inside surface of preformed pipe insulation and extended through the longitudinal joint to outside surface of insulation under insulation jacket. Factory apply a white, polymer, vapor-retarder jacket with self-sealing adhesive tape seam and evaporation holes running continuously along the longitudinal seam, exposing the absorbent cloth. **(REQUIRED IN DATA CENTERS)**

1. **Products:** Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
   a. Knauf Insulation; Permawick Pipe Insulation.
   b. Owens Corning; VaporWick Pipe Insulation.

2.2 INSULATING CEMENTS


1. **Products:** Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
   a. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. **Products:** Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
   a. Aeroflex USA, Inc.; Aeroseal.
   b. Armacell LLC; Armaflex 520 Adhesive.
   d. K-Flex USA; R-373 Contact Adhesive.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services’ "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. **Products:** Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
b. Eagle Bridges - Marathon Industries; 225.
d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).


1. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

   b. Eagle Bridges - Marathon Industries; 225.
   d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

   a. Dow Corning Corporation; 739, Dow Silicone.
   d. Speedline Corporation; Polycor VP Adhesive.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

b. **Vimasco Corporation; 749.**

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.

C. **Breather Mastic:** Water based; suitable for indoor and outdoor use on above-ambient services.

1. **Products:** Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
   b. Eagle Bridges - Marathon Industries; 550.
   e. **Vimasco Corporation; WC-1/WC-5.**

2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: 60 percent by volume and 66 percent by weight.

### 2.5 SEALANTS

**A. Joint Sealants:**

1. **Joint Sealants for Cellular-Glass Products:** Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
   b. Eagle Bridges - Marathon Industries; 405.
   d. Mon-Eco Industries, Inc.; 44-05.
   e. **Pittsburgh Corning Corporation; Pittseal 444.**

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Permanently flexible, elastomeric sealant.
4. Service Temperature Range: Minus 100 to plus 300 deg F.
5. Color: White or gray.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

**B. FSK and Metal Jacket Flashing Sealants:**

1. **Products:** Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
b. Eagle Bridges - Marathon Industries; 405.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
d. Mon-Eco Industries, Inc.; 44-05.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.6 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for pipe.

1. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
   b. Vimasco Corporation; Elastafab 894.

2.7 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
1. **Products:** Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

   a. Johns Manville; Zeston.
   c. Proto Corporation; LoSmoke.
   d. Speedline Corporation; SmokeSafe.

2. **Adhesive:** As recommended by jacket material manufacturer.

3. **Color:** White, see colors listed in section 230553-2 for Central Plants.

4. **Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.**

   a. **Shapes:** 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

D. **Aluminum Jacket:** Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.

   1. **Products:** Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

      b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
      c. RPR Products, Inc.; Insul-Mate.

   2. **Sheet and roll stock ready for shop or field sizing.**

   3. **Finish and thickness are indicated in field-applied jacket schedules.**

   4. **Moisture Barrier for Indoor Applications:** 1-mil- thick, heat-bonded polyethylene and kraft paper.

   5. **Moisture Barrier for Outdoor Applications:** 3-mil- thick, heat-bonded polyethylene and kraft paper or 2.5-mil- (0.063-mm-) thick polysurlyn.

   6. **Factory-Fabricated Fitting Covers:**

      a. Same material, finish, and thickness as jacket.
      b. Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
      c. Tee covers.
      d. Flange and union covers.
      e. End caps.
      f. Beveled collars.
      g. Valve covers.
      h. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

E. **PVDC Jacket for Indoor Applications:** 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.

   1. **Products:** Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

      a. Dow Chemical Company (The); Saran 540 Vapor Retarder Film.

1. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
   a. Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

2.8 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
   a. ABI, Ideal Tape Division; 428 AWF ASJ.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
   c. Compac Corporation; 104 and 105.
   d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

2. Width: 3 inches.
3. Thickness: 11.5 mils.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
   a. ABI, Ideal Tape Division; 491 AWF FSK.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
   c. Compac Corporation; 110 and 111.
   d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.

2. Width: 3 inches.
3. Thickness: 6.5 mils.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
   a. ABI, Ideal Tape Division; 370 White PVC tape.
b. Compac Corporation; 130.
c. Venture Tape; 1506 CW NS.

2. Width: 2 inches.
3. Thickness: 6 mils.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
   a. ABI, Ideal Tape Division; 488 AWF.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
   c. Compac Corporation; 120.
   d. Venture Tape; 3520 CW.

2. Width: 2 inches.
3. Thickness: 3.7 mils.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

E. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
   a. Dow Chemical Company (The); Saran 540 Vapor Retarder Tape.

2. Width: 3 inches.
3. Film Thickness: 4 mils.
4. Adhesive Thickness: 1.5 mils.
5. Elongation at Break: 145 percent.
6. Tensile Strength: 55 lbf/inch in width.

2.9 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

2.10 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive approved by SRP and by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches (100 mm) o.c.
      a. For below-ambient services, apply vapor-barrier mastic over staples.
   4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
   5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:
   1. Vibration-control devices.
   2. Testing agency labels and stamps.
   3. Nameplates and data plates.
   5. Handholes.
   6. Cleanouts.

2.11 PENETRATIONS.

B. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
   4. Seal jacket to roof flashing with flashing sealant.

C. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

D. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
   4. Seal jacket to wall flashing with flashing sealant.

E. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

F. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

G. Insulation Installation at Floor Penetrations:
   1. Pipe: Install insulation continuously through floor penetrations.
   2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

2.12 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
   1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
   2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
   3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
   4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
   5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
   6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
   7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
   8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
   9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

2.13 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

3. Install insulation to flanges as specified for flange insulation application.

4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

2.14 INSTALLATION OF MINERAL-FIBER PREFORMED PIPE INSULATION

A. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
   2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
   4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
   4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
   3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   4. Install insulation to flanges as specified for flange insulation application.

2.15 FIELD-APPLIED JACKET INSTALLATION

A. Where FSK jackets are indicated, install as follows:
1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

D. Where PVDC jackets are indicated, install as follows:

1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
2. Wrap factory-presized jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of 2 inches over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
3. Continuous jacket can be spiral-wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. The 33-1/2-inch circumference limit allows for 2-inch-overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

2.16 FINISHES

A. Pipe Insulation with ASJ or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
C. Color: See colors listed in section 230553-2 and/or color as specified on drawings or specifications selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

2.17 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Inspect pipe, fittings, strainers, and valves, randomly selected by Engineer or Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

2.18 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

2.19 INDOOR PIPING INSULATION SCHEDULE

A. Chilled Water above 40 Deg F: Insulation shall be one of the following:

   1. Flexible Elastomeric:
      a. Pipe sizes 1-1/2 inches and smaller: 1 inch thick.
      b. Pipe sizes larger than 1-1/2 inches: Do not use.

   2. Mineral-Fiber, Preformed Pipe, Type I:
      a. Pipe sizes 1-1/2 inches and smaller: 1 inch thick.
      b. Pipe sizes larger than 1.5 inches: 1-1/2 inch thick.

B. Refrigerant Suction and Hot-Gas Piping/Tubing: Flexible elastomeric or Mineral-fiber, preformed pipe insulation.

   a. Pipe sizes 1-1/2 inches and smaller: 1 inch thick.
   b. Pipe sizes larger than 1.5 inches: 1-1/2 inch thick

2.20 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Chilled Water: Insulation shall be one of the following:

   1. Flexible Elastomeric:
a. Pipe sizes 1 inch and smaller: 1-1/2 inch thick.
b. Pipe sizes larger than 1 inch: Do not use.

2. Mineral-Fiber, Preformed Pipe Insulation, Type I:
   a. Pipe sizes 10 inches and smaller: 2 inch thick.
   b. Pipe sizes larger than 10 inches: 2-1/2 inches thick.

B. Refrigerant Suction and Hot-Gas Piping/Tubing: Insulation shall be one of the following:
   1. Flexible Elastomeric:
      a. Pipe sizes 1 inch and smaller: 1 inch thick.
      b. Pipe sizes larger than 1 inch: 1-1/2 inch thick.
   2. Mineral-Fiber, Preformed Pipe Insulation, Type I:
      a. Pipe sizes 1 inch and smaller: 1 inch thick.
      b. Pipe sizes larger than 1 inch: 1-1/2 inch thick.

2.21 OUTDOOR, UNDERGROUND PIPING INSULATION SCHEDULE
   A. See Section 232114 for underground chilled water piping.
   B. Chilled Water, All Sizes: Cellular glass, 2 inches thick.
   C. See Section 232300 for underground Refrigerant Suction and Hot-Gas Piping/Tubing:
      1. Flexible Elastomeric:
         a. Pipe sizes 1 inch and smaller: 1 inch thick.
         b. Pipe sizes larger than 1 inch: 1-1/2 inch thick.
      2. Mineral-Fiber, Preformed Pipe Insulation, Type I:
         a. Pipe sizes 1 inch and smaller: 1 inch thick.
         b. Pipe sizes larger than 1 inch: 1-1/2 inch thick.

2.22 INDOOR, FIELD-APPLIED JACKET SCHEDULE
   A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
   B. Piping, Concealed:
      1. PVC: 20 mils thick.
   C. Piping, Exposed:
      1. PVC: 20 mils thick.

2.23 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE
   A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:
   1. Aluminum, stucco embossed: 0.020 inch

D. Piping, Exposed:
   1. Aluminum, stucco embossed: 0.040 inch

2.24 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET

A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.
SECTION 230923 – INSTRUMENTATION AND CONTROLS FOR HVAC

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APPENDIX A: NAMING CONVENTIONS
1.1 Related Sections

A. The General Conditions of the Contract, Supplementary Conditions, and General Requirements are part of this specification and shall be used in conjunction with this section as part of the contract documents.

B. The following sections constitute related work:
   1. Section 23 21 23 - Hydronic Pumps
   2. Section 23 36 00 - Air Terminal Units
   3. Section 23 64 16 – Centrifugal Water Chillers
   4. Section 23 65 00 – Cooling Towers
   5. Section 23 73 13 – Indoor Central Station Air Handling Units
   6. Section 23 74 13 - Outdoor Central Station Air Handling Units
   7. Section 23 81 23 – Computer Room Air-Conditioners
   8. Section 26 05 19 – Low Voltage Conductors and Cables
   9. Section 26 05 23 – Control Voltage Cables
   10. Section 26 05 33 – Raceways and Boxes

1.2 Description

A. General: The control system shall consist of a high-speed, peer-to-peer network of DDC controllers and a web-based operator interface. Depict each mechanical system and building floor plan by a point-and-click graphic. A web server with a network interface card shall gather data from this system and generate web pages accessible through a conventional web browser on each PC connected to the network. Operators shall be able to perform all normal operator functions through the web browser interface.

B. The system shall directly control HVAC equipment as specified in Section 23 09 93 – Sequence of Operations for HVAC Controls. Each zone controller shall provide occupied and unoccupied modes of operation by individual zone. Furnish energy conservation features such as optimal start and stop, night setback, request-based logic, and demand level adjustment of setpoints as specified in the sequence.

C. Provide for future system expansion to include monitoring of occupant card access, fire alarm, and lighting control systems.

D. System shall use the BACnet protocol for communication to the operator workstation or web server and for communication between control modules. I/O points, schedules, setpoints, trends, and alarms specified in Section 23 09 93 – "Sequence of Operations for HVAC Controls" shall be BACnet objects.

1.3 Approved Control Systems

A. Use control system hardware and software that meet the requirements of this specification.
1.4 Quality Assurance

A. Installer and Manufacturer Qualifications
   1. Installer shall have an established working relationship with Control System Manufacturer.
   2. Installer shall have successfully completed Control System Manufacturer’s control system training. Upon request, Installer shall present record of completed training including course outlines.

1.5 Codes and Standards

A. Work, materials, and equipment shall comply with the most restrictive of local, state, and federal authorities' codes and ordinances or these plans and specifications. As a minimum, the installation shall comply with current editions in effect 30 days prior to receipt of bids of the following codes:
   1. National Electric Code (NEC)
   2. International Building Code (IBC)
   3. International Mechanical Code (IMC)

1.6 System Performance

A. Performance Standards. System shall conform to the following minimum standards over network connections. Systems shall be tested using manufacturer's recommended hardware and software for operator workstation (server and browser for web-based systems).
   1. Graphic Display. A graphic with 20 dynamic points shall display with current data within 10 sec.
   2. Graphic Refresh. A graphic with 20 dynamic points shall update with current data within 8 sec. and shall automatically refresh every 15 sec.
   3. Configuration and Tuning Screens. Screens used for configuring, calibrating, or tuning points, PID loops, and similar control logic shall automatically refresh within 6 sec.
   4. Object Command. Devices shall react to command of a binary object within 2 sec. Devices shall begin reacting to command of an analog object within 2 sec.
   5. Alarm Response Time. An object that goes into alarm shall be annunciated at the workstation within 15 sec.
   6. Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 5 sec. Select execution times consistent with the mechanical process under control.
   7. Performance. Programmable controllers shall be able to completely execute DDC PID control loops at a frequency adjustable down to once per sec. Select execution times consistent with the mechanical process under control.
   8. Multiple Alarm Annunciations. Each workstation on the network shall receive alarms within 5 sec of other workstations.
   9. Reporting Accuracy. System shall report values with minimum end-to-end accuracy listed in Table 1.
  10. Control Stability and Accuracy. Control loops shall maintain measured variable at setpoint within tolerances listed in Table 2.
### Table 1
**Reporting Accuracy**

<table>
<thead>
<tr>
<th>Measured Variable</th>
<th>Reported Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Space Temperature</td>
<td>±0.5°C (±1°F)</td>
</tr>
<tr>
<td>Ducted Air</td>
<td>±0.5°C (±1°F)</td>
</tr>
<tr>
<td>Outside Air</td>
<td>±1.0°C (±2°F)</td>
</tr>
<tr>
<td>Dew Point</td>
<td>±1.5°C (±3°F)</td>
</tr>
<tr>
<td>Water Temperature</td>
<td>±0.5°C (±1°F)</td>
</tr>
<tr>
<td>Delta-T</td>
<td>±0.15°C (±0.25°F)</td>
</tr>
<tr>
<td>Relative Humidity</td>
<td>±5% RH</td>
</tr>
<tr>
<td>Water Flow</td>
<td>±2% of full scale</td>
</tr>
<tr>
<td>Airflow (terminal)</td>
<td>±10% of full scale (see Note 1)</td>
</tr>
<tr>
<td>Airflow (measuring stations)</td>
<td>±5% of full scale</td>
</tr>
<tr>
<td>Airflow (pressurized spaces)</td>
<td>±3% of full scale</td>
</tr>
<tr>
<td>Air Pressure (ducts)</td>
<td>±25 Pa (±0.1 in. w.g.)</td>
</tr>
<tr>
<td>Air Pressure (space)</td>
<td>±3 Pa (±0.01 in. w.g.)</td>
</tr>
<tr>
<td>Water Pressure</td>
<td>±2% of full scale (see Note 2)</td>
</tr>
<tr>
<td>Electrical (A, V, W, Power Factor)</td>
<td>±1% of reading (see Note 3)</td>
</tr>
<tr>
<td>Carbon Monoxide (CO)</td>
<td>±5% of reading</td>
</tr>
<tr>
<td>Carbon Dioxide (CO₂)</td>
<td>±50 ppm</td>
</tr>
</tbody>
</table>

**Note 1:** Accuracy applies to 10% - 100% of scale  
**Note 2:** For both absolute and differential pressure  
**Note 3:** Not including utility-supplied meters

### Table 2
**Control Stability and Accuracy**

<table>
<thead>
<tr>
<th>Controlled Variable</th>
<th>Control Accuracy</th>
<th>Range of Medium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Pressure</td>
<td>±50 Pa (±0.2 in. w.g.) ±3 Pa (±0.01 in. w.g.)</td>
<td>0-1.5 kPa (0-6 in. w.g.) -25 to 25 Pa (-0.1 to 0.1 in. w.g.)</td>
</tr>
<tr>
<td>Airflow</td>
<td>±10% of full scale</td>
<td></td>
</tr>
<tr>
<td>Space Temperature</td>
<td>±1.0°C (±2°F)</td>
<td></td>
</tr>
<tr>
<td>Duct Temperature</td>
<td>±1.5°C (±3°F)</td>
<td></td>
</tr>
<tr>
<td>Humidity</td>
<td>±5% RH</td>
<td></td>
</tr>
<tr>
<td>Fluid Pressure</td>
<td>±10 kPa (±1.5 psi) ±250 Pa (±1.0 in. w.g.)</td>
<td>MPa (1-150 psi) 0-12.5 kPa (0-50 in. w.g.) differential</td>
</tr>
</tbody>
</table>
1.7 Submittals

A. Product Submittal Requirements: Meet requirements of Section 01 30 00 on Shop Drawings, Product Data, and Samples. Provide shop drawings and other submittals on hardware, software, and equipment to be installed or furnished in PDF file format. Begin no work until submittals have been approved for conformity with design intent. When manufacturer's cutsheets apply to a product series rather than a specific product, clearly indicate applicable data by highlighting or by other means. Clearly reference covered specification and drawing on each submittal. General catalogs shall not be accepted as cutsheets to fulfill submittal requirements. Select and show submittal quantities appropriate to scope of work. Submittal approval does not relieve Contractor of responsibility to supply sufficient quantities to complete work. Provide submittals on the following:

1. Direct Digital Control System Hardware
   a. Complete bill of materials indicating quantity, manufacturer, model number, and relevant technical data of equipment to be used.
   b. Manufacturer's description and technical data such as performance curves, product specifications, and installation and maintenance instructions for items listed below and for relevant items not listed below:
      i. Direct digital controllers (controller panels)
      ii. Transducers and transmitters
      iii. Sensors (include accuracy data)
      iv. Actuators
      v. Valves
      vi. Relays and switches
      vii. Control panels
      viii. Power supplies
      ix. Batteries
      x. Operator interface equipment
      xi. Wiring
   c. Wiring diagrams and layouts for each control panel. Show termination numbers and legend.
   d. Floor plan schematic diagrams indicating field sensor and controller locations.
   e. Riser diagrams showing control network layout, communication protocol, and wire types.

2. Central System Hardware and Software
   a. Complete bill of material indicating quantity, manufacturer, model number, and relevant technical data of equipment used.
   b. Manufacturer's description and technical data such as product specifications and installation and maintenance instructions for items listed below and for relevant items furnished under this contract not listed below:
      i. Central Processing Unit (CPU) or web server
      ii. Monitors
      iii. Keyboards
      iv. Power supplies
      v. Battery backups
      vi. Interface equipment between CPU or server and control panels
      vii. Operating System software
      viii. Operator interface software
      ix. Color graphic software
      x. Third-party software
c. Schematic diagrams of control, communication, and power wiring for central system installation. Show interface wiring to control system.
d. Network riser diagrams of wiring between central control unit and control panels.

3. Controlled Systems
   a. Riser diagrams showing control network layout, communication protocol, and wire types.
   b. Schematic diagram of each controlled system. Label control points with point names. Graphically show locations of control elements.
   c. Schematic wiring diagram of each controlled system. Label control elements and terminals. Where a control element is also shown on control system schematic, use the same name.
   d. Instrumentation list (Bill of Materials) for each controlled system. List each control system element in a table. Show element name, type of device, manufacturer, model number, and product data sheet number.
   e. Complete description of control system operation including sequences of operation. Include and reference schematic diagram of controlled system. List I/O points and software points specified in Section 23 09 93. Indicate alarmed and trended points.

4. Description of process, report formats, and checklists to be used in Section 23 09 23 Article 3.17 (Control System Demonstration and Acceptance).

5. BACnet Protocol Implementation Conformance Statement (PICS) for each submitted type of controller and operator interface.

B. Schedules
1. Schedule of work provided within one month of contract award, indicating:
   a. Intended sequence of work items
   b. Start date of each work item
   c. Duration of each work item
   d. Planned delivery dates for ordered material and equipment and expected lead times
   e. Milestones indicating possible restraints on work by other trades or situations
2. Monthly written status reports indicating work completed and revisions to expected delivery dates. Include updated schedule of work.

C. Project Record Documents. Submit three copies of record (as-built) documents upon completion of installation for approval prior to final completion. Submittal shall consist of:
1. Project Record Drawings. As-built versions of submittal shop drawings provided as AutoCAD 2006 (or newer) compatible files on magnetic or optical disk (file format: .DWG, .DXF, .VSD, or comparable) and 2 prints of each drawing on 11” x 17” paper.
2. Testing and Commissioning Reports and Checklists. Completed versions of reports, checklists, and trend logs used to meet requirements of Section 23 09 23 Article 3.17 (Control System Demonstration and Acceptance).
3. Operation and Maintenance (O&M) Manual. Printed, electronic, or online help documentation of the following:
   a. As-built versions of submittal product data.
   b. Names, addresses, and telephone numbers of installing contractors and service representatives for equipment and control systems.
   c. Operator’s manual with procedures for operating control systems: logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing setpoints and variables.
d. Programming manual or set of manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
e. Engineering, installation, and maintenance manual or set of manuals that explains how to design and install new points, panels, and other hardware; how to perform preventive maintenance and calibration; how to debug hardware problems; and how to repair or replace hardware.
f. Documentation of programs created using custom programming language including setpoints, tuning parameters, and object database. Electronic copies of programs shall meet this requirement if control logic, setpoints, tuning parameters, and objects can be viewed using furnished programming tools.
g. Graphic files, programs, and database on magnetic or optical media.
h. List of recommended spare parts with part numbers and suppliers.
i. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
j. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation or web server software, and graphics software.
k. Licenses, guarantees, and warranty documents for equipment and systems.
l. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.

D. Training Materials: Provide course outline and materials for each class at least six weeks before first class. Training shall be furnished via instructor-led sessions, computer-based training, or web-based training. Engineer will modify course outlines and materials if necessary to meet Owner's needs. Engineer will review and approve course outlines and materials at least three weeks before first class.

1.8 Warranty

A. Warrant work as follows:

1. Warrant labor and materials for specified control system free from defects for a period of 24 months after final acceptance. Control system failures during warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner. Respond during normal business hours within 24 hours of Owner's warranty service request.

2. Work shall have a single warranty date, even if Owner receives beneficial use due to early system start-up. If specified work is split into multiple contracts or a multi-phase contract, each contract or phase shall have a separate warranty start date and period.

3. If Engineer determines that equipment and systems operate satisfactorily at the end of final start-up, testing, and commissioning phase, Engineer will certify in writing that control system operation has been tested and accepted in accordance with the terms of this specification. Date of acceptance shall begin warranty period.

4. Provide updates to operator workstation or web server software, project-specific software, graphic software, database software, and firmware that resolve Contractor-identified software deficiencies at no charge during warranty period. If available, Owner can purchase in-warranty service agreement to receive upgrades for functional
enhancements associated with above-mentioned items. Do not install updates or upgrades without Owner's written authorization.

5. Exception: Contractor shall not be required to warrant reused devices except those that have been rebuilt or repaired. Installation labor and materials shall be warranted. Demonstrate operable condition of reused devices at time of Engineer's acceptance.

1.9 Ownership of Proprietary Material

A. Project-specific software and documentation shall become Owner's property. This includes, but is not limited to:
   1. Graphics
   2. Record drawings
   3. Database
   4. Application programming code
   5. Documentation

PART 2: PRODUCTS

2.1 Materials

A. Use new products the manufacturer is currently manufacturing and selling for use in new installations. Do not use this installation as a product test site unless explicitly approved in writing by Owner. Spare parts shall be available for at least five years after completion of this contract.

2.2 Communication

A. Control products, communication media, connectors, repeaters, hubs, and routers shall comprise a BACnet internetwork. Controller and operator interface communication shall conform to ANSI/ASHRAE Standard 135, BACnet.
B. Install new wiring and network devices as required to provide a complete and workable control network. Use existing Ethernet backbone for network segments marked "existing" on project drawings.
C. Each controller shall have a communication port for temporary connection to a laptop computer or other operator interface. Connection shall support memory downloads and other commissioning and troubleshooting operations.
D. Internetwork operator interface and value passing shall be transparent to internetwork architecture.
   1. An operator interface connected to a controller shall allow the operator to interface with each internetwork controller as if directly connected. Controller information such as data, status, and control algorithms shall be viewable and editable from each internetwork controller.
   2. Inputs, outputs, and control variables used to integrate control strategies across multiple controllers shall be readable by each controller on the internetwork. Program and test all cross-controller links required to execute control strategies specified in
Section 23 09 93. An authorized operator shall be able to edit cross-controller links by typing a standard object address or by using a point-and-click interface.

E. Controllers with real-time clocks shall use the BACnet Time Synchronization service. System shall automatically synchronize system clocks daily from an operator-designated controller via the internetwork. If applicable, system shall automatically adjust for daylight saving and standard time.

F. System shall be expandable to at least twice the required input and output objects with additional controllers, associated devices, and wiring.

2.3 Operator Interface

A. Operator Interface. Web server shall reside on high-speed network with building controllers. Each standard browser connected to server shall be able to access all system information.

B. Communication. Web server or workstation and controllers shall communicate using BACnet protocol. Web server or workstation and control network backbone shall communicate using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing as specified in ANSI/ASHRAE 135, BACnet Annex J.

C. Hardware. Each workstation or web server shall consist of the following:
   1. Hardware Base. Industry-standard hardware shall meet or exceed DDC system manufacturer's recommended specifications and shall meet response times specified in Section 23 09 23 Paragraph 1.9. Hard disk shall have sufficient memory to store system software, one year of data for trended points specified in Section 23 09 93, and a system database at least twice the size of the existing database at system acceptance. Configure computers and network connections if multiple computers are required to meet specified memory and performance. Web server or workstations shall be IBM-compatible PCs with a minimum of:
      a. Intel Core 2 Duo 3 GHz processor
      b. 2 GB RAM
      c. 250 GB hard disk providing data at 100 MB/sec
      d. 16x CD-RW/DVD drive
      e. Serial, parallel, and network communication ports and cables required for proper system operation

D. Operator Functions. Operator interface shall allow each authorized operator to execute the following functions as a minimum:
   1. Log In and Log Out. System shall require user name and password to log in to operator interface.
   2. Point-and-click Navigation. Operator interface shall be graphically based and shall allow operators to access graphics for equipment and geographic areas using point-and-click navigation.
   3. View and Adjust Equipment Properties. Operators shall be able to view controlled equipment status and to adjust operating parameters such as setpoints, PID gains, on and off controls, and sensor calibration.
   4. View and Adjust Operating Schedules. Operators shall be able to view scheduled operating hours of each schedulable piece of equipment on a weekly or monthly calendar-based graphical schedule display, to select and adjust each schedule and time period, and to simultaneously schedule related equipment. System shall clearly show exception schedules and holidays on the schedule display.
   5. View and Respond to Alarms. Operators shall be able to view a list of currently active system alarms, to acknowledge each alarm, and to clear (delete) unneeded alarms.
6. View and Configure Trends. Operators shall be able to view a trend graph of each trended point and to edit graph configuration to display a specific time period or data range. Operator shall be able to create custom trend graphs to display on the same page data from multiple trended points.

7. View and Configure Reports. Operators shall be able to run preconfigured reports, to view report results, and to customize report configuration to show data of interest.

8. Manage Control System Hardware. Operators shall be able to view controller status, to restart (reboot) each controller, and to download new control software to each controller.

9. Manage Operator Access. Typically, only a few operators are authorized to manage operator access. Authorized operators shall be able to view a list of operators with system access and of functions they can perform while logged in. Operators shall be able to add operators, to delete operators, and to edit operator function authorization. Operator shall be able to authorize each operator function separately.

E. System Software.

1. Operating System. Web server shall have an industry-standard professional-grade operating system. Acceptable systems include Microsoft Windows 7 or higher.

2. System Graphics. Operator interface shall be graphically based and shall include at least one graphic per piece of equipment or affected zone, graphics for each direct expansion, chilled water, and hot water system, and graphics that summarize conditions on each floor of each building included in this contract. Indicate thermal comfort on floor plan summary graphics using dynamic colors to represent zone temperature relative to zone setpoint.
   a. Functionality. Graphics shall allow operator to monitor system status, to view a summary of the most important data for each controlled zone or piece of equipment, to use point-and-click navigation between zones or equipment, and to edit setpoints and other specified parameters.
   b. Animation. Graphics shall be able to animate by displaying different image files for changed object status.
   c. Alarm Indication. Indicate areas or equipment in an alarm condition using color or other visual indicator.

F. Format. Graphics shall be saved in an industry-standard format such as BMP, JPEG, PNG, or GIF. Web-based system graphics shall be viewable on browsers compatible with World Wide Web Consortium browser standards. Web graphic format shall require no plug-in (such as HTML and JavaScript) or shall only require widely available no-cost plug-ins (such as Active-X and Adobe Flash).

G. System Tools. System shall provide the following functionality to authorized operators as an integral part of the operator interface or as stand-alone software programs. If furnished as part of the interface, the tool shall be available from each workstation or web browser interface. If furnished as a stand-alone program, software shall be installable on standard IBM-compatible PCs with no limit on the number of copies that can be installed under the system license.
   1. Automatic System Database Configuration. Each workstation or web server shall store on its hard disk a copy of the current system database, including controller firmware and software. Stored database shall be automatically updated with each system configuration or controller firmware or software change.
   2. Controller Memory Download. Operators shall be able to download memory from the system database to each controller.
   3. System Configuration. Operators shall be able to configure the system.
   4. Online Help. Context-sensitive online help for each tool shall assist operators in operating and editing the system.
5. Security. System shall require a user name and password to view, edit, add, or delete data.
   a. Operator Access. Each user name and password combination shall define accessible viewing, editing, adding, and deleting functions in each system application, editor, and object.
   b. Automatic Log Out. Automatically log out each operator if no keyboard or mouse activity is detected. Operators shall be able to adjust automatic log out delay.

6. System Diagnostics. System shall automatically monitor controller and I/O point operation. System shall annunciate controller failure and I/O point locking (manual overriding to a fixed value).

7. Alarm Processing. System input and status objects shall be configurable to alarm on departing from and on returning to normal state. Operator shall be able to enable or disable each alarm and to configure alarm limits, alarm limit differentials, alarm states, and alarm reactions for each system object. Configure and enable alarm points as specified in Section 23 09 93 – Sequence of Operations for HVAC Controls. Alarms shall be BACnet alarm objects and shall use BACnet alarm services.

8. Alarm Messages. Alarm messages shall use an English language descriptor without acronyms or mnemonics to describe alarm source, location, and nature.

9. Alarm Reactions. Operator shall be able to configure (by object) actions workstation or web server shall initiate on receipt of each alarm. As a minimum, workstation or web server shall be able to log, print, start programs, display messages, send e-mail, send page, and audibly annunciate.

10. Alarm Maintenance. Operators shall be able to view system alarms and changes of state chronologically, to acknowledge and delete alarms, and to archive closed alarms to the workstation or web server hard disk from each workstation or web browser interface.

11. Trend Configuration. Operator shall be able to configure trend sample or change of value (COV) interval, start time, and stop time for each system data object and shall be able to retrieve data for use in spreadsheets and standard database programs. Controller shall sample and store trend data and shall be able to archive data to the hard disk. Configure trends as specified in Section 23 09 93 – Sequence of Operations for HVAC Controls. Trends shall be BACnet trend objects.

12. Object and Property Status and Control. Operator shall be able to view, and to edit if applicable, the status of each system object and property by menu, on graphics, or through custom programs.

13. Reports and Logs. Operator shall be able to select, to modify, to create, and to print reports and logs. Operator shall be able to store report data in a format accessible by standard spreadsheet and word processing programs.

14. Standard Reports. Furnish the following standard system reports:
   a. Objects. System objects and current values filtered by object type, by status (in alarm, locked, normal), by equipment, by geographic location, or by combination of filter criteria.
   c. Logs. System shall log the following to a database or text file and shall retain data for an adjustable period:
i. Alarm History.

ii. Trend Data. Operator shall be able to select trends to be logged.

iii. Operator Activity. At a minimum, system shall log operator log in and log out, control parameter changes, schedule changes, and alarm acknowledgment and deletion. System shall date and time stamp logged activity.

15. Graphics Generation. Graphically based tools and documentation shall allow Operator to edit system graphics, to create graphics, and to integrate graphics into the system. Operator shall be able to add analog and binary values, dynamic text, static text, and animation files to a background graphic using a mouse.

16. Graphics Library. Complete library of standard HVAC equipment graphics shall include equipment such as chillers, boilers, air handlers, terminals, fan coils, and unit ventilators. Library shall include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork. Library graphic file format shall be compatible with graphics generation tools.

17. Custom Application Programming. Operator shall be able to create, edit, debug, and download custom programs. System shall be fully operable while custom programs are edited, compiled, and downloaded. Programming language shall have the following features:

a. Language. Language shall be graphically based or English language oriented. If graphically based, language shall use function blocks arranged in a logic diagram that clearly shows control logic flow. Function blocks shall directly provide functions listed below, and operators shall be able to create custom or compound function blocks. If English language oriented, language shall be based on the syntax of BASIC, FORTRAN, C, or PASCAL, and shall allow for free-form programming that is not column-oriented or "fill-in-the-blanks."

b. Programming Environment. Tool shall provide a full-screen, cursor-and-mouse-driven programming environment that incorporates word processing features such as cut and paste. Operators shall be able to insert, add, modify, and delete custom programming code, and to copy blocks of code to a file library for reuse in other control programs.

c. Independent Program Modules. Operator shall be able to develop independently executing program modules that can disable, enable and exchange data with other program modules.

d. Debugging and Simulation. Operator shall be able to step through the program observing intermediate values and results. Operator shall be able to adjust input variables to simulate actual operating conditions. Operator shall be able to adjust each step's time increment to observe operation of delays, integrators, and other time-sensitive control logic. Debugger shall provide error messages for syntax and for execution errors.

e. Conditional Statements. Operator shall be able to program conditional logic using compound Boolean (AND, OR, and NOT) and relational (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.

f. Mathematical Functions. Language shall support floating-point addition, subtraction, multiplication, division, and square root operations, as well as absolute value calculation and programmatic selection of minimum and maximum values from a list of values.

g. Variables: Operator shall be able to use variable values in program conditional statements and mathematical functions.
i. Time Variables. Operator shall be able to use predefined variables to represent time of day, day of the week, month of the year, and date. Other predefined variables or simple control logic shall provide elapsed time in seconds, minutes, hours, and days. Operator shall be able to start, stop, and reset elapsed time variables using the program language.

ii. System Variables. Operator shall be able to use predefined variables to represent status and results of Controller Software and shall be able to enable, disable, and change setpoints of Controller Software as described in Controller Software section.

H. Portable Operator's Terminal. Provide all necessary software to configure an IBM-compatible laptop computer for use as a Portable Operator's Terminal. Operator shall be able to connect configured Terminal to the system network or directly to each controller for programming, setting up, and troubleshooting.

I. Operator Workstation: Web server or workstation shall conform to BACnet Operator Workstation (B-OWS) device profile or BACnet Advanced Workstation (B-AWS) as specified in ANSI/ASHRAE 135, BACnet Annex L and shall be listed as a certified B-OWS or B-AWS in the BACnet Testing Laboratories (BTL) Product Listing.

2.4 Controller Software

A. Building and energy management application software shall reside and operate in system controllers. Applications shall be editable through operator workstation, web browser interface, or engineering workstation.

B. System Security. See Paragraph 2.3.F.5 (Security) and Paragraph 2.3.F.15.c (Operator Activity).

C. Scheduling. See Paragraph 2.3.D.4 (View and Adjust Operating Schedules). System shall provide the following schedule options as a minimum:

1. Weekly. Provide separate schedules for each day of the week. Each schedule shall be able to include up to 5 occupied periods (5 start-stop pairs or 10 events).
2. Exception. Operator shall be able to designate an exception schedule for each of the next 365 days. After an exception schedule has executed, system shall discard and replace exception schedule with standard schedule for that day of the week.
3. Holiday. Operator shall be able to define 24 special or holiday schedules of varying length on a scheduling calendar that repeats each year.

D. System Coordination. Operator shall be able to group related equipment based on function and location and to use these groups for scheduling and other applications.

E. Binary and Analog Alarms. See Paragraph 2.3.F.7 (Alarm Processing).

F. Alarm Reporting. See Paragraph 2.3.F.9 (Alarm Reactions).

G. Remote Communication. System shall automatically contact operator workstation or server on receipt of critical alarms. If no network connection is available, system shall use a modem connection.

H. Demand Limiting.

1. System shall monitor building power consumption from building power meter pulse generator signals or from building feeder line watt transducer or current transformer.
2. When power consumption exceeds adjustable levels, system shall automatically adjust setpoints, de-energize low-priority equipment, and take other programmatic actions to reduce demand as specified in Section 23 09 93 – Sequence of Operations for HVAC Controls. When demand drops below adjustable levels, system shall restore loads as specified.
I. Maintenance Management. System shall generate maintenance alarms when equipment exceeds adjustable runtime, equipment starts, or performance limits. Configure and enable maintenance alarms as specified in Section 23 09 93 – Sequence of Operations for HVAC Controls.

J. Sequencing. Application software shall sequence chillers, boilers, and pumps as specified in Section 23 09 93 – Sequence of Operations for HVAC Controls.

K. PID Control. System shall provide direct- and reverse-acting PID (proportional-integral-derivative) algorithms. Each algorithm shall have anti-windup and selectable controlled variable, setpoint, and PID gains. Each algorithm shall calculate a time-varying analog value that can be used to position an output or to stage a series of outputs.

L. PID controller should also be able to auto tune.

M. Staggered Start. System shall stagger controlled equipment restart after power outage. Operator shall be able to adjust equipment restart order and time delay between equipment restarts.

N. Energy Calculations.
   1. System shall accumulate and convert instantaneous power (kW) or flow rates (L/s [gpm]) to energy usage data.
   2. System shall calculate a sliding-window average (rolling average). Operator shall be able to adjust window interval to 15 minutes, 30 minutes, or 60 minutes.

O. Anti-Short Cycling. Binary output objects shall be protected from short cycling by means of adjustable minimum on-time and off-time settings.

P. On and Off Control with Differential. System shall provide direct- and reverse-acting on and off algorithms with adjustable differential to cycle a binary output based on a controlled variable and setpoint.

Q. Runtime Totalization. System shall provide an algorithm that can totalize runtime for each binary input and output. Operator shall be able to enable runtime alarm based on exceeded adjustable runtime limit. Configure and enable runtime totalization and alarms as specified in Section 23 09 93 – Sequence of Operations for HVAC Controls.

2.5 Controllers

A. General. Provide Building Controllers (BC), Advanced Application Controllers (AAC), Application Specific Controllers (ASC), Smart Actuators (SA), and Smart Sensors (SS) as required to achieve performance specified in Section 23 09 23 Article 1.9 (System Performance). Every device in the system which executes control logic and directly controls HVAC equipment must conform to a standard BACnet Device profile as specified in ANSI/ASHRAE 135, BACnet Annex L. Unless otherwise specified, hardwired actuators and sensors may be used in lieu of BACnet Smart Actuators and Smart Sensors.

B. BACnet.
   1. Building Controllers (BCs). Each BC shall conform to BACnet Building Controller (B-BC) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L and shall be listed as a certified B-BC in the BACnet Testing Laboratories (BTL) Product Listing. Combination Building Controllers (BC) and Application Specific Controllers (ASC) such as the JCI NCE shall not be used.
   2. Advanced Application Controllers (AACs). Each AAC shall conform to BACnet Advanced Application Controller (B-AAC) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L and shall be listed as a certified B-AAC in the BACnet Testing Laboratories (BTL) Product Listing.
   3. Application Specific Controllers (ASCs). Each ASC shall conform to BACnet Application Specific Controller (B-ASC) device profile as specified in ANSI/ASHRAE
135, BACnet Annex L and shall be listed as a certified B-ASC in the BACnet Testing Laboratories (BTL) Product Listing.

4. Smart Actuators (SAs). Each SA shall conform to BACnet Smart Actuator (B-SA) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L and shall be listed as a certified B-SA in the BACnet Testing Laboratories (BTL) Product Listing.

5. Smart Sensors (SSs). Each SS shall conform to BACnet Smart Sensor (B-SS) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L and shall be listed as a certified B-SS in the BACnet Testing Laboratories (BTL) Product Listing.

6. BACnet Communication.
   a. Each BC shall reside on or be connected to a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing.
   b. BACnet routing shall be performed by BCs or other BACnet device routers as necessary to connect BCs to networks of AACs and ASCs.
   c. Each AAC shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet/IP addressing, or it shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.
   d. Each ASC shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.
   e. Each SA shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.
   f. Each SS shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet/IP addressing, or it shall reside on a BACnet network using ARCNET or MS/TP Data Link/Physical layer protocol.

C. Communication.
   1. Service Port. Each controller shall provide a service communication port for connection to a Portable Operator's Terminal. Connection shall be extended to space temperature sensor ports where shown on drawings.
   2. Signal Management. BC and ASC operating systems shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and to allow for central monitoring and alarms.
   3. Data Sharing. Each BC and AAC shall share data as required with each networked BC and AAC.
   4. Stand-Alone Operation. Each piece of equipment specified in Section 23 09 93 shall be controlled by a single controller to provide stand-alone control in the event of communication failure. All I/O points specified for a piece of equipment shall be integral to its controller. Provide stable and reliable stand-alone control using default values or other method for values normally read over the network.

D. Environment. Controller hardware shall be suitable for anticipated ambient conditions.
   1. Controllers used outdoors or in wet ambient conditions shall be mounted in waterproof enclosures and shall be rated for operation at -29°C to 60°C (-20°F to 140°F).
   2. Controllers used in conditioned space shall be mounted in dust-protective enclosures and shall be rated for operation at 0°C to 50°C (32°F to 120°F).

E. Keypad. Provide a local keypad and display for each BC and AAC. Operator shall be able to use keypad to view and edit data. Keypad and display shall require password to prevent unauthorized use. If the manufacturer does not normally provide a keypad and display for each BC and AAC, provide the software and any interface cabling needed to use a laptop computer as a Portable Operator's Terminal for the system.

F. Real-Time Clock. Controllers that perform scheduling shall have a real-time clock.

G. Serviceability.
1. Controllers shall have diagnostic LEDs for power, communication, and processor.
2. Wires shall be connected to a field-removable modular terminal strip or to a termination card connected by a ribbon cable.
3. Each BC and AAC shall continually check its processor and memory circuit status and shall generate an alarm on abnormal operation. System shall continuously check controller network and generate alarm for each controller that fails to respond.

H. Memory.
1. Controller memory shall support operating system, database, and programming requirements.
2. Each BC and AAC shall retain BIOS and application programming for at least 72 hours in the event of power loss.
3. Each ASC and SA shall use nonvolatile memory and shall retain BIOS and application programming in the event of power loss. System shall automatically download dynamic control parameters following power loss.

I. Immunity to Power and Noise. Controllers shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft.).

J. Transformer. ASC power supply shall be fused or current limiting and shall be rated at a minimum of 125% of ASC power consumption.

2.6 Input and Output Interface

A. General. Hard-wire input and output points to BCs, AACs, ASCs, or SAs.
B. Protection. Shorting an input or output point to itself, to another point, or to ground shall cause no controller damage. Input or output point contact with up to 24 V for any duration shall cause no controller damage.
C. Binary Inputs. Binary inputs shall monitor the on and off signal from a remote device. Binary inputs shall provide a wetting current of at least 12 mA and shall be protected against contact bounce and noise. Binary inputs shall sense dry contact closure without application of power external to the controller.
D. Pulse Accumulation Inputs. Pulse accumulation inputs shall conform to binary input requirements and shall accumulate up to 10 pulses per second.
E. Analog Inputs. Analog inputs shall monitor low-voltage (0-10 Vdc), current (4-20 mA), or resistance (thermistors or RTD) signals. Analog inputs shall be compatible with and field configurable to commonly available sensing devices.
F. Binary Outputs. Binary outputs shall send an on-or-off signal for on and off control. Building Controller binary outputs shall have three-position (on-off-auto) override switches and status lights. Outputs shall be selectable for normally open or normally closed operation.
G. Analog Outputs. Analog outputs shall send a modulating 0-10 Vdc or 4-20 mA signal as required to properly control output devices. Each Building Controller analog output shall have a two-position (auto-manual) switch, a manually adjustable potentiometer, and status lights. Analog outputs shall not drift more than 0.4% of range annually.
H. Tri-State Outputs. Control three-point floating electronic actuators without feedback with tri-state outputs (two coordinated binary outputs). Tri-State outputs may be used to provide analog output control in zone control and terminal unit control applications such as VAV terminal units, duct-mounted heating coils, and zone dampers.
I. Universal Inputs and Outputs. Inputs and outputs that can be designated as either binary or analog in software shall conform to the provisions of this section that are appropriate for their designated use.

2.7 Power Supplies and Line Filtering

A. Power Supplies. Control transformers shall be UL listed. Furnish Class 2 current-limiting type or furnish over-current protection in primary and secondary circuits for Class 2 service in accordance with NEC requirements. Limit connected loads to 80% of rated capacity.
   1. DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1.0% line and load combined, with 100-microsecond response time for 50% load changes. Unit shall have built-in over-voltage and over-current protection and shall be able to withstand 150% current overload for at least three seconds without trip-out or failure.
      a. Unit shall operate between 0°C and 50°C (32°F and 120°F). EM/RF shall meet FCC Class B and VDE 0871 for Class B and MILSTD 810C for shock and vibration.
      b. Line voltage units shall be UL recognized and CSA listed.

B. Power Line Filtering.
   1. Provide internal or external transient voltage and surge suppression for workstations and controllers. Surge protection shall have:
      a. Dielectric strength of 1000 V minimum
      b. Response time of 10 nanoseconds or less
      d. Transverse mode noise attenuation of 65 dB or greater
      e. Common mode noise attenuation of 150 dB or greater at 40-100 Hz

2.8 Auxiliary Control Devices

A. Motorized Control Dampers.
   1. Type. Control dampers shall have linear flow characteristics and shall be parallel- or opposed-blade type as specified below or as scheduled on drawings.
      a. Outdoor and return air mixing dampers and face-and-bypass dampers shall be parallel-blade and shall direct airstreams toward each other.
      b. Other modulating dampers shall be opposed-blade.
      c. Two-position shutoff dampers shall be parallel- or opposed-blade with blade and side seals.
   2. Frame. Damper frames shall be 2.38 mm (13 gage) galvanized steel channel or 3.175 mm (1/8 in.) extruded aluminum with reinforced corner bracing.
   3. Blades. Damper blades shall not exceed 20 cm (8 in.) in width or 125 cm (48 in.) in length. Blades shall be suitable for medium velocity (10 m/s [2000 fpm]) performance. Blades shall be not less than 1.5875 mm (16 gage).
   4. Shaft Bearings. Damper shaft bearings shall be as recommended by manufacturer for application, oil impregnated sintered bronze, or better.
   5. Seals. Blade edges and frame top and bottom shall have replaceable seals of butyl rubber or neoprene. Side seals shall be spring-loaded stainless steel. Blade seals shall leak no more than 50 L/s-m² (10 cfm per ft²) at 1000 Pa (4 in. w.g.) differential pressure. Blades shall be airfoil type suitable for wide-open face velocity of 7.5 m/s (1500 fpm).
6. Sections. Damper sections shall not exceed 125 cm - 150 cm (48 in. - 60 in.). Each section shall have at least one damper actuator.

7. Linkages. Dampers shall have exposed linkages.

B. Electric Damper and Valve Actuators.
   1. Stall Protection. Mechanical or electronic stall protection shall prevent actuator damage throughout the actuator's rotation.
   2. Spring-return Mechanism. Actuators used for power-failure and safety applications shall have an internal mechanical spring-return mechanism or an uninterruptible power supply (UPS).
   3. Signal and Range. Proportional actuators shall accept a 0-10 Vdc or a 0-20 mA control signal and shall have a 2-10 Vdc or 4-20 mA operating range. (Floating motor actuators may be substituted for proportional actuators in terminal unit applications as described in paragraph 2.6H.)
   4. Wiring. 24 Vac and 24 Vdc actuators shall operate on Class 2 wiring.
   5. Manual Positioning. Operators shall be able to manually position each actuator when the actuator is not powered. Non-spring-return actuators shall have an external manual gear release. Spring-return actuators with more than 7 N·m (60 in.-lb.) torque capacity shall have a manual crank.

C. Control Valves.
   1. General. Select body and trim materials in accordance with manufacturer's recommendations for design conditions and service shown.
   2. Type. Provide two- or three-way control valves for two-position or modulating service as shown.
      a. Valves providing two-position service shall be quick opening. Two-way valves shall have replaceable disc or ball.
      b. Close-off (Differential) Pressure Rating. Valve actuator and trim shall provide the following minimum close-off pressure ratings.
         i. Two-way: 150% of total system (pump) head.
         ii. Three-way: 300% of pressure differential between ports A and B at design flow or 100% of total system (pump) head.
      c. Ports. Valves providing modulating service shall have equal percentage ports.
      d. Sizing.
         i. Two-position service: line size.
         ii. Two-way modulating service: select pressure drop equal to the greatest of twice the pressure drop through heat exchanger (load), 50% of the pressure difference between supply and return mains, or 35 kPa (5 psi).
         iii. Three-way modulating service: select pressure drop equal to the smaller of twice the pressure drop through the coil exchanger (load) or 35 kPa (5 psi).
      e. Fail Position. Water valves shall fail normally open or closed as follows unless otherwise specified.
         i. Water zone valves: normally open.
         ii. Heating coils in air handlers: normally open.
         iii. Chilled water control valves: normally closed.
         iv. Other applications: as scheduled or as required by sequences of operation.
   4. Steam Valves.
      a. Close-off (Differential) Pressure Rating. Valve actuator and trim shall provide minimum close-off pressure rating equal to 150% of operating (inlet) pressure.
b. Ports. Valves providing modulating service shall have linear ports.

c. Sizing.
   i. Two-position service: select pressure drop equal to 10%-20% of inlet psig.
   ii. Modulating service at 100 kPa (15 psig) or less: select pressure drop equal to 80% of inlet psig.
   iii. Modulating service at 101-350 kPa (16-50 psig): select pressure drop equal to 50% of inlet psig.
   iv. Modulating service at over 350 kPa (50 psig): select pressure drop as scheduled on drawings.

D. Binary Temperature Devices.
   1. Low-Voltage Space Thermostats. Low-voltage space thermostats shall be 24 V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed setpoint adjustment, 13°C-30°C (55°F-85°F) setpoint range, 1°C (2°F) maximum differential, and vented ABS plastic cover.
   2. Line-Voltage Space Thermostats. Line-voltage space thermostats shall be bimetal-actuated, open-contact type or bellows-actuated, enclosed, snap-switch type or equivalent solid-state type, with heat anticipator, UL listing for electrical rating, concealed setpoint adjustment, 13°C-30°C (55°F-85°F) setpoint range, 1°C (2°F) maximum differential, and vented ABS plastic cover.
   3. Low-Limit Thermostats. Low-limit airstream thermostats shall be UL listed, vapor pressure type. Element shall be at least 6 m (20 ft) long. Element shall sense temperature in each 30 cm (1 ft) section and shall respond to lowest sensed temperature. Low-limit thermostat shall be manual reset only.

E. Temperature Sensors.
   1. Type. Temperature sensors shall be Resistance Temperature Device (RTD) or thermistor.
   2. Duct Sensors. Duct sensors shall be single point or averaging as shown. Averaging sensors shall be a minimum of 1.5 m (5 ft) in length per 1 m$^2$ (10 ft$^2$) of duct cross-section.
   3. Immersion Sensors. Provide immersion sensors with a separable stainless steel well. Well pressure rating shall be consistent with system pressure it will be immersed in. Well shall withstand pipe design flow velocities.
   4. Space Sensors. Space sensors shall have remote setpoint adjustment, vertical wall box enclosure, SA Bus screw terminal block, BACnet Listed sensor, and communication port.

F. Humidity Sensors.
   1. Duct and room sensors shall have a sensing range of 20%-80%.
   2. Duct sensors shall have a sampling chamber.
   3. Outdoor air humidity sensors shall have a sensing range of 20%-95% RH and shall be suitable for ambient conditions of 40°C-75°C (40°F-170°F).
   4. Humidity sensors shall not drift more than 1% of full scale annually.

G. Flow Switches. Flow-proving switches shall be solid state thermal sensor or differential pressure type (air or water service) as shown. Differential pressure switches shall be UL listed, SPDT snap-acting, and pilot duty rated (125 VA minimum).
   1. Solid state thermal sensors shall have adjustable sensitivity and NEMA 1 enclosure unless otherwise specified.
2. Differential pressure switches shall have scale range and differential suitable for intended application and NEMA 1 enclosure unless otherwise specified.

H. Relays.
   1. Control Relays. Control relays shall be plug-in type, UL listed, and shall have dust cover and LED "energized" indicator. Contact rating, configuration, and coil voltage shall be suitable for application.
   2. Time Delay Relays. Time delay relays shall be solid-state plug-in type, UL listed, and shall have adjustable time delay. Delay shall be adjustable ±100% from setpoint shown. Contact rating, configuration, and coil voltage shall be suitable for application. Provide NEMA 1 enclosure for relays not installed in local control panel.

I. Override Timers.
   1. Unless implemented in control software, override timers shall be spring-wound line voltage, UL Listed, with contact rating and configuration required by application. Provide 0-6 hour calibrated dial unless otherwise specified. Flush mount timer on local control panel face or where shown.

J. Current Transmitters.
   1. AC current transmitters shall be self-powered, combination split-core current transformer type with built-in rectifier and high-gain servo amplifier with 4-20 mA two-wire output. Full-scale unit ranges shall be 10 A, 20 A, 50 A, 100 A, 150 A, and 200 A, with internal zero and span adjustment. Unit accuracy shall be ±1% full-scale at 500 ohm maximum burden.
   2. Transmitter shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA recognized.
   3. Unit shall be split-core type for clamp-on installation on existing wiring.

K. Current Transformers.
   1. AC current transformers shall be UL/CSA recognized and shall be completely encased (except for terminals) in approved plastic material.
   2. Transformers shall be available in various current ratios and shall be selected for ±1% accuracy at 5 A full-scale output.
   3. Use fixed-core transformers for new wiring installation and split-core transformers for existing wiring installation.

L. Voltage Transmitters.
   1. AC voltage transmitters shall be self-powered single-loop (two-wire) type, 4-20 mA output with zero and span adjustment.
   2. Adjustable full-scale unit ranges shall be 100-130 Vac, 200-250 Vac, 250-330 Vac, and 400-600 Vac. Unit accuracy shall be ±1% full-scale at 500 ohm maximum burden.
   3. Transmitters shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA recognized at 600 Vac rating.

M. Voltage Transformers.
   1. AC voltage transformers shall be UL/CSA recognized, 600 Vac rated, and shall have built-in fuse protection.
   2. Transformers shall be suitable for ambient temperatures of 4°C-55°C (40°F-130°F) and shall provide ±0.5% accuracy at 24 Vac and 5 VA load.
   3. Windings (except for terminals) shall be completely enclosed with metal or plastic.

N. Power Monitors.
   1. Power monitors shall be three-phase type and shall have three-phase disconnect and shorting switch assembly, UL listed voltage transformers, and UL listed split-core current transformers.
2. Power monitors shall provide selectable output: rate pulse for kWh reading or 4-20 mA for kW reading. Power monitors shall operate with 5 A current inputs and maximum error of ±2% at 1.0 power factor or ±2.5% at 0.5 power factor.

O. Current Switches.
1. Current-operated switches shall be self-powered, solid-state with adjustable trip current. Select switches to match application current and DDC system output requirements.

P. Pressure Transducers.
1. Transducers shall have linear output signal and field-adjustable zero and span.
2. Continuous operating conditions of positive or negative pressure 50% greater than calibrated span shall not damage transducer sensing elements.
3. Water pressure transducer diaphragm shall be stainless steel with minimum proof pressure of 1000 kPa (150 psi). Transducer shall have 4-20 mA output, suitable mounting provisions, and block and bleed valves.
4. Water differential pressure transducer diaphragm shall be stainless steel with minimum proof pressure of 1000 kPa (150 psi). Over-range limit (differential pressure) and maximum static pressure shall be 2000 kPa (300 psi.) Transducer shall have 4-20 mA output, suitable mounting provisions, and 5-valve manifold.

Q. Differential Pressure Switches. Differential pressure switches (air or water service) shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum) and shall have scale range and differential suitable for intended application and NEMA 1 enclosure unless otherwise specified.

R. Pressure-Electric (PE) Switches. PE switches shall be UL listed, pilot duty rated (125 VA minimum) or motor control rated, metal or neoprene diaphragm actuated, operating pressure rated for 0-175 kPa (0-25 psig), with calibrated scale minimum setpoint range of 14-125 kPa (2-18 psig).
1. Provide one- or two-stage switch action (SPDT, DPST, or DPDT) as required by application.
2. Switches shall be open type (panel-mounted). Exception: Switches shall be enclosed type for remote installation. Enclosed type shall be NEMA 1 unless otherwise specified.
3. Each pneumatic signal line to PE switches shall have permanent indicating gauge.

S. Local Control Panels.
1. Indoor control panels shall be fully enclosed NEMA 1 construction with hinged door key-lock latch and removable sub-panels. A common key shall open each control panel and sub-panel.
2. Prewire internal and face-mounted device connections with color-coded stranded conductors tie-wrapped or neatly installed in plastic troughs. Field connection terminals shall be UL listed for 600 V service, individually identified per control and interlock drawings, with adequate clearance for field wiring.
3. Each local panel shall have a control power source power switch (on-off) with overcurrent protection.

T. Environment. Auxiliary Control Devices shall be suitable for anticipated ambient conditions.
1. Devices used outdoors or in wet ambient conditions shall be mounted in waterproof enclosures and shall be rated for operation at -29°C to 60°C (-20°F to 140°F).
2. Devices used in conditioned space shall be mounted in dust-protective enclosures and shall be rated for operation at 0°C to 50°C (32°F to 120°F).
3. The Devices themselves shall possess the appropriate NEMA Rating for the intended environment. Plastic covers, canvas bags, or other supplemental enclosures are unacceptable.
2.9 Wiring and Raceways

A. General. Provide copper wiring, plenum cable, and raceways as specified in applicable sections of Division 26.

B. Insulated wire shall use copper conductors and shall be UL listed for 90°C (200°F) minimum service.

C. Conductors shall conform to the following table:

<table>
<thead>
<tr>
<th>USAGE</th>
<th>SHEATH COLOR</th>
<th>GAGE/QTY</th>
<th>SHIELDED</th>
<th>PLENUM RATED</th>
<th>WCW Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analog Inputs</td>
<td>Yellow</td>
<td>18-2</td>
<td>Yes</td>
<td>Yes</td>
<td>WCW-18/2YEL-WC</td>
</tr>
<tr>
<td>Analog Inputs</td>
<td>Yellow</td>
<td>18-3</td>
<td>Yes</td>
<td>Yes</td>
<td>WCW-18/3YEL-WC</td>
</tr>
<tr>
<td>Analog Outputs</td>
<td>Tan</td>
<td>18-2</td>
<td>Yes</td>
<td>Yes</td>
<td>WCW-18/2TAN-WC</td>
</tr>
<tr>
<td>Analog Outputs</td>
<td>Tan</td>
<td>18-3</td>
<td>Yes</td>
<td>Yes</td>
<td>WCW-18/3TAN-WC</td>
</tr>
<tr>
<td>Binary Inputs</td>
<td>Orange</td>
<td>18-2</td>
<td>Yes</td>
<td>Yes</td>
<td>WCW-18/2ORG-WC</td>
</tr>
<tr>
<td>Binary Outputs</td>
<td>Violet</td>
<td>18-2</td>
<td>Yes</td>
<td>Yes</td>
<td>WCW-18/2VLT-WC</td>
</tr>
<tr>
<td>24v Power</td>
<td>White with Red Stripe</td>
<td>18-2</td>
<td>No</td>
<td>Yes</td>
<td>002361</td>
</tr>
<tr>
<td>24v Power</td>
<td>White with Blue Stripe</td>
<td>16-2</td>
<td>No</td>
<td>Yes</td>
<td>001362</td>
</tr>
<tr>
<td>24v Power</td>
<td>White with Yellow Stripe</td>
<td>14-2</td>
<td>No</td>
<td>Yes</td>
<td>007963</td>
</tr>
<tr>
<td>FC Bus</td>
<td>Yellow with Blue Stripe</td>
<td>22-3</td>
<td>Yes</td>
<td>Yes</td>
<td>0043339</td>
</tr>
<tr>
<td>SA Bus</td>
<td>Brown</td>
<td>22-2P</td>
<td>Yes</td>
<td>Yes</td>
<td>WCW-22/2P-SA-PLN</td>
</tr>
</tbody>
</table>

NOTE: The Windy City Wire Part Number is the basis of design. Comparable cables from other manufacturers may be acceptable.

2.10 Fiber Optic Cable System

A. Optical Cable. Optical cables shall be duplex 900 mm tight-buffer construction designed for intra-building environments. Sheath shall be UL listed OFNP in accordance with NEC Article 770. Optical fiber shall meet the requirements of FDDI, ANSI X3T9.5 PMD for 62.5/125mm.

B. Connectors. Field terminate optical fibers with ST type connectors. Connectors shall have ceramic ferrules and metal bayonet latching bodies.
PART 3: EXECUTION

3.1 Examination

A. Thoroughly examine project plans for control device and equipment locations. Report discrepancies, conflicts, or omissions to Architect or Engineer for resolution before starting rough-in work.
B. Inspect site to verify that equipment can be installed as shown. Report discrepancies, conflicts, or omissions to Engineer for resolution before starting rough-in work.
C. Examine drawings and specifications for work of others. Report inadequate headroom or space conditions or other discrepancies to Engineer and obtain written instructions for changes necessary to accommodate Section 23 09 23 work with work of others. Controls Contractor shall perform at his expense necessary changes in specified work caused by failure or neglect to report discrepancies.

3.2 Protection

A. Controls Contractor shall protect against and be liable for damage to work and to material caused by Contractor's work or employees.
B. Controls Contractor shall be responsible for work and equipment until inspected, tested, and accepted. Protect material not immediately installed. Close open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

3.3 Coordination

A. Site.
   1. Assist in coordinating space conditions to accommodate the work of each trade where work will be installed near or will interfere with work of other trades. If installation without coordination causes interference with work of other trades, Contractor shall correct conditions without extra charge.
   2. Coordinate and schedule work with other work in the same area and with work dependent upon other work to facilitate mutual progress.
B. Submittals. See Section 23 09 23 Article 1.10 (Submittals).
C. Test and Balance.
   1. Provide Test and Balance Contractor a single set of necessary tools to interface to control system for testing and balancing.
   2. Train Test and Balance Contractor to use control system interface tools.
   3. Provide a qualified technician to assist with testing and balancing the first 20 terminal units.
   4. Test and Balance Contractor shall return tools undamaged and in working condition at completion of testing and balancing.
D. Life Safety.
   1. Duct smoke detectors required for air handler shutdown are provided under Division 28. Interlock smoke detectors to air handlers for shutdown as specified in Section 23 09 93 – Sequence of Operations for HVAC Controls.
2. Smoke dampers and actuators required for duct smoke isolation are provided under Division 23. Interlock smoke dampers to air handlers as specified in Section 23 09 93 – Sequence of Operations for HVAC Controls.

3. Fire and smoke dampers and actuators required for fire-rated walls are provided under Division 23. Fire and smoke damper control is provided under Division 28.

E. Coordination with Other Controls. Integrate with and coordinate controls and control devices furnished or installed by others as follows.
   1. Communication media and equipment shall be provided as specified in Section 23 09 23 Article 2.2 (Communication).
   2. Each supplier of a controls product shall configure, program, start up, and test that product to meet the sequences of operation described in Section 23 09 93 Appendix A regardless of where within the contract documents those products are described.
   3. Coordinate and resolve incompatibility issues that arise between control products provided under this section and those provided under other sections or divisions of this specification.
   4. Controls Contractor shall be responsible for integration of control products provided by multiple suppliers regardless of where integration is described within the contract documents.

3.4 General Workmanship

A. Install equipment, piping, and wiring or raceway horizontally, vertically, and parallel to walls wherever possible.
B. Provide sufficient slack and flexible connections to allow for piping and equipment vibration isolation.
C. Install equipment in readily accessible locations as defined by National Electrical Code (NEC) Chapter 1 Article 100 Part A.
D. Verify wiring integrity to ensure continuity and freedom from shorts and ground faults.
E. Equipment, installation, and wiring shall comply with industry specifications and standards and local codes for performance, reliability, and compatibility.

3.5 Field Quality Control

A. Work, materials, and equipment shall comply with rules and regulations of applicable local, state, and federal codes and ordinances as identified in Section 23 09 23 Article 1.8 (Codes and Standards).
B. Continually monitor field installation for code compliance and workmanship quality.
C. Contractor shall arrange for work inspection by local or state authorities having jurisdiction over the work.

3.6 Existing Equipment

A. Wiring. Interconnecting control wiring to be removed shall become Contractor's property unless specifically noted or shown to be reused.
B. Local Control Panels. Remove and deliver existing control panels to Owner.
C. Repair. Unless otherwise directed, Contractor is not responsible for repair or replacement of existing energy equipment and systems, valves, dampers, or actuators. Notify Engineer in writing immediately of existing equipment that requires maintenance.
D. Indicator Gauges. Ensure operation of and recalibrate for reasonable accuracy or replace existing gauges.
E. Room Thermostats. Remove and deliver existing room thermostats to Owner unless otherwise noted. Patch and finish holes and marks left by removal to match existing walls.
F. Electronic Sensors and Transmitters. Remove and deliver existing sensors and transmitters to Owner.
G. Controllers and Auxiliary Electronic Devices. Remove and deliver existing controllers and auxiliary electronic devices to Owner.
H. Damper Actuators, Linkages, and Appurtenances: Remove and deliver existing damper actuators, linkages and appurtenances to Owner.
I. Control Valves. Replace existing control valves with new. Deliver removed control valves to Owner.
J. Existing System Operating Schedule. Existing mechanical system may be disabled during this work after requesting such impairment 7 days in advance and receiving approval from the Owner.
K. Maintain fan scheduling using existing or temporary time clocks or control systems throughout the control system installation.
L. Modify existing starter control circuits if necessary to provide hand-off-auto control of each controlled starter. Furnish new starters or starter control packages as required.
M. Patch holes and finish to match existing walls.
N. At Owner's request, items not to be delivered to Owner shall instead be properly disposed of. Hazardous materials shall be disposed of under Division 02.

3.7 Wiring
A. Control and interlock wiring and installation shall comply with national and local electrical codes, Division 26, and manufacturer's recommendations. Where the requirements of Section 23 09 23 differ from Division 26, Section 23 09 23 shall take precedence.
B. NEC Class 1 (line voltage) wiring shall be UL listed in approved raceway as specified by NEC and Division 26.
C. Low-voltage wiring shall meet NEC Class 2 requirements. Subfuse low-voltage power circuits as required to meet Class 2 current limit.
D. NEC Class 2 (current-limited) wires not in raceway but in concealed and accessible locations such as return air plenums shall be UL listed for the intended application.
E. Install wiring in raceway where subject to mechanical damage and at levels below 10ft in mechanical, electrical, or service rooms.
F. Install Class 1 and Class 2 wiring in separate raceways. Boxes and panels containing high-voltage wiring and equipment shall not be used for low-voltage wiring except for the purpose of interfacing the two through relays and transformers.
G. Do not install wiring in raceway containing tubing.
H. Run exposed Class 2 wiring parallel to a surface or perpendicular to it and tie neatly at (5 ft.) intervals.
I. Use structural members to support or anchor plenum cables without raceway. Do not use ductwork, electrical raceways, piping, or ceiling suspension systems to support or anchor cables.
J. Secure raceways with raceway clamps fastened to structure and spaced according to code requirements. Raceways and pull boxes shall not be hung on or attached to ductwork, electrical raceways, piping, or ceiling suspension systems.
K. Size raceway and select wire size and type in accordance with manufacturer's recommendations and NEC requirements.
L. Include one pull string in each raceway 2.5 cm (1 in.) or larger.
M. Use color-coded conductors throughout.
N. Locate control and status relays in designated enclosures only. Do not install control and status relays in packaged equipment control panel enclosures containing Class 1 starters.
O. Conceal raceways except within mechanical, electrical, or service rooms. Maintain minimum clearance of 15 cm (6 in.) between raceway and high-temperature equipment such as steam pipes or flues.
P. Adhere to requirements in Division 26 where raceway crosses building expansion joints.
Q. Install insulated bushings on raceway ends and enclosure openings. Seal top ends of vertical raceways.
R. Terminate control and interlock wiring related to the work of this section. Maintain at the job site updated (as-built) wiring diagrams that identify terminations.
S. Flexible metal raceways and liquid-tight flexible metal raceways shall not exceed 1 m (3 ft.) in length and shall be supported at each end. Do not use flexible metal raceway less than ½ in. electrical trade size. Use liquid-tight flexible metal raceways in areas exposed to moisture including chiller and boiler rooms.
T. Install raceway rigidly, support adequately, ream at both ends, and leave clean and free of obstructions. Join raceway sections with couplings and according to code. Make terminations in boxes with fittings. Make terminations not in boxes with bushings.

3.8 Communication Wiring

A. Communication wiring shall be low-voltage Class 2 wiring and shall comply with Article 3.7 (Wiring).
B. Install communication wiring in separate raceways and enclosures from other Class 2 wiring.
C. During installation do not exceed maximum cable pulling, tension, or bend radius specified by the cable manufacturer.
D. Verify entire network’s integrity following cable installation using appropriate tests for each cable.
E. Install lightning arrester according to manufacturer’s recommendations between cable and ground where a cable enters or exits a building.
F. Each run of communication wiring shall be a continuous length without splices when that length is commercially available. Runs longer than commercially available lengths shall have as few splices as possible using commercially available lengths.
G. Label communication wiring to indicate origination and destination.
H. Ground coaxial cable according to NEC regulations article on "Communications Circuits, Cable, and Protector Grounding."
I. BACnet MS/TP communications wiring shall be installed in accordance with ASHRAE/ANSI Standard 135. This includes but is not limited to:
   1. The network shall use shielded, twisted-pair cable with characteristic impedance between 100 and 120 ohms. Distributed capacitance between conductors shall be less than 100 pF per meter (30 pF per foot.)
   2. The maximum length of an MS/TP segment is 1200 meters (4000 ft.) with AWG 18 cable. The use of greater distances and/or different wire gauges shall comply with the electrical specifications of EIA-485.
   3. The maximum number of nodes per segment shall be 32, as specified in the EIA 485 standard. Additional nodes may be accommodated by the use of repeaters.
   4. An MS/TP EIA-485 network shall have no T connections.
3.9 Fiber Optic Cable

A. During installation do not exceed maximum pulling tensions specified by cable manufacturer. Post-installation residual cable tension shall be within cable manufacturer's specifications.

B. Install cabling and associated components according to manufacturers' instructions. Do not exceed minimum cable and unjacketed fiber bend radii specified by cable manufacturer.

3.10 Installation of Sensors

A. Install sensors according to manufacturer's recommendations.

B. Mount sensors rigidly and adequately for operating environment.

C. Install room temperature sensors on concealed junction boxes properly supported by wall framing.

D. Air seal wires attached to sensors in their raceways or in the wall to prevent sensor readings from being affected by air transmitted from other areas.

E. Use averaging sensors in mixing plenums and hot and cold decks. Install averaging sensors in a serpentine manner vertically across duct. Support each bend with a capillary clip.

F. Install mixing plenum low-limit sensors in a serpentine manner horizontally across duct. Support each bend with a capillary clip. Provide 3 m (1 ft.) of sensing element for each 1 m² (1 ft²) of coil area.

G. Install pipe-mounted temperature sensors in wells. Install liquid temperature sensors with heat-conducting fluid in thermal wells.

H. Install outdoor air temperature sensors on north wall at designated location with sun shield.

I. Differential Air Static Pressure.
   1. Supply Duct Static Pressure. Pipe high-pressure tap to duct using a pitot tube. Make pressure tap connections according to manufacturer's recommendations.
   2. Return Duct Static Pressure. Pipe high-pressure tap to duct using a pitot tube. Make pressure tap connections according to manufacturer's recommendations.
   3. Building Static Pressure. Pipe pressure sensor's low-pressure port to the static pressure port located on the outside of the building through a high-volume accumulator. Pipe high-pressure port to a location behind a thermostat cover.
   4. Piping to pressure transducer pressure ports shall contain a capped test port adjacent to transducer.
   5. Pressure transducers, except those controlling VAV boxes, shall be located in control panels, not on monitored equipment or on ductwork. Mount transducers in a vibration-free location accessible for service without use of ladders or special equipment.

J. Smoke detectors, freezestats, high-pressure cut-offs, and other safety switches shall be hard-wired to de-energize equipment as described in the sequence of operation. Switches shall require manual reset. Provide contacts that allow DDC software to monitor safety switch status.

3.11 Flow Switch Installation

A. Use correct sensor for pipe diameter and application.

B. Adjust flow switch according to manufacturer's instructions.
3.12 Actuators

A. General. Mount actuators and adapters according to manufacturer’s recommendations.
B. Electric and Electronic Damper Actuators. Mount actuators directly on damper shaft or jackshaft unless shown as a linkage installation. Link actuators according to manufacturer’s recommendations.
   1. For low-leakage dampers with seals, mount actuator with a minimum 5° travel available for damper seal tightening.
   2. To compress seals when spring-return actuators are used on normally closed dampers, power actuators to approximately 5° open position, manually close the damper, and then tighten linkage.
   3. Check operation of damper-actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
   4. Provide necessary mounting hardware and linkages for actuator installation.
C. Valve Actuators. Connect actuators to valves with adapters approved by actuator manufacturer.

3.13 Warning Labels

A. Affix permanent warning labels to equipment that can be automatically started by the control system.
   1. Labels shall use white lettering (12-point type or larger) on a red background.
   2. Warning labels shall read as follows.

   CAUTION
   This equipment is operating under automatic control and may start or stop at any time without warning. Switch disconnect to "Off" position before servicing.

B. Affix permanent warning labels to motor starters and control panels that are connected to multiple power sources utilizing separate disconnects.
   1. Labels shall use white lettering (12-point type or larger) on a red background.
   2. Warning labels shall read as follows.

   CAUTION
   This equipment is fed from more than one power source with separate disconnects. Disconnect all power sources before servicing.

3.14 Identification of Hardware and Wiring

A. Label wiring and cabling, including that within factory-fabricated panels, with control system address or termination number at each end within 5 cm (2 in.) of termination.
B. Label pneumatic tubing at each end within 5 cm (2 in.) of termination with a descriptive identifier.
C. Permanently label or code each point of field terminal strips to show instrument or item served.
D. Label control panels with minimum 1 cm (½ in.) letters on laminated plastic nameplates.
E. Label each control component with a permanent label. Label plug-in components such that labels remain stationary during component replacement.
F. Label room sensors related to terminal boxes or valves with nameplates.
G. Manufacturers’ nameplates and UL or CSA labels shall be visible and legible after equipment is installed.
H. Label identifiers shall match record documents.

3.15 Programming

A. Naming Conventions. Name devices and points as shown in Appendix A of this specification.
B. Software Programming. Programming shall provide actions for each possible situation.
   1. Application Programming. Provide application programming that adheres to sequences of operation specified in Section 23.09.93. Program documentation or comment statements shall reflect language used in sequences of operation.
   2. System Programming. Provide system programming necessary for system operation.
C. Operator Interface.
   1. Graphics++. Provide graphics as specified in Section 23.09.23 Article 2.3 Paragraph E.2 (System Graphics) utilizing the Graphic Generation Tool (GGT). Show on each equipment graphic input and output points and relevant calculated points such as indicated on the applicable Points List in Section 23.09.93. Point information on graphics shall dynamically update.
   2. Install, initialize, start up, and troubleshoot operator interface software and functions (including operating system software, operator interface database, and third-party software installation and integration required for successful operator interface operation) as described in Section 23.09.23.

3.16 Control System Checkout and Testing

A. Startup Testing. Complete startup testing to verify operational control system before notifying Owner of system demonstration. Provide Owner with schedule for startup testing. Owner may have representative present during any or all startup testing.
   1. Calibrate and prepare for service each instrument, control, and accessory equipment furnished under Section 23.09.23.
   2. Verify that control wiring is properly connected and free of shorts and ground faults. Verify that terminations are tight.
   3. Enable control systems and verify each input device's calibration. Calibrate each device according to manufacturer's recommendations.
   4. Verify that binary output devices such as relays, solenoid valves, two-position actuators and control valves, and magnetic starters, operate properly and that normal positions are correct.
   5. Verify that analog output devices such as I/Ps and actuators are functional, that start and span are correct, and that direction and normal positions are correct. Check control valves and automatic dampers to ensure proper action and closure. Make necessary adjustments to valve stem and damper blade travel.
   6. Prepare a log documenting startup testing of each input and output device, with technician's initials certifying each device has been tested and calibrated.
   7. Verify that system operates according to sequences of operation. Simulate and observe each operational mode by overriding and varying inputs and schedules. Tune PID loops and each control routine that requires tuning.
   8. Alarms and Interlocks.
      a. Check each alarm with an appropriate signal at a value that will trip the alarm.
b. Trip interlocks using field contacts to check logic and to ensure that actuators fail in the proper direction.
c. Test interlock actions by simulating alarm conditions to check initiating value of variable and interlock action.

3.17 Control System Demonstration and Acceptance

A. Demonstration. Prior to acceptance, perform the following performance tests to demonstrate system operation and compliance with specification after and in addition to tests specified in Article 3.17 (Control System Checkout and Testing). Provide Engineer with log documenting completion of startup tests.

1. Engineer will be present to observe and review system demonstration. Notify Engineer at least 10 days before system demonstration begins.
2. Demonstration shall follow process submitted and approved under Section 23 09 23 Article 1.10 (Submittals). Complete approved checklists and forms for each system as part of system demonstration.
3. Demonstrate actual field operation of each sequence of operation as specified in Section 23 09 93. Provide at least two persons equipped with two-way communication. Demonstrate calibration and response of any input and output points requested by Engineer. Provide and operate test equipment required to prove proper system operation.
4. Demonstrate compliance with Section 23 09 23 Part 1 (System Performance).
5. Demonstrate compliance with sequences of operation through each operational mode.
6. Demonstrate complete operation of operator interface.
7. Demonstrate each of the following.
   a. DDC loop response. Supply graphical trend data output showing each DDC loop's response to a setpoint change representing an actuator position change of at least 25% of full range. Trend sampling rate shall be from 10 seconds to 3 minutes, depending on loop speed. Each sample's trend data shall show setpoint, actuator position, and controlled variable values. Engineer will require further tuning of each loop that displays unreasonably under- or over-damped control.
   b. Demand limiting. Supply trend data output showing demand-limiting algorithm action. Trend data shall document action sampled each minute over at least a 30-minute period and shall show building kW, demand-limiting setpoint, and status of setpoints and other affected equipment parameters.
   c. Building fire alarm system interface.
   d. Trend logs for each system. Trend data shall indicate setpoints, operating points, valve positions, and other data as specified in the points list provided with each sequence of operation in Section 23 09 93. Each log shall cover three 48-hour periods and shall have a sample frequency not less than 10 minutes or as specified on its points list. Logs shall be accessible through system's operator interface and shall be retrievable for use in other software programs as specified in Section 23 09 23 Article 2.3 Paragraph E.11 (Trend Configuration).

8. Tests that fail to demonstrate proper system operation shall be repeated after Contractor makes necessary repairs or revisions to hardware or software to successfully complete each test.

B. Acceptance.
   1. After tests described in this specification are performed to the satisfaction of both Engineer and Owner, Engineer will accept control system as meeting completion
requirements. Engineer may exempt tests from completion requirements that cannot be performed due to circumstances beyond Contractor's control. Engineer will provide written statement of each exempted test. Exempted tests shall be performed as part of warranty.

2. System shall not be accepted until completed demonstration forms and checklists are submitted and approved as required in Section 23 09 23 Article 1.10 (Submittals).

3.18 Cleaning

A. Each day clean up debris resulting from work. Remove packaging material as soon as its contents have been removed. Collect waste and place in designated location.
B. On completion of work in each area, clean work debris and equipment. Keep areas free from dust, dirt, and debris.
C. On completion of work, check equipment furnished under this section for paint damage. Repair damaged factory-finished paint to match adjacent areas. Replace deformed cabinets and enclosures with new material and repaint to match adjacent areas.

3.19 Training

A. Provide training for a designated staff of Owner's representatives. Training shall be provided via self-paced training, web-based or computer-based training, classroom training, or a combination of training methods.
B. Training shall enable students to accomplish the following objectives.
   1. Proficiently operate system
   2. Understand control system architecture and configuration
   3. Understand DDC system components
   4. Understand system operation, including DDC system control and optimizing routines (algorithms)
   5. Operate workstation and peripherals
   6. Log on and off system
   7. Access graphics, point reports, and logs
   8. Adjust and change system setpoints, time schedules, and holiday schedules
   9. Recognize common HVAC system malfunctions by observing system graphics, trend graphs, and other system tools
   10. Understand system drawings and Operation and Maintenance manual
   11. Understand job layout and location of control components
   12. Access data from DDC controllers
   13. Operate portable operator's terminals
   14. Create and change system graphics
   15. Create, delete, and modify alarms, including configuring alarm reactions
   16. Create, delete, and modify point trend logs (graphs) and multi-point trend graphs
   17. Configure and run reports
   18. Add, remove, and modify system's physical points
   19. Create, modify, and delete application programming
   20. Add operator interface stations
   21. Add a new controller to system
   22. Download firmware and advanced applications programming to a controller
   23. Configure and calibrate I/O points
   24. Maintain software and prepare backups
25. Interface with job-specific, third-party operator software
26. Add new users and understand password security procedures

C. Divide presentation of objectives into three sessions (1-13, 14-23, and 24-26). Participants will attend one or more of sessions, depending on knowledge level required.
   1. Day-to-day Operators (objectives 1-13)
   2. Advanced Operators (objectives 1-13 and 14-23)
   3. System Managers and Administrators (objectives 1-13 and 24-26)

D. Provide course outline and materials according to Section 23 09 23 Article 1.10 (Submittals). Provide one copy of training material per student.

E. Instructors shall be factory-trained and experienced in presenting this material.

F. Perform classroom training using a network of working controllers that are representative of installed hardware.
APPENDIX A – NAMING CONVENTIONS

1.1 Abbreviations

A - Alarm
AC - Air Conditioning
ACLG - Actual Cooling
ACU - Air Conditioning Unit
AHTG - Actual Heating
AHU - Air Handling Unit
AI - Analog Input
AO - Analog Output
APPRCH - Approach
AUTO - Automatic
AUX - Auxiliary

BI - Binary Input
BLDG - Building
BO - Binary Output
BSP - Building Static Pressure
BST - Booster
BYP - Bypass

C – Command
CAL - Calibration
CD-T = Cold Deck temperature
CHLR - Chiller
CHW - Chilled Water
CHWE – Chilled Water Entering
CHWL - Chilled Water Leaving
CHWP - Chilled Water Pump
CHWR - Chilled Water Return
CHWS - Chilled Water Supply
CLG - Cooling
COMP - Compressor
COND - Condenser
CRAC - Computer Room Air Conditioner
CT - Cooling Tower
CTF – Cooling Tower Fan
CTL - Control
CW - Condenser Water
CWP - Condenser Water Pump
CWR - Condenser Water Return
CWS - Condenser Water Supply
DA – Discharge Air
DA-T = Discharge Air Temperature
DA-P - Discharge Air Static Pressure
DB - Deadband
DPR – Damper
DP - Differential Pressure

EA - Exhaust Air
ECON - Economizer
EF - Exhaust Fan
EFFCLG – Effective Cooling
EFFHTG – Effective Heating
EFFOCC – Effective Occupancy
ENA - Enable
EVAP –Evaporator
EWT – Entering Water Temperature

FBD - Face/Bypass dampers
FCU - Fan Coil Unit
F - Flow
FLTR - Filter
FVAV - Fan Powered VAV Terminal Unit
FWD - Forward

GEN - Generator

HD-T = Hot Deck Temperature
HHP – High Head Pressure
HOA - Hand / Off / Auto
HP - Heat Pump
HRU - Heat Recovery Unit
HT – High Temperature
HTG – Heating
HUM - Humidifier
HW - Hot Water
HWP - Hot Water Pump
HWR - Hot Water Return
HWS - Hot Water Supply
HX - Heat Exchanger

ISO - Isolation

KWH - Kilowatt Hour

LSP – Low Suction Pressure
LVL – Level
LWT – Leaving Water Temperature

MA-T = Mixed Air Temperature
MAX - Maximum
MAXPOS - Maximum Position
MIN - Minimum
MINPOS - Minimum Position
MISC – Miscellaneous
MOT – Minimum On Time

NC - Normally Closed
NO - Normally Open

O - Output
OA - Outdoor Air
OAD - Outside Air Damper
OCCCLG - Occupied Cooling
OCCHTG - Occupied Heating
OL - Overload

P - Pressure
PB - Proportional Band
PCHW – Primary Chilled Water
PD – Pressure Differential
PIU - Powered Induction Unit

RA - Return Air
REV - Reverse
RF - Return Fan
RH - Relative Humidity
RLF - Relief Fan
RM – Room
RS - Reset
RTU - Roof-top Unit

S – Status
SA – Supply Air
SC – Short Cycle
SCHW – Secondary Chilled Water
SDWN - Shutdown
SF - Supply Fan
SMKDET – Smoke Detector
SP – Setpoint
SPD – Speed
SYS - System
T – Temperature  
TO – Thermal Overload  
TOCC – Temporary Occupancy  

UFSP – Under Floor Static Pressure  
UH - Unit Heater  
UNOCC - Unoccupied  
UPS - Uninterruptable Power Supply  
UV - Unit Ventilator  

VLV - Valve  
VAV - Variable Air Volume  
VFD - Variable Frequency (Speed) Drive  
VIB - Vibration  
VVTU - Variable Volume Terminal Unit  

W/ - with  
W/O - without  
W/C - Warm/Cool  
WB - Wet Bulb  
WSHP - Water Source Heat Pump  
WUF – Water Under Floor  

ZN - Zone  
ZN-H = Zone Humidity  
ZN-T = Zone Temperature
1.2 SITE LOCATION ABBREVIATIONS

16 – 16th Street Facility
27 – 27th Street Facility
CU – Credit Union Building
EV – East Valley Service Center
FT – Foothills Training Center
IS – Information Services Building
PA – Project Administration Building
PB – Papago Buttes Facility
PC – Pinal Customer Center
PO – Power Operations Building
SS – Southside Water Facility
TE – Tempe Service Center
WV – West Valley Service Center
XC – Crosscut Facility
1.3 Naming Conventions

SITE CONTROLLER NAMING:
   NAE## SITE NAME (LISTED IN OBJECT NAME)
   NOTE: The object description will contain site/application information
   
   EXAMPLE:
   NAE10 Tempe Service Center
   Object Description = “Tempe Service Center Bldg. 3”

TRUNK NAMES:
   MSTP-1 OR MSTP-2
   N2-1 OR N2-2

DEVICE NAMES:
   EXAMPLE: FCU’S
   2701FCU101 1-13N7E OFFICE
   27 (SITE NAME)
   01 (BLDG#)
   FCU101 (DEVICE OR SYSTEM NAME)
   1-13N7E (LOCATION COORDINATES)
   OFFICE (SPACE TYPE)

   NOTE: The device object description should include the asset Maximo number and the location coordinates (when applicable).

POINT NAMES:
   EXAMPLE:
   2701FCU101 1-13N7E OFFICE DA-T
   27 (SITE NAME)
   01 (BLDG#)
   FCU101 (DEVICE OR SYSTEM NAME)
   1-13N7E (LOCATION COORDINATES)
   OFFICE (SPACE TYPE)
   DA-T (DISCHARGE AIR TEMPERATURE)

   NOTE: The device object description should include the asset Maximo number and the location coordinates (when applicable).

Label and Set 10 minute trends, repository enabled on Analog Input, Output and Analog Data Points:
ZN-T, DA-T, SA-F, SA-F-SP, DMP-O, CLG-O, HTG-O, etc.

Label and Set COS trends, repository enabled on Binary Input, Output and Binary Data Points:
SF-C, SF-S, HTG1-C, HTG2-C, etc.
1.4 Typical Points Included by Equipment Type

This is a list of typical points to be included in the Metasys Facility Folders for various types of equipment. Please confirm these for each project with the Owner.

A. Terminal Unit, Variable Volume, Cooling Only

   ZN-T          Zone Temperature, deg F
   CLGOCC-SP    Cooling Occupied Temperature Setpoint, deg F
   SA-F          Supply Air Flow Rate, cfm
   SA-F-SP      Supply Air Flow Rate Setpoint, cfm
   CLG-MIN-F    Cooling Minimum Air Flow Rate, cfm
   CLG-MAX-F    Cooling Maximum Air Flow Rate, cfm
   DPR-O        Supply Air Damper Output, %
   CLG-O        Cooling Output, %

B. Terminal Unit, Variable Volume, Cooling & Heating

   ZN-T          Zone Temperature, deg F
   CLGOCC-SP    Cooling Occupied Temperature Setpoint, deg F
   HTGOSCC-SP   Heating Occupied Temperature Setpoint, deg F
   SA-F          Supply Air Flow Rate, cfm
   SA-F-SP      Supply Air Flow Rate Setpoint, cfm
   HTG-MIN-F    Heating Minimum Air Flow Rate, cfm
   CLG-MIN-F    Cooling Minimum Air Flow Rate, cfm
   CLG-MAX-F    Cooling Maximum Air Flow Rate, cfm
   DPR-O        Supply Air Damper Output, %
   CLG-O        Cooling Output, %
   DA-T          Discharge Air Temperature, deg F
   HTG-O         Heating Output, %
   HTG1-C        Heating Stage 1 Command, On/Off
   HTG2-C        Heating Stage 2 Command, On/Off

C. Terminal Unit, Fan Powered, Variable Volume, Cooling & Heating

   ZN-T          Zone Temperature, deg F
   CLGOCC-SP    Cooling Occupied Temperature Setpoint, deg F
   HTGOSCC-SP   Heating Occupied Temperature Setpoint, deg F
   SA-F          Supply Air Flow Rate, cfm
   SA-F-SP      Supply Air Flow Rate Setpoint, cfm
   HTG-MIN-F    Heating Minimum Air Flow Rate, cfm
   CLG-MIN-F    Cooling Minimum Air Flow Rate, cfm
   CLG-MAX-F    Cooling Maximum Air Flow Rate, cfm
   DPR-O        Damper Output, %
CLG-O  Cooling Output, %
DA-T  Discharge Air Temperature, deg F
SF-C  Supply Fan Command, On/Off
SF-S  Supply Fan Status, On/Off
HTG-O  Heating Output, %
HTG1-C  Heating Stage 1 Command, On/Off
HTG2-C  Heating Stage 2 Command, On/Off

D. Fan Coil Unit, Cooling Only

ZN-T  Zone Temperature, deg F
CLGOCC-SP  Cooling Occupied Temperature Setpoint, deg F
CLG-O  Cooling Output, %
DA-T  Discharge Air Temperature, deg F
SF-C  Supply Fan Command, On/Off
SF-S  Supply Fan Status, On/Off

E. Fan Coil Unit, Heating and Cooling

ZN-T  Zone Temperature, deg F
CLGOCC-SP  Cooling Occupied Temperature Setpoint, deg F
HTGOCC-SP  Heating Occupied Temperature Setpoint, deg F
CLG-O  Cooling Output, %
DA-T  Discharge Air Temperature, deg F
SF-C  Supply Fan Command, On/Off
SF-S  Supply Fan Status, On/Off
HTG-O  Heating Output, %

F. Computer Room Air Conditioning (CRAC) Unit

UNIT-S  Unit Status, On/Off
UNIT-A  Unit Alarm, On/Off
SMKDET-A  Smoke Detected, Normal/Alarm
WUF-A  Water Under Floor Alarm, Normal/Alarm
ZN-T  Zone Temperature, deg F
RA-T  Return Air Temperature, deg F
SF-O  Supply Fan Output, %
SF-S  Supply Fan Status, On/Off
CLG-O  Cooling Output, %
RH-SP  Relative Humidity Setpoint, %RH
RA-RH  Return Air Relative Humidity, %RH
HUM-O  Humidifier Output, %
COMP1-LSP  Compressor 1 Low Suction Pressure, Normal/Alarm
COMP1-HHP  Compressor 1 High Head Pressure, Normal/Alarm
COMP1-TO  Compressor 1 Thermal Overload
COMP1-PD  Compressor 1 Pump Down Issue
COMP1-SC  Compressor 1 Short Cycle (Compressors)
COMP2-LSP  Compressor 2 Low Suction Pressure, Normal/Alarm
COMP2-HHP  Compressor 2 High Head Pressure, Normal/Alarm
COMP2-TO  Compressor 2 Thermal Overload
COMP2-PD  Compressor 2 Pump Down Issue
COMP2-SC  Compressor 2 Short Cycle (Compressors)

G. Direct Expansion System, Cooling Only

SF-C  Fan Command, On/Off
SF-S  Fan Status, On/Off
ZN-T  Zone Temperature, deg F
CLG0CC-SP  Cooling Occupied Temperature Setpoint, deg F
CLG1-S  Cooling Stage 1 Status, On/Off
CLG2-S  Cooling Stage 2 Status, On/Off

H. Direct Expansion System, Cooling w/Electric Heat

SF-C  Fan Command, On/Off
SF-S  Fan Status, On/Off
ZN-T  Zone Temperature, deg F
CLG0CC-SP  Cooling Occupied Setpoint, deg F
HTG0CC-SP  Heating Occupied Setpoint, deg F
CLG1-S  Cooling Stage 1 Status, On/Off
CLG2-S  Cooling Stage 2 Status, On/Off
HTG1-S  Heating Stage 1 Status, On/Off
HTG2-S  Heating Stage 2 Status, On/Off

I. Direct Expansion System, Heat Pump

SF-C  Fan Command, On/Off
SF-S  Fan Status, On/Off
ZN-T  Zone Temperature, deg F
CLG0CC-SP  Cooling Occupied Setpoint, deg F
HTG0CC-SP  Heating Occupied Setpoint, deg F
CLG1-S  Cooling Stage 1 Status, On/Off
CLG2-S  Cooling Stage 2 Status, On/Off
HTG1-S  Heating Stage 1 Status, On/Off
HTG2-S  Heating Stage 2 Status, On/Off
### J. Air Handling Unit

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SF-C</td>
<td>Supply Fan Command, On/Off</td>
</tr>
<tr>
<td>SF-S</td>
<td>Supply Fan Status, On/Off</td>
</tr>
<tr>
<td>SF-SPD</td>
<td>Supply Fan Speed, %</td>
</tr>
<tr>
<td>RF-C</td>
<td>Return Fan Command, On/Off</td>
</tr>
<tr>
<td>RF-S</td>
<td>Return Fan Status, On/Off</td>
</tr>
<tr>
<td>RF-SPD</td>
<td>Return Fan Speed, %</td>
</tr>
<tr>
<td>DUCT-P-SP</td>
<td>Duct Static Pressure Setpoint, in. w.c.</td>
</tr>
<tr>
<td>DUCT-P</td>
<td>Duct Static Pressure, in. w.c.</td>
</tr>
<tr>
<td>DAT-SP</td>
<td>Discharge Air Temperature Setpoint, deg F</td>
</tr>
<tr>
<td>DA-T</td>
<td>Discharge Air Temperature, deg F</td>
</tr>
<tr>
<td>RA-T</td>
<td>Return Air Temperature, deg F</td>
</tr>
<tr>
<td>MA-T</td>
<td>Mixed Air Temperature, deg F</td>
</tr>
<tr>
<td>0SA-T</td>
<td>Outside Air Temperature, deg F</td>
</tr>
<tr>
<td>CLG-VLV-O</td>
<td>Cooling Valve Output, %</td>
</tr>
<tr>
<td>OA-DMP-SP</td>
<td>Outside Air Damper Setpoint, %</td>
</tr>
<tr>
<td>OA-DMP-O</td>
<td>Outside Air Damper Output, %</td>
</tr>
<tr>
<td>SA-F</td>
<td>Supply Air Flow Rate, cfm</td>
</tr>
<tr>
<td>RA-F</td>
<td>Return Air Flow Rate, cfm</td>
</tr>
<tr>
<td>SMKDETS-S</td>
<td>Duct Smoke Detector Status, On/Off</td>
</tr>
</tbody>
</table>

### K. Chiller, Air Cooled

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>UNIT-C</td>
<td>Chiller Command, On/Off</td>
</tr>
<tr>
<td>UNIT-S</td>
<td>Chiller Status, On/Off</td>
</tr>
<tr>
<td>Comp-S</td>
<td>Compressor Status, On/Off</td>
</tr>
<tr>
<td>ISOVLV-C</td>
<td>Chiller Isolation Valve Command</td>
</tr>
<tr>
<td>ISOVLV-S</td>
<td>Chiller Isolation Valve Status</td>
</tr>
<tr>
<td>CHWS-SP</td>
<td>CHWS Temperature Setpoint, deg F</td>
</tr>
<tr>
<td>CHWS-RS-LT-SP</td>
<td>CHWS Temperature Reset: Low OA Temperature, deg F</td>
</tr>
<tr>
<td>CHWS-RS-LT</td>
<td>CHWS Temperature@ Low OA Reset, deg F</td>
</tr>
<tr>
<td>CHWS-RS-HT-SP</td>
<td>CHWS Temperature Reset: High OA Temperature, deg F</td>
</tr>
<tr>
<td>CHWS-RS-HT</td>
<td>CHWS Temperature@ High OA Reset, deg F</td>
</tr>
<tr>
<td>SYS1SUCT-P</td>
<td>System 1 Suction Pressure</td>
</tr>
<tr>
<td>SYS1DIS-P</td>
<td>System 1 Discharge Pressure</td>
</tr>
<tr>
<td>SYS1RUNTIME</td>
<td>System 1 Runtime</td>
</tr>
<tr>
<td>SYS1COMP1-R</td>
<td>System 1 Compressor 1 Run</td>
</tr>
<tr>
<td>SYS1COMP2-R</td>
<td>System 1 Compressor 2 Run</td>
</tr>
<tr>
<td>SYS1LLSV</td>
<td>System 1 Liquid Line Solenoid Valve</td>
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<tr>
<td>SYS1HGBYPV</td>
<td>System 1 Hot Gas Bypass Valve</td>
</tr>
<tr>
<td>SYS1FAULT</td>
<td>System 1 Fault</td>
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<tr>
<td>SYS1ALARM</td>
<td>System 1 Alarm</td>
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<tr>
<td>HOA</td>
<td>Chiller HOA &amp; Reset Toggle after event</td>
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<td>Code</td>
<td>Description</td>
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<td>--------------------------------------------------</td>
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<tr>
<td>S-A</td>
<td>Chiller Status Alarm, On/Off</td>
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<tr>
<td>ISOVLV-A</td>
<td>Chiller Isolation Valve Alarm, On/Off</td>
</tr>
<tr>
<td>CHWS-T</td>
<td>Chiller CHW Supply Temperature, deg F</td>
</tr>
<tr>
<td>CHWR-T</td>
<td>Chiller CHW Return Temperature, deg F</td>
</tr>
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<td></td>
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</tr>
<tr>
<td>L. Chiller, Water Cooled</td>
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</tr>
<tr>
<td>UNIT-C</td>
<td>Chiller Command, On/Off</td>
</tr>
<tr>
<td>UNIT-S</td>
<td>Chiller Status, On/Off</td>
</tr>
<tr>
<td>Comp-S</td>
<td>Compressor Status, On/Off</td>
</tr>
<tr>
<td>ISOVLV-C</td>
<td>Chiller Isolation Valve Command</td>
</tr>
<tr>
<td>ISOVLV-S</td>
<td>Chiller Isolation Valve Status</td>
</tr>
<tr>
<td>CHWS-SP</td>
<td>CHWS Temperature Setpoint, deg F</td>
</tr>
<tr>
<td>CHWS-RS-LT-SP</td>
<td>CHWS Temperature Reset: Low OA Temperature, deg F</td>
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<tr>
<td>CHWS-RS-LT</td>
<td>CHWS Temperature@ Low OA Reset, deg F</td>
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<tr>
<td>CHWS-RS-HT-SP</td>
<td>CHWS Temperature Reset: High OA Temperature, deg F</td>
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<tr>
<td>CHWS-RS-HT</td>
<td>CHWS Temperature@ High OA Reset, deg F</td>
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<tr>
<td>PD-TIME</td>
<td>Pump-Down Time</td>
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<tr>
<td>HOA</td>
<td>Chiller Minimum On Time</td>
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<td>S-A</td>
<td>Chiller Status Alarm, On/Off</td>
</tr>
<tr>
<td>ISOVLV-A</td>
<td>Chiller Isolation Valve Alarm, On/Off</td>
</tr>
<tr>
<td>CHWS-T</td>
<td>Chiller CHW Supply Temperature, deg F</td>
</tr>
<tr>
<td>CHWR-T</td>
<td>Chiller CHW Return Temperature, deg F</td>
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<tr>
<td>CWR-T</td>
<td>Chiller CW Return Temperature, deg F</td>
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<td></td>
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<tr>
<td>M. Cooling Tower</td>
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</tr>
<tr>
<td>UNIT-C</td>
<td>Cooling Tower Command, On/Off</td>
</tr>
<tr>
<td>UNIT-S</td>
<td>Cooling Tower Status, On/Off</td>
</tr>
<tr>
<td>UNIT-O</td>
<td>Cooling Tower Output, %</td>
</tr>
<tr>
<td>CTF-SPD</td>
<td>Cooling Tower Fan Speed, %</td>
</tr>
<tr>
<td>APPRCH-T</td>
<td>Cooling Tower Approach Temperature, deg F</td>
</tr>
<tr>
<td>ISOVLV-C</td>
<td>Cooling Tower Isolation Valve Command</td>
</tr>
<tr>
<td>ISOVLV-S</td>
<td>Cooling Tower Isolation Valve Status</td>
</tr>
<tr>
<td>ISOVLV-A</td>
<td>Cooling Tower Isolation Valve Alarm, On/Off</td>
</tr>
<tr>
<td>EWT</td>
<td>Cooling Tower Entering Water Temperature, deg F</td>
</tr>
<tr>
<td>LWT</td>
<td>Cooling Tower Leaving Water Temperature, deg F</td>
</tr>
<tr>
<td>LWT-SP</td>
<td>CT Leaving Water Temperature Setpoint, deg F</td>
</tr>
<tr>
<td>BYPVVLV-0</td>
<td>Cooling Tower Bypass Valve Output, %</td>
</tr>
</tbody>
</table>
PART 1: GENERAL

1.1 VARIABLE AIR VOLUME - AHU (typical of 1)

Run Conditions - Continuous:
The unit shall run continuously.

Emergency Shutdown:
The unit shall shut down and generate an alarm upon receiving an emergency shutdown signal.

Freeze Protection:
The unit shall shut down and generate an alarm upon receiving a freezestat status.

High Static Shutdown:
The unit shall shut down and generate an alarm upon receiving an high static shutdown signal.

Supply Air Smoke Detection:
The unit shall shut down and generate an alarm upon receiving a supply air smoke detector status.

Supply Fan:
The supply fan shall run anytime the unit is commanded to run, unless shutdown on safeties. To prevent short cycling, the supply fan shall have a user definable (adj.) minimum runtime.

Alarms shall be provided as follows:

- Supply Fan Failure: Commanded on, but the status is off.
- Supply Fan in Hand: Commanded off, but the status is on.
- Supply Fan Runtime Exceeded: Status runtime exceeds a user definable limit (adj.).

Supply Air Duct Static Pressure Control:
The controller shall measure duct static pressure and shall modulate the supply fan VFD speed to maintain a duct static pressure setpoint of 1.5in H₂O (adj.). The supply fan VFD speed shall not drop below 30% (adj.).

Alarms shall be provided as follows:

- High Supply Air Static Pressure: If the supply air static pressure is 25% (adj.) greater than setpoint.
- Low Supply Air Static Pressure: If the supply air static pressure is 25% (adj.) less than setpoint.
- Supply Fan VFD Fault.

Return Fan:
The return fan shall run whenever the supply fan runs.

Alarms shall be provided as follows:

- Return Fan Failure: Commanded on, but the status is off.
- Return Fan in Hand: Commanded off, but the status is on.
- Return Fan Runtime Exceeded: Status runtime exceeds a user definable limit (adj.).
- Return Fan VFD Fault.

**Building Static Pressure Control:**
The controller shall measure building static pressure and modulate the return fan VFD speed to maintain a building static pressure setpoint of 0.05in H₂O (adj.). The return fan VFD speed shall not drop below 20% (adj.).

Alarms shall be provided as follows:

- High Building Static Pressure: If the building air static pressure is 25% (adj.) greater than setpoint.
- Low Building Static Pressure: If the building air static pressure is 25% (adj.) less than setpoint.

**Energy Recovery - Run-Around Loop Coils:**
The controller shall run the run-around loop pump and modulate the run-around loop mixing valve for energy recovery as follows.

**Cooling Recovery Mode:**
The run-around loop pump shall run continuously. The controller shall measure the run-around loop coil discharge air temperature (downstream of the outside air coil) and modulate the run-around loop mixing valve to maintain a setpoint 2°F (adj.) less than the unit supply air temperature setpoint. The run-around loop shall run for cool recovery whenever:

- Unit return air temperature is 5°F (adj.) or more below the outside air temperature.
- AND the unit is in a cooling mode.
- AND the economizer (if present) is off.
- AND the supply fan is on.

**Heating Recovery Mode:**
The run-around loop pump shall run continuously. The controller shall measure the run-around loop coil discharge air temperature (downstream of the outside air coil) and modulate the run-around loop mixing valve to maintain a setpoint 2°F (adj.) greater than the unit supply air temperature setpoint. The run-around loop shall run for heat recovery whenever:

- Unit return air temperature is 5°F (adj.) or more above the outside air temperature.
- AND the unit is in a heating mode.
- AND the economizer (if present) is off.
- AND the supply fan is on.

**Frost Protection:**
The run-around loop pump shall run and the run-around loop mixing valve shall close to 0% (adj.) in order to circulate water through the run-around loop exhaust air coil whenever:

- Run-around loop temperature drops below 33°F (adj.)
- OR the exhaust air temperature drops below 30°F (adj.).

Alarms shall be provided as follows:

- Run-Around Loop Pump Failure: Commanded on, but the status is off.
- Run-Around Loop Pump in Hand: Commanded off, but the status is on.
• Run-Around Loop Pump Runtime Exceeded: Status runtime exceeds a user definable limit (adj.).

**Supply Air Temperature Setpoint - Optimized:**
The controller shall monitor the supply air temperature and shall maintain a supply air temperature setpoint reset based on zone cooling and heating requirements.

The supply air temperature setpoint shall be reset for cooling based on zone cooling requirements as follows:

• The initial supply air temperature setpoint shall be 55°F (adj.).
• As cooling demand increases, the setpoint shall incrementally reset down to a minimum of 53°F (adj.).
• As cooling demand decreases, the setpoint shall incrementally reset up to a maximum of 72°F (adj.).

If more zones need heating than cooling, then the supply air temperature setpoint shall be reset for heating as follows:

• The initial supply air temperature setpoint shall be 82°F (adj.).
• As heating demand increases, the setpoint shall incrementally reset up to a maximum of 85°F (adj.).
• As heating demand decreases, the setpoint shall incrementally reset down to a minimum of 72°F (adj.).

**Cooling Coil Valve:**
The controller shall measure the supply air temperature and modulate the cooling coil valve to maintain its cooling setpoint.

The cooling shall be enabled whenever:

• Outside air temperature is greater than 60°F (adj.).
• AND the economizer (if present) is disabled or fully open.
• AND the supply fan status is on.
• AND the heating (if present) is not active.

The cooling coil valve shall open to 50% (adj.) whenever the freezestat (if present) is on.

Alarms shall be provided as follows:

• High Supply Air Temp: If the supply air temperature is 5°F (adj.) greater than setpoint.

**Heating Coil Valve:**
The controller shall measure the supply air temperature and modulate the heating coil valve to maintain its heating setpoint.

The heating shall be enabled whenever:

• Outside air temperature is less than 65°F (adj.).
• AND the supply fan status is on.
• AND the cooling (if present) is not active.
The heating coil valve shall open whenever:

- Supply air temperature drops from 40°F to 35°F (adj.).
- OR the freezestat (if present) is on.

Alarms shall be provided as follows:

- Low Supply Air Temp: If the supply air temperature is 5°F (adj.) less than setpoint.

**Economizer:**
The controller shall measure the mixed air temperature and modulate the economizer dampers in sequence to maintain a setpoint 2°F (adj.) less than the supply air temperature setpoint. The outside air dampers shall maintain a minimum adjustable position of 20% (adj.) open whenever occupied.

The economizer shall be enabled whenever:

- Outside air temperature is less than 65°F (adj.).
- AND the outside air temperature is less than the return air temperature.
- AND the supply fan status is on.

The economizer shall close whenever:

- Mixed air temperature drops from 40°F to 35°F (adj.).
- OR the freezestat (if present) is on.
- OR on loss of supply fan status.

The outside and exhaust air dampers shall close and the return air damper shall open when the unit is off. If Optimal Start Up is available the mixed air damper shall operate as described in the occupied mode except that the outside air damper shall modulate to fully closed.

**Minimum Outside Air Ventilation - Fixed Percentage:**
The outside air dampers shall maintain a minimum adjustable position during building occupied hours and be closed during unoccupied hours.

**Mixed Air Temperature:**
The controller shall monitor the mixed air temperature and use as required for economizer control (if present) or preheating control (if present).

Alarms shall be provided as follows:

- High Mixed Air Temp: If the mixed air temperature is greater than 90°F (adj.).
- Low Mixed Air Temp: If the mixed air temperature is less than 45°F (adj.).

**Return Air Temperature:**
The controller shall monitor the return air temperature and use as required for setpoint control or economizer control (if present).

Alarms shall be provided as follows:

- High Return Air Temp: If the return air temperature is greater than 90°F (adj.).
• Low Return Air Temp: If the return air temperature is less than 45°F (adj.).

Supply Air Temperature:
The controller shall monitor the supply air temperature.

Alarms shall be provided as follows:

• High Supply Air Temp: If the supply air temperature is greater than 120°F (adj.).
• Low Supply Air Temp: If the supply air temperature is less than 45°F (adj.).

<table>
<thead>
<tr>
<th>Point Name</th>
<th>Hardware Points</th>
<th>Software Points</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AI</td>
<td>AO</td>
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<tr>
<td>Supply Air Static Pressure</td>
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<td>Outside Air Temp</td>
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<tr>
<td>Exhaust Air Temp</td>
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<tr>
<td>Run-Around Loop Temp</td>
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<tr>
<td>Mixed Air Temp</td>
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<td>Building Static Pressure Setpoint</td>
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<td>High Building Static Pressure</td>
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<tr>
<td>Return Fan in Hand</td>
<td>×</td>
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</tr>
<tr>
<td>Return Fan Runtime Exceeded</td>
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<tr>
<td>Run-Around Loop Pump Failure</td>
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<tr>
<td>Low Supply Air Temp</td>
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**Totals**: 9 6 8 3 4 1 0 28 28 30

**Total Hardware**: (26)  
**Total Software**: (61)
## 1.2 POINT SUMMARY

<table>
<thead>
<tr>
<th>Equipment Name</th>
<th>Qty</th>
<th>Hardware Points</th>
<th>Software Points</th>
<th>Show On Graphic</th>
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<td></td>
<td></td>
<td>AI</td>
<td>AO</td>
<td>BI</td>
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<tr>
<td>Variable Air Volume - AHU (Typical of 1)</td>
<td>Each</td>
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<td>6</td>
<td>8</td>
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<td></td>
<td>Total (x1)</td>
<td>9</td>
<td>6</td>
<td>8</td>
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</table>

| Project Totals | 9  | 6  | 8  | 3  | 4  | 1  | 0    | 28    | 28    | 30      |

| Total Hardware | 26 |
| Total Software | 61 |
APPENDIX A: Glossary of Terms

Terms used within the Specification Text:

- **Advanced Application Controller (AAC):**
  
  A fully programmable control module. This control module may be capable of some of the advanced features found in Building Controllers (storing trends, initiating read and write requests, etc.) but it does not serve as a master controller. Advanced Application Controllers may reside on either the Ethernet/IP backbone or on a subnet.

- **Application Specific Controller (ASC):**

  A pre-programmed control module which is intended for use in a specific application. ASCs may be configurable, in that the user can choose between various pre-programmed options, but it does not support full custom programming. ASCs are often used on terminal equipment such as VAV boxes or fan coil units. In many vendors' architectures ASCs do not store trends or schedules but instead rely upon a Building Controller to provide those functions.

- **BACnet/IP:**

  An approved BACnet network type which uses an Ethernet carrier and IP addressing.

- **BACnet MS/TP:**

  An approved BACnet network type which uses a Master-Slave Token Passing configuration. MS/TP networks are unique to BACnet and utilize EIA485 twisted pair topology running at 9600 to 76,800 bps.

- **BACnet over ARCNET:**

  An approved BACnet network type which uses an ARCNET (attached resource computer network) carrier. ARCNET is an industry standard that can utilize several speeds and wiring standards. The most common configuration used by BACnet controllers is an EIA485 twisted pair topology running at 156,000 bps.

- **Building Controller (BC):**

  A fully programmable control module which is capable of storing trends and schedules, serving as a router to devices on a subnet, and initiating read and write requests to other controllers. Typically this controller is located on the Ethernet/IP backbone of the BAS. In many vendors' architectures a Building Controller will serve as a master controller, storing schedules and trends for controllers on a subnet underneath the Building Controller.

- **Direct Digital Control (DDC):**
A control system in which a digital computer or microprocessor is directly connected to the valves, dampers, and other actuators which control the system, as opposed to indirectly controlling a system by resetting setpoints on an analog pneumatic or electronic controller.

- **PICS - Protocol Implementation Conformance Statement:**
  
  A written document, created by the manufacturer of a device, which identifies the particular options specified by BACnet that are implemented in the device.

- **Smart Actuator (SA):**

  An actuator which is controlled by a network connection rather than a binary or analog signal. (0-10v, 4-20mA, relay, etc.)

- **Smart Sensor (SS):**

  A sensor which provides information to the BAS via network connection rather than a binary or analog signal. (0-10000 ohm, 4-20mA, dry contact, etc.)

- **Web services:**

  Web services are a standard method of exchanging data between computer systems using the XML (extensible markup language) and SOAP (simple object access protocol) standards. Web services can be used at any level within a Building Automation System (BAS), but most commonly they are used to transfer data between BAS using different protocols or between a BAS and a non-BAS system such as a tenant billing system or a utility management system.

**Terms used within the Sequences of Operation:**

- **adj.**

  Adjustable by the end user, through the supplied user interface.

- **AI, AO, etc. (Column Headings on Points List)**

  - **AI** = Analog Input. A physical input to the control module.
  
  - **AO** = Analog Output. A physical output from the control module.
  
  - **AV** = Analog Value. An intermediate (software) point that may be editable or read-only. Editable AVs are typically used to allow the user to set a fixed control parameter, such as a setpoint. Read Only AVs are typically used to display the status of a control operation.
  
  - **BI** = Binary Input. A physical input to the control module.
  
  - **BO** = Binary Output. A physical output from the control module.
  
  - **BV** = Binary Value. An intermediate (software) point that may be editable or read-only. Editable BVs are typically used to allow the user to set a fixed control parameter, such as a setpoint. Read Only BVs are typically used to display the status of a control operation.
  
  - **Sched** = Schedule. The control algorithm for this equipment shall include a user editable schedule.
  
  - **Trend**. The control system shall be configured to collect and display a trend log of this object. The trending interval shall be no less than one sample every 5 minutes. (Change of Value trending, where a sample is taken every time the value changes by more than a user-defined minimum, is an acceptable alternative.)
**Alarm.** The control system shall be configured to generate an alarm when this object exceeds user definable limits, as described in the Sequence of Controls.

**Note:** If the specifications require use of the BACnet protocol, all of the above shall be provided as BACnet objects.

- **KW Demand Limiting:** *

  An energy management strategy that reduces energy consumption when a system's electric power meter exceeds an operator-defined threshold.

  When power consumption exceeds defined levels, the system automatically adjust setpoints, de-energizes low priority equipment, and takes other pre-programmed actions to avoid peak demand charges. As the demand drops, the system restores loads in a predetermined manner.

- **Occupant Override Switch, or Timed Local Override:**

  A control option that allows building occupants to override the programmed HVAC schedule for a limited period of time.

  When the override time expires, the zone returns to its unoccupied state.

- **Occupant Setpoint Adjustment:**

  A control option that allows building occupants to adjust - within limits set by the HVAC control system - the heating and cooling setpoints of selected zones. Typically the user interface for this function is built into the zone sensor.

- **Optimal Start-Up:** *

  A control strategy that automatically starts an HVAC system at the latest possible time yet ensures comfort conditions by the time the building becomes occupied.

  In a typical implementation, a controller measures the temperature of the zone and the outside air. Then, using design heating or cooling capacity at the design outside air temperature, the system computes how long a unit must run at maximum capacity to bring the zone temperature to its occupied setpoint.

  The optimal start algorithm often includes a self-learning feature to adjust for variations from design capacity.

  A distributed system must use Run on Request with Optimal Start. (See below.)

- **Requested, or Run on Request:** *

  A control strategy that optimizes the runtime of a source piece of equipment that supplies one or more receiving units - such as an air handler unit supplying zone terminal units with heating, cooling, ventilation, or similar service. Source equipment runs only when needed, not on a fixed schedule.
The source equipment runs when one or more receiving units request its services. An operator determines how many requests are required to start the source equipment.

For example, if all the zones in a building are unoccupied and the zone terminal units do not need heating or cooling, the AHU will shut down. However, if a zone becomes occupied or needs cooling, the terminal unit will send a run request to the AHU to initiate the start-up sequence. If this AHU depends on a central chiller, it can send a run request to the chiller.

The run on request algorithm also allows an operator to schedule occupancy for individual zones based on the needs of the occupants without having to adjust the schedules of related AHUs and chillers.

- **Trim and Respond, or Setpoint Optimization:**

  A control strategy that optimizes the setpoint of a source piece of equipment that supplies one or more receiving units - such as an air handler unit supplying zone terminal units with heating, cooling, ventilation, or similar service.

  The source unit communicates with receiving units to determine heating, cooling, and other requirements, and then adjusts its setpoint.

  For example, if all zones are comfortable and do not request cooling, the AHU will gradually increase (trim) its supply air setpoint. When a zone requests cooling, the AHU responds by dropping its setpoint. The more zones that request cooling, the more it drops the setpoint. The AHU repeats this process throughout the day to keep zones cool, but with a supply air setpoint that is no cooler than necessary.
APPENDIX B: Abbreviations

The following abbreviations may be used in graphics, schematics, point names, and other UI applications where space is at a premium.

AC - Air Conditioning
ACU - Air Conditioning Unit
AHU - Air Handling Unit
AI - Analog Input
AO - Analog Output
AUTO - Automatic
AUX - Auxiliary
BI - Binary Input
BO - Binary Output
C - Common
CHW - Chilled Water
CHWP - Chilled Water Pump
CHWR - Chilled Water Return
CHWS - Chilled Water Supply
COND - Condenser
CW - Condenser Water
CWP - Condenser Water Pump
CWR - Condenser Water Return
CWS - Condenser Water Supply
DA - Discharge Air
EA - Exhaust Air
EF - Exhaust Fan
EVAP - Evaporators
FCU - Fan Coil Unit
HOA - Hand / Off / Auto
HP - Heat Pump
HRU - Heat Recovery Unit
HTEX - Heat Exchanger
HW - Hot Water
HWP - Hot Water Pump
HWR - Hot Water Return
HWS - Hot Water Supply
MAX - Maximum
MIN - Minimum
MISC - Miscellaneous
NC - Normally Closed
NO - Normally Open
OA - Outdoor Air
PIU - Powered Induction Unit
RA - Return Air
RF - Return Fan
RH - Relative Humidity
RTU - Roof-top Unit
SA - Supply Air
SF - Supply Fan
SP - Static Pressure
TEMP - Temperature
UH - Unit Heater
UV - Unit Ventilator
VAV - Variable Air Volume
VVTU - Variable Volume Terminal Unit
W/ - with
W/O - without
WSHP - Water Source Heat Pump
SECTION 231123 - FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pipes, tubes, and fittings.
   2. Piping specialties.
   3. Piping and tubing joining materials.
   4. Valves.
   5. Pressure regulators.

1.2 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:
   1. Piping and Valves: 100 psig minimum unless otherwise indicated.
   2. Service Regulators: 65 psig minimum unless otherwise indicated.

B. Natural-Gas System Pressure within Buildings: [0.5 psig or less] [More than 0.5 psig but not more than 2 psig].

C. Natural-Gas System Pressures within Buildings: Two pressure ranges. Primary pressure is more than 0.5 psig but not more than 2 psig, and is reduced to secondary pressure of 0.5 psig or less.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated provide materials of construction, pressure ratings, capacities, electrical requirements, and dimensions.

B. Operation and maintenance data.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.5 COORDINATION

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated.
   1. Notify Architect not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.

5. Steel Flanges and Flanged Fittings: ASME B16.5.
6. Gasket Material: Asbestos free, thickness, material, and type suitable for natural gas.
7. [Protective Coating for Underground Piping:]

a. Piping:
   1.) Manufacturer and Product: Subject to compliance with requirements, provide 3M Extrucoat or approved equal.
   2.) Coating: Factory applied, corrosion-resistant, minimum 2 mils thick, polyethylene coating for protection of steel piping in corrosive atmospheres or below ground.

b. Fittings and Joints:
   1.) Manufacturer and Product: Subject to compliance with requirements, provide Tyco Adhesives Polyken #1027 primer and #930-35 tape or approved equal.
   2.) Primer: Rubber adhesive primer.
   3.) Tape: Minimum 35 mils thick polyethylene tape with butyl adhesive on one side.

B. Corrugated, Stainless-Steel Tubing: Comply with ANSI/IAS LC 1.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. OmegaFlex, Inc.
   b. Parker Hannifin Corporation; Parflex Division.
   c. Titeflex.
   d. Tru-Flex Metal Hose Corp.

3. Coating: PE with flame retardant.

a. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1) Flame-Spread Index: 25 or less.
2) Smoke-Developed Index: 50 or less.

4. Fittings: Copper-alloy mechanical fittings with ends made to fit and listed for use with corrugated stainless-steel tubing and capable of metal-to-metal seal without gaskets. Include brazing socket or threaded ends complying with ASME B1.20.1.

5. Striker Plates: Steel, designed to protect tubing from penetrations.

6. Manifolds: Malleable iron or steel with factory-applied protective coating. Threaded connections shall comply with ASME B1.20.1 for pipe inlet and corrugated tubing outlets.

7. Operating-Pressure Rating: 5 psig.

C. PE Pipe: ASTM D 2513, SDR 11.

1. PE Fittings: ASTM D 2683, socket-fusion type or ASTM D 3261, butt-fusion type with dimensions matching PE pipe.

2. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D 2513, SDR 11; and steel pipe complying with ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.

   b. Casing: Steel pipe complying with ASTM A 53/A 53M, Schedule 40, black steel, Type E or S, Grade B, with corrosion-protective coating covering. Vent casing aboveground.
   c. Aboveground Portion: PE transition fitting.
   d. Outlet shall be threaded or suitable for welded connection.
   e. Tracer wire connection.
   f. Ultraviolet shield.
   g. Stake supports with factory finish to match steel pipe casing or carrier pipe.

2.2 PIPING SPECIALTIES

A. Appliance Flexible Connectors:


4. Corrugated stainless-steel tubing with polymer coating.

5. Operating-Pressure Rating: 0.5 psig.


B. Quick-Disconnect Devices: Comply with ANSI Z21.41.

1. Copper-alloy convenience outlet and matching plug connector.

2. Nitrile seals.

3. Hand operated with automatic shutoff when disconnected.

4. For indoor or outdoor applications.

5. Adjustable, retractable restraining cable.

C. Y-Pattern Strainers:
1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.

D. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.3 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.

2.4 MANUAL GAS SHUTOFF VALVES

A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.
B. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.

1. CWP Rating: 125 psig.
4. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
5. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.

C. General Requirements for Metallic Valves, NPS 2-1/2 (DN 50) and Larger: Comply with ASME B16.38.

1. CWP Rating: 125 psig.
2. Flanged Ends: Comply with ASME B16.5.
4. Service Mark: Valves shall have initials “WOG” permanently marked on valve body.

D. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. BrassCraft Manufacturing Company; a Masco company.

VER:12/07 FACILITY NATURAL-GAS PIPING
c. Lyall, R. W. & Company, Inc.
e. Perfection Corporation; a subsidiary of American Meter Company.

3. Ball: Chrome-plated bronze.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Threaded-body packnut design with adjustable-stem packing.
7. Ends: Threaded.
8. CWP Rating: 600 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

E. Bronze Plug Valves: MSS SP-78.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Lee Brass Company.

4. Ends: Threaded.
5. Operator: Square head or lug type with tamperproof feature where indicated.
6. Pressure Class: 125 psig.
7. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

F. Cast-Iron Lubricated Plug Valves: MSS SP-78.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Davis Valve.
   b. Hamestead Valve Div.
   d. Olson Technologies, Inc.

2. Body: Cast-iron, complying with ASTM A126-B.
3. Plug: Cast-iron, complying with ASTM A126-B.
5. Operator: Square head or lug type with tamperproof feature where indicated.
6. Pressure Class: 125 psig.

G. [PE Ball Valves: Comply with ASME B16.40.]
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Kerotest Manufacturing Corp.
   b. Lyall, R. W. & Company, Inc.
   c. Perfection Corporation; a subsidiary of American Meter Company.

2. Body: PE.
3. Ball: PE.
5. Seats and Seals: Nitrile.
6. Ends: Plain or fusible to match piping.
7. CWP Rating: 80 psig.
8. Operating Temperature: Minus 20 to plus 140 deg F.
9. Operator: Nut or flat head for key operation.
10. Include plastic valve extension.
11. Include tamperproof locking feature for valves where indicated on Drawings.

H. [Valve Boxes:]

1. Cast-iron, two-section box.
2. Top section with cover with "GAS" lettering.
3. Bottom section with base to fit over valve and barrel a minimum of 5 inches in diameter.
4. Adjustable cast-iron extensions of length required for depth of bury.
5. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head, and with stem of length required to operate valve.

2.5 MOTORIZED GAS VALVES

A. Electrically Operated Valves: Comply with UL 429.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ASCO Power Technologies, LP; Division of Emerson.
   b. Dungs, Karl, Inc.
   c. Eclipse Combustion, Inc.
   d. Goyen Valve Corp.; Tyco Environmental Systems.
   e. Magnatrol Valve Corporation.
   f. Parker Hannifin Corporation; Climate & Industrial Controls Group; Skinner Valve Div.
   g. Watts Regulator Co.; Division of Watts Water Technologies, Inc.

2. Pilot operated.
3. Body: Brass or aluminum.
5. Springs and Valve Trim: Stainless steel.
6. 120-V ac, 60 Hz, Class B, continuous-duty molded coil, and replaceable.
7. NEMA ICS 6, Type 4, coil enclosure.
2.6  [EARTHQUAKE VALVES]

A.  Earthquake Valves: Comply with ASCE 25.

1.  Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a.  Vanguard Valves, Inc.

2.  Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
3.  Maximum Operating Pressure: 5 psig.
5.  Nitrile-rubber valve washer.
7.  Threaded end connections complying with ASME B1.20.1.
8.  Wall mounting bracket with bubble level indicator.

B.  Earthquake Valves: Comply with ASCE 25.

1.  Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a.  Pacific Seismic Products, Inc.

2.  Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
3.  Maximum Operating Pressure: [0.5 psig] [7 psig] [60 psig].
4.  Cast-aluminum body with stainless-steel internal parts.
6.  Valve position, open or closed, indicator.
7.  Composition valve seat with clapper held by spring or magnet locking mechanism.
8.  Level indicator.

2.7  PRESSURE REGULATORS

A.  General Requirements:

1.  Single stage and suitable for natural gas.
2.  Steel jacket and corrosion-resistant components.
3.  Elevation compensator.


1.  Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a.  American Meter Company.
   b.  Fisher Control Valves and Regulators; Division of Emerson Process Management.
   c.  Invensys.
   d.  Maxitrol Company.
2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
10. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
11. Maximum Inlet Pressure: [2 psig] [5 psig] [10 psig].

C. Appliance Pressure Regulators: Comply with ANSI Z21.18.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Eaton Corporation; Controls Div.
   b. Harper Wyman Co.
   c. Maxitrol Company.
   d. SCP, Inc.

5. Seat Disc: Nitrile rubber.
8. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
9. Maximum Inlet Pressure: [1 psig] [2 psig] [5 psig].

2.8 LABELING AND IDENTIFYING

A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

PART 3 - EXECUTION

3.1 OUTDOOR PIPING INSTALLATION

B. Extend natural-gas piping to meter location.

1. Gas service piping from utility main to meter, including service pressure regulator and service meter will be provided by gas utility. Coordinate location and schedule with gas utility.

C. Install underground, natural-gas piping buried at least 18 inches below finished grade. Comply with requirements in Division 2 for excavating, trenching, and backfilling.

1. If natural-gas piping is installed less than 18 inches below finished grade, install it in containment conduit.

D. Install underground, PE, natural-gas piping according to ASTM D 2774.

E. [Steel Piping with Protective Coating:]

1. Field Applied Tape:
   a. Apply to all joints, fittings and other areas where the factory applied coating is missing or damaged.
   b. Apply to clean and dry surfaces.
   c. Apply adhesive primer prior to application of tape.
   d. Wrap tape with minimum 50 percent overlap.
   e. Extend tape a minimum of 4 inches over intact, factory-applied coating.

F. Install fittings for changes in direction and branch connections.

G. Install schedule 40 PVC pipe sleeve for pipe installed under paved walks or driveways, extend 18 inches beyond edge of paving.

H. Exterior-Wall Pipe Penetrations: Seal penetrations using steel or cast-iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals. See Division 15 Section “Common Work Results for Plumbing” for sleeve and mechanical sleeve seals.

3.2 INDOOR PIPING INSTALLATION


B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved.

C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.

D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
E. Install piping indicated at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

G. Locate valves for easy access.

H. Install natural-gas piping at uniform grade of 0.1 percent down toward drip and sediment traps.

I. Install piping free of sags and bends.

J. Install fittings for changes in direction and branch connections.

K. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 7 Section.

L. Verify final equipment locations for roughing-in.

M. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

N. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

O. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap or turned-down, reducing-elbow fittings with corrosion-resistant insect screen in large end.

P. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.

Q. [Install corrugated, stainless-steel tubing according to manufacturer’s written instructions. Include striker plates to protect tubing from puncture where tubing is restrained and cannot move.]

R. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

S. Connect branch piping from top or side of horizontal piping.

T. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required on flanged devices.

U. Install flanges on valves, specialties, and equipment having NPS 2-1/2 and larger connections.

V. Do not use natural-gas piping as grounding electrode.
W. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

X. Install pressure gage downstream from each line regulator. Pressure gages are specified in Division 15 Section "Meters and Gages for Plumbing Piping."

3.3 VALVE INSTALLATION

A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing.

B. [Install underground valves with valve boxes.]

C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

D. [Install earthquake valves aboveground outside buildings according to listing.]

3.4 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints:

1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:

2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

E. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.

1. Plain-End Pipe and Fittings: Use butt fusion.
2. Plain-End Pipe and Socket Fittings: Use socket fusion.
3.5 HANGER AND SUPPORT INSTALLATION

A. [Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 15 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."]

B. Comply with requirements for pipe hangers and supports specified in Division 15 Section "Hangers and Supports for Plumbing Piping and Equipment."

C. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, ½ inch.
5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.

D. Install hangers for horizontal, corrugated stainless-steel tubing with the following maximum spacing and minimum rod sizes:

1. NPS 3/8: Maximum span, 48 inches; minimum rod size, 3/8 inch.
2. NPS 1/2: Maximum span, 72 inches; minimum rod size, 3/8 inch.
3. NPS 3/4 and Larger: Maximum span, 96 inches; minimum rod size, 3/8 inch.

3.6 CONNECTIONS

A. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

B. Install piping adjacent to appliances to allow service and maintenance of appliances.

C. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

D. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.7 LABELING AND IDENTIFYING

A. Comply with requirements in Division 15 Section "Identification for Plumbing Piping and Equipment" for piping and valve identification.

B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.
3.8 FIELD QUALITY CONTROL

A. Test, inspect, and purge natural gas according to NFPA 54 and [the Arizona State Plumbing Code] [the International Fuel Gas Code] and authorities having jurisdiction.

B. Natural-gas piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.9 OUTDOOR PIPING SCHEDULE

A. Underground natural-gas piping shall be [one of] the following:
   1. PE pipe and fittings joined by heat fusion; service-line risers with tracer wire terminated in an accessible location.
   2. [Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.]

B. Aboveground natural-gas piping shall be one of the following:
   1. Steel pipe with malleable-iron fittings and threaded joints.
   2. Steel pipe with wrought-steel fittings and welded joints.

C. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

3.10 INDOOR PIPING SCHEDULE

A. Aboveground, branch piping NPS 1 and smaller shall be [one of] the following:
   1. [Corrugated stainless-steel tubing with mechanical fittings having socket or threaded ends to match adjacent piping.]
   2. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping shall be the following:
   1. NPS 3/4 through 1-1/2: Steel pipe with malleable-iron fittings and threaded joints.
   2. NPS 2 and Larger: Steel pipe with wrought-steel fittings and welded joints.

C. Underground, below building, piping shall be the following:
   1. NPS 3/4 through 1-1/2: Steel pipe with malleable-iron fittings and threaded joints.
   2. NPS 2 and Larger: Steel pipe with wrought-steel fittings and welded joints.

D. Containment Conduit: Schedule 40, steel pipe, minimum two pipe sizes larger than carrier pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping. Vent to exterior of building.

E. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.
3.11 [UNDERGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE]

A. Underground: PE valves.

3.12 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves at service meter shall be one of the following:

1. Pipe Sizes NPS 2 and Smaller:
   a. Two-piece, full-port, bronze ball valves with bronze trim.
   b. Bronze plug valve.

2. Pipe Sizes NPS 2-1/2 and Larger: Cast-iron lubricated plug valve.

B. Distribution piping valves shall be the following:

1. Pipe Sizes NPS 2 and Smaller:
   a. Two-piece, full-port, bronze ball valves with bronze trim.
   b. Bronze plug valve.

2. Pipe Sizes NPS 2-1/2 and Larger: Cast-iron lubricated plug valve.

C. Valves in branch piping for single appliance shall be one of the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.
2. Bronze plug valve.

END OF SECTION
SECTION 232113 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:

1. Hot-water heating piping.
2. Chilled-water piping.
3. Condenser-water piping.
4. Makeup-water piping.
5. Blowdown-drain piping.
6. Air-vent piping.
7. Safety-valve-inlet and -outlet piping.

B. See Section 232123 Section "Hydronic Pumps" for pumps, motors, and accessories for hydronic piping.

1.2 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:

1. Hot-Water Heating Piping: [125 psig] at 200 deg F.
2. Chilled-Water Piping: [125 psig] at 200 deg F.
3. Condenser-Water Piping: [125 psig] at 150 deg F.
4. Makeup-Water Piping: 80 psig at 150 deg F.
5. Blowdown-Drain Piping: 200 deg F.
6. Air-Vent Piping: 200 deg F.
7. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

1.3 SUBMITTALS

A. Product Data: For each type of the following:

1. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
2. Air control devices.
3. Hydronic specialties.
4. [Mechanical joint couplings.]

B. Operation and maintenance data.
1.4 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.

B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.

C. Wrought-Copper Fittings: ASME B16.22.

D. Wrought-Copper Unions: ASME B16.22.

2.2 STEEL PIPE AND FITTINGS

A. Steel Pipe:
   1. NPS 2 and Smaller: ASTM A 53, Type S (seamless), Grade B, Schedule 40, black steel [or hot-dip zinc coated], plain ends.
   2. NPS 2-1/2 through 12: ASTM A 53, Type E (electric-resistance welded), Grade B, Schedule 40, black steel [or hot-dip zinc coated], plain ends.
   3. NPS 4 and Larger: ASTM A 53, Type E (electric-resistance welded), Grade B, Standard Weight, black steel [or hot-dipped zinc coated], plain ends.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in Part 3 "Piping Applications" Article.


E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 125, and 250; raised ground face, and bolt holes spot faced as indicated in Part 3 "Piping Applications" Article.

F. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
   2. End Connections: Butt welding.
   3. Facings: Raised face.

G. Wrought Cast- and Forged-Steel Welding Fittings: ASME B16.9 or ASME B 16.11.
H. [Grooved Mechanical-Joint Fittings and Couplings:]

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Anvil International, Inc.
   b. S. P. Fittings; a division of Star Pipe Products.
   c. Victaulic Company of America.

2. Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47/A 47M, Grade 32510 malleable iron; ASTM A 53/A 53M, Type F, E, or S, Grade B fabricated steel; or ASTM A 106, Grade B steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

3. Couplings: Ductile- or malleable-iron housing and synthetic rubber gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

2.3 [STAINLESS STEEL PIPE AND FITTINGS]

A. Stainless Steel Pipe: ASTM A312, Type 304/304L full finish annealed, 0.049 inch wall, plain ends, certified for use with Vic-Press 304 piping system.

B. Stainless Steel Fittings:
   1. Manufacturer: Subject to compliance with requirements, provide products by Victaulic Company.
   2. Fittings: Precision cold drawn austenitic stainless steel with synthetic rubber O-rings.

2.4 PROTECTIVE COATING

A. Piping:
   1. Manufacturer and Product: Subject to compliance with requirements, provide 3M Extrucoat or approved equal.
   2. Coating: Factory applied, corrosion-resistant, minimum 2 mils thick, polyethylene coating for protection of steel piping in corrosive atmospheres or below ground.

B. Fittings and Joints:
   1. Manufacturer and Product: Subject to compliance with requirements, provide Tyco Adhesives Polyken #1027 primer and #930-35 tape or approved equal.
   2. Primer: Rubber adhesive primer.
   3. Tape: Minimum 35 mils thick polyethylene tape with butyl adhesive on one side.

2.5 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
   a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
   b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.


D. Brazing Filler Metals: AWS A5.8, BAg-1, silver alloy.

E. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.6 VALVES

A. Gate, Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 15 Section "General Duty Valves for HVAC Piping."

B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Division 22 Section "Instrumentation and Controls for HVAC."

C. Bronze, Calibrated, Balancing Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Anvil International, Inc.
      b. Armstrong Pumps, Inc.
      c. Bell & Gossett Domestic Pump; a division of ITT Industries.
      d. Gerard Engineering Co.
      e. Griswold Controls.
      f. Tour & Andersson; available through Victaulic Company of America
   2. Body: Bronze, ball or plug type with calibrated orifice or venturi.
   3. Ball: Brass or stainless steel.
   4. Plug: Resin.
   5. Seat: PTFE.
   6. End Connections: Threaded or socket.
   8. Handle Style: Lever, with memory stop to retain set position.
  10. Maximum Operating Temperature: 250 deg F.

D. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Anvil International, Inc.
b. Armstrong Pumps, Inc.
c. Bell & Gossett Domestic Pump; a division of ITT Industries.
d. Flow Design Inc.
e. Gerand Engineering Co.
f. Griswold Controls.
g. MEPCO (Marshall Engineering Products Co.)
h. Taco.

2. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
5. Disc: Glass and carbon-filled PTFE.
6. Seat: PTFE.
7. End Connections: Flanged or grooved.
9. Handle Style: Lever, with memory stop to retain set position.
11. Maximum Operating Temperature: 250 deg F.

E. Diaphragm-Operated, Pressure-Reducing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Amtrol, Inc.
   b. Armstrong Pumps, Inc.
   c. Bell & Gossett Domestic Pump; a division of ITT Industries.
   d. Conbraco Industries, Inc.
   e. Fisher Controls, Inc.
   f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Body: Bronze or brass.
3. Disc: Glass and carbon-filled PTFE.
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.
7. Low inlet-pressure check valve.
8. Inlet Strainer: Stainless steel, removable without system shutdown.
10. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

F. Diaphragm-Operated Safety Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Amtrol, Inc.
   b. Armstrong Pumps, Inc.
   c. Bell & Gossett Domestic Pump; a division of ITT Industries.
   d. Conbraco Industries, Inc.
   e. Fisher Controls, Inc.
   f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Body: Bronze or brass.
3. Disc: Glass and carbon-filled PTFE.
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.
8. Inlet Strainer: Stainless steel, removable without system shutdown.
10. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

G. Automatic Flow-Control Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Flow Design Inc.
   b. Griswold Controls.

2. Body: Brass or ferrous metal.
3. Piston and Spring Assembly: Stainless steel, tamper proof, self cleaning, and removable.
5. Identification Tag: Marked with valve number, and flow rate.
6. Size: Same as pipe in which installed.
7. Performance: Maintain constant flow, plus or minus 5 percent over an operating pressure differential range of at least 14 times the minimum required for control.
9. Maximum Operating Temperature: 250 deg F.

2.7 AIR CONTROL DEVICES

A. Manual Air Vents:

1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. Operator: Screwdriver or thumbscrew.
4. Inlet Connection: NPS 1/2.
7. Maximum Operating Temperature: 225 deg F.

B. Automatic Air Vent:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armstrong Pumps, Inc.
   b. Bell & Gossett Domestic Pump; a division of ITT Industries.
   c. Empire.
   d. Hoffman.
   e. Spirax Sarco.
f. Taco.

2. Body: Bronze.
3. Internal Parts: Nonferrous.
5. Inlet Connection: NPS 1/2
6. Discharge Connection: NPS 1/4
7. CWP Rating: 150 psig.
8. Maximum Operating Temperature: 240 degrees F.

C. Bladder Expansion Tanks:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armstrong Pumps, Inc.
   b. Bell & Gossett ITT; Div. of ITT Fluid Technology Corp.
   c. John Wood Company.

2. Tank: Welded carbon steel, rated for 125-psig working pressure and 240 degrees F maximum operating temperature, with taps in top of tank for system connection and tank charging, and tap in bottom of tank for draining. Tank shall be fitted with lifting rings. Provide a floor mounting skirt for vertical installations. Tanks shall be factory tested with taps fabricated and labeled according to the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.


D. Centrifugal Air Separator:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armstrong Pumps, Inc.
   b. Bell & Gossett ITT; Div. of ITT Fluid Technology Corp.
   c. Spirax Sarco, Inc.
   d. Spirotherm, Inc.

2. Separator: Cast-iron or steel body with tangential connections, perforated stainless steel air collector tube. Body diameter shall be not less than three times the nominal inlet/outlet pipe diameter with a body volume for sufficient velocity reduction. Maximum working pressure of 125 psig and temperature of 250 degrees F. Air separator shall be fabricated and labeled according to ASME Boiler and Pressure Vessel Code Section VIII, Division 1.

E. In-Line Air Separators:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Amtrol, Inc.
   b. Armstrong Pumps, Inc.
   c. Bell & Gossett Domestic Pump; a division of ITT Industries.
d. Taco.

2. Tank: One-piece cast iron with an integral weir constructed to decelerate system flow to maximize air separation.


4. Maximum Operating Temperature: Up to 300 deg F.

2.8 HYDRONIC PIPING SPECIALTIES

A. Bypass Chemical Feeder: Welded steel construction; 125-psig working pressure; 5-gal. capacity; with fill funnel and inlet, outlet, and drain valves.

B. Y-Pattern Strainers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Armstrong Pumps, Inc.
   b. Bell & Gossett ITT; Div. of ITT Fluid Technology Corp.
   c. Griswold Controls.
   d. Guvlok.
   e. Mueller Steam Specialty.
   f. Spirax Sarco Inc.

2. Body: ASTM A 126, Class B, cast iron, or ASTM A 395, Grade 64-45-15 or ASTM A536, Grade 64-45-12 ductile iron, with bolted cover and bottom drain connection for NPS 2-1/2 and larger. Bronze body with threaded cover and bottom drain connection for NPS 2 and smaller.

3. End Connections: Threaded ends for NPS 2 and smaller; flanged [or grooved] ends for NPS 2-1/2 and larger.

4. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.

5. CWP Rating: 125 psig.

C. Stainless-Steel Bellow, Flexible Connectors:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Flex-Hose Co., Inc.
   b. Flexonics.
   c. Metraflex.
   d. Twin City Hose.


3. End Connections: Threaded or flanged to match equipment connected.


5. CWP Rating: 150 psig.

6. Maximum Operating Temperature: 250 deg F.

D. Flexible Pump Connectors:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Mason Industries.
   b. Metraflex Co.
   c. Proco Products, Inc.
   d. Vibration Mountings & Controls, Inc.

2. Body: Flexible, single- or double-sphere of EPDM liner and cover, Kevlar tire cord fractioning with steel ring embedded in raised face of rubber-flanged end. Provide ductile iron, external ring between double-spheres.

3. End Connections: Split ductile-iron or steel flanges with hooked interlocks.

4. Control Rods: Required where recommended by manufacturer or indicated on Drawings.

5. CWP Rating: 150 psig.

6. Maximum Operating Temperature: 250 degrees F.

E. Expansion fittings are specified in Division 15 Section "Expansion Fittings and Loops for HVAC Piping."

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Hot-water heating piping, aboveground, [NPS 2 and smaller,] shall be any of the following:
   1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or brazed joints.
   2. Schedule 40 steel pipe; Class 125, cast-iron or Class 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints.
   3. [Schedule 40 steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.]
   4. [Stainless steel pipe, Vic-Press 304 fittings and couplings subject to gasket suitability.]

B. Hot-water heating piping, aboveground, [NPS 2-1/2 and larger,] shall be any of the following:
   1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or brazed joints.
   2. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
   3. [Schedule 40 steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.]

C. Chilled-water piping, aboveground, NPS 2 and smaller, shall be any of the following:
   1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or brazed joints.
   2. Schedule 40 steel pipe; Class 125, cast-iron or Class 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints.
   3. [Schedule 40 steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.]
4. [Stainless steel pipe, Vic-Press 304 fittings and couplings subject to gasket suitability.]

D. Chilled-water piping, aboveground, NPS 2-1/2 and larger, shall be any of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or brazed joints.
2. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
3. [Schedule 40 steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.]

E. [Condenser-][System-]Water piping, aboveground, NPS 2 and smaller, shall be any of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or brazed joints.
2. Schedule 40 steel pipe; Class 125, cast-iron or Class 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints.
3. [Schedule 40 steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.]
4. [Stainless steel pipe, Vic-Press 304 fittings and couplings subject to gasket suitability.]
5. [Steel pipe and fittings installed outside shall be galvanized.]

F. [Condenser-][System-]Water piping, aboveground, NPS 2-1/2 and larger, shall be any of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or brazed joints.
2. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
3. [Schedule 40 steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.]
4. [Steel pipe and fittings installed outside shall be galvanized.]

G. [Condenser-][System-]Water Piping below ground and within slabs, NPS 2 and smaller shall be any of the following:

1. Type K, annealed-temper copper tubing, wrought-copper fittings, and brazed joints. Use fewest joints possible.
2. Schedule 40 steel pipe; Class 125, cast-iron or Class 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints.
3. Steel pipe and fittings installed belowground shall have protective coating as specified in “Protective Coating” Article in Part 2.

H. [Condenser-][System-]Water Piping below ground and within slabs, NPS 2 and smaller shall be any of the following:

1. Type K, annealed-temper copper tubing, wrought-copper fittings, and brazed joints. Use fewest joints possible.
2. Schedule 40 steel pipe; Class 125, cast-iron or Class 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints.
3. Steel pipe and fittings installed belowground shall have protective coating as specified in “Protective Coating” Article in Part 2.

I. Makeup-water piping installed aboveground shall be the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or brazed joints.

J. Makeup-Water Piping Installed Belowground and within Slabs:  Type K, annealed-temper copper tubing, wrought-copper fittings, and soldered joints. Use the fewest possible joints.

K. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.

L. Air-Vent Piping:

1. Inlet: Same as service where installed.
2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.

M. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed.

3.2 VALVE APPLICATIONS

A. Install shutoff-duty valves at each branch connection to supply and return mains, and at supply connection to each piece of equipment.

B. Install calibrated balancing valves in the return pipe of each heating or cooling terminal and elsewhere as required to facilitate system balancing.

C. Install check valves at each pump discharge and elsewhere as required to control flow direction.

D. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install safety-valve discharge pipe without valves to nearest floor sink or floor drain, or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

E. Install pressure-reducing valves at makeup- and fill-water connection to regulate system pressure.

3.3 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
C. Install piping at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit servicing of valves and specialties.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Select system components with pressure rating equal to or greater than system operating pressure.

K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

N. Reduce pipe sizes using concentric reducer fittings. Exception: Use eccentric reducer fitting installed with level side up on condenser water pump suction piping.

O. Make branch connections to mains using flow tees where branch size is not less than 1/3 the diameter of the main. Weld-O-Lets and Thread-O-Lets, may be used in other applications. Hot-taps shall only be used to connect branch lines to live mains.

P. Unless otherwise indicated, install branch connections to mains with the branch connected to the top or side of the main pipe.

Q. Install valves according to Division 15 Section "General-Duty Valves for HVAC Piping."

R. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated. [Unions may be omitted in piping systems with mechanical joints.]

S. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated. [Flanges may be omitted in piping systems with mechanical joints.]

T. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2. Select mesh opening size based on item being protected.

U. Install expansion loops, expansion joints, anchors, and pipe alignment guides as specified in Division 15 Section "Pipe Expansion Fittings and Loops for HVAC Piping."
V. Provide concrete thrust blocks at all changes in direction, dead ends, reducers and valves in underground piping.

W. Identify piping as specified in Division 15 Section "Identification for HVAC Piping and Equipment."

3.4 HANGERS AND SUPPORTS

A. Hanger, support, and anchor devices are specified in Division 15 Section "Hangers and Supports for HVAC Piping and Equipment." Comply with the following requirements for maximum spacing of supports.

B. Seismic restraints are specified in Division 15 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

C. Vibration control devices are specified in Division 15 Section "Vibration Controls for HVAC Piping and Equipment."

D. Install the following pipe attachments:
   1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
   2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
   3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
   4. Spring hangers to support horizontal piping adjacent to the top and bottom of vertical runs.
   5. Provide spring hangers on the first three hangers adjacent to spring-isolated, rotating equipment.

E. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
   1. NPS 3/4: Maximum span, 7 feet; minimum rod size, 1/4 inch.
   2. NPS 1: Maximum span, 7 feet; minimum rod size, 1/4 inch.
   3. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
   4. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
   5. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 3/8 inch.
   6. NPS 3: Maximum span, 12 feet; minimum rod size, 3/8 inch.
   7. NPS 4: Maximum span, 14 feet; minimum rod size, 1/2 inch.
   8. NPS 6: Maximum span, 17 feet; minimum rod size, 1/2 inch.
   9. NPS 8: Maximum span, 19 feet; minimum rod size 5/8 inch.
   10. NPS 10: Maximum span, 20 feet; minimum rod size, 3/4 inch.
   11. NPS 12: Maximum span, 23 feet; minimum rod size, 7/8 inch.
   12. NPS 14 thru 16: Maximum span, 25 feet; minimum rod size, 1 inch.
   13. NPS 18 thru 20: Maximum span, 28 feet; minimum rod size, 1-1/4 inch.

F. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:
   1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
   2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
   3. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
4. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
5. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
6. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.
7. NPS 4: Maximum span, 12 feet; minimum rod size, 1/2 inch.
8. NPS 6: Maximum span, 14 feet; minimum rod size, 1/2 inch.

G. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.5 PIPE JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 15 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.


F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

H. [Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness.]
   1. [Use grooved-end fittings and rigid, grooved-end-pipe couplings in all locations.]

I. [Vic-Press 304 Joints: Construct and install in strict conformance with manufacturer's written recommendations.]

3.6 [PROTECTIVE COATING]

A. Field Applied Tape.
1. Apply to all joints, fittings and other areas where the factory applied coating is missing or damaged.
2. Apply to clean and dry surfaces.
3. Apply adhesive primer prior to application of tape.
4. Wrap tape with minimum 50 percent overlap.
5. Extend tape a minimum of 4 inches over intact, factory-applied coating.

3.7 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

B. Install automatic air vents in mechanical equipment rooms at high points of system piping, at heat transfer coils, at the air outlet on the air separator, and elsewhere as required for system air venting.
   1. Provide shutoff valve on inlet side of each automatic air vent.
   2. Provide drain piping from each automatic air vent outlet to nearest floor sink, mop sink or floor drain.

C. Install piping from [boiler air outlet,] air separator, or air purger to expansion tank with a 2 percent upward slope toward air vent.

D. Install in-line air separators in pump suction NPS 1-1/2 and smaller and centrifugal air separators in NPS 2 through NPS 24. Install drain valve on air separators NPS 2 and larger.

E. Install bypass chemical feeders in each hydronic system where indicated, in upright position with top of funnel not more than 48 inches above the floor. Install feeder where indicated on Drawings, using full port ball valve on inlet and outlet. Install NPS 3/4 pipe from chemical feeder drain, to nearest equipment drain and include a full-size, full-port, ball valve.

F. Install expansion tanks where indicated on Drawings.
   1. Charge tank to initial fill pressure.
   2. Support tank from floor or structure above with sufficient strength to carry weight of tank, piping connections, fittings, plus tank full of water. Do not overload building components and structural members.

3.8 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install ports for pressure gages and thermometers at coil inlet and outlet connections according to Division 15 Section "Meters and Gages for HVAC Piping."

D. Install flexible connectors at the inlet and outlet of all moving equipment, except pumps. Match size of adjacent pipe.
E. Install flexible pump connectors at the inlet and outlet of all pumps, except in-line pumps. Match size of adjacent pipe.

3.9 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:

2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.
3.10 CLEANING

A. Clean interior of piping systems using chemicals supplied by HVAC Water Treatment Contractor. Circulate chemicals as directed to remove oils, dirt, and other compounds detrimental to the proper operation of the system.

B. Flush hydronic piping systems with clean water. Remove and clean or replace strainer screens. After cleaning and flushing hydronic piping systems, but before balancing, remove disposable fine-mesh start-up strainers in pump suction diffusers and replace with permanent strainer.

END OF SECTION
SECTION 232123 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 SUMMARY
A. This Section includes the following:
   1. In-line circulators.
   2. In-line pumps.
   3. Close-coupled, end-suction pumps.
   4. Pump accessories.

1.2 SUBMITTALS
A. Product Data: Include pump dimensions, weights, certified performance curves and rated capacities; furnished specialties; final impeller dimensions; and accessories for each pump indicated. Indicate pump’s operating point on curves.
B. Operation and maintenance data.

1.3 QUALITY ASSURANCE
A. UL Compliance: Fabricate and label pumps to comply with UL 778, "Motor-Operated Water Pumps," for construction requirements.
B. Regulatory Requirements: Fabricate and test steam condensate pumps to comply with HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation," and HI 1.6, "Centrifugal Pump Tests."
C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 GENERAL PUMP REQUIREMENTS
A. Pump Units: Factory assembled and tested.
B. Motors: Include built-in, thermal-overload protection on single phase motors and grease-lubricated ball bearings on all motors. Select each motor to be nonoverloading over full range of pump performance curve. See Division 15 Section "Common Motor Requirements for HVAC Equipment" for general motor requirements.

2.3 IN-LINE CIRCULATORS

A. Horizontal, in-line, centrifugal, single-stage, radially split case design; rated for 125-psig minimum working pressure and a continuous water temperature of 225 degrees F.

1. Manufacturers:

   a. Amtral, Inc.
   b. Armstrong Pumps, Inc.
   c. Bell & Gossett ITT; Div. of ITT Fluid Technology Corp.
   d. Burks Pumps, Inc.; Div. of Crane Pumps & Systems, Inc.
   e. Grundfos Pumps Corp.
   f. MEPCO (Marshall Engineering Products Co.).
   g. Taco; Fabricated Products Div.

2. Casing: Bronze, with threaded companion flanges or unions for piping connections, and threaded gage tappings at inlet and outlet connections.


4. Shaft and Sleeve: Steel shaft with oil-lubricated copper sleeve.

5. Seals: Mechanical type, carbon-steel rotating ring, stainless-steel spring, ceramic seat, and flexible bellows and gasket.


7. Motor Bearings: Oil-lubricated, sleeve type, or permanently lubricated ball bearings.

8. Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.


2.4 COMPACT IN-LINE CIRCULATORS

A. Cartridge type, horizontal, in-line, compact, seal-less, centrifugal, and single stage. Include pump and motor assembled on a common shaft in cartridge-type, hermetically sealed unit, without stuffing boxes or mechanical seals. Include isolation of motor section from motor-stator windings by corrosion-resistant, nonmagnetic, alloy liner. Include design rated for 125-psig minimum working pressure and a continuous water temperature of 225 degrees F.

1. Manufacturers:

   a. Amtral, Inc.
   b. Armstrong Pumps, Inc.
   c. Bell & Gossett ITT; Div. of ITT Fluid Technology Corp.
   d. Grundfos Pumps Corp.
   e. PACO Pumps.
   f. Taco; Fabricated Products Div.

2. Casing: Lead-free cast bronze, with stainless-steel liner, static O-ring seal to separate motor section from motor stator, and flanged piping connections.
3. Impeller: Overhung, single suction, closed or open, nonmetallic.

2.5 IN-LINE PUMPS

A. Centrifugal, flexible-coupled or close-coupled, single-stage, radially split case design suitable for horizontal or vertical-mounting as indicated on Drawings. Pump shall be bronze-fitted design with mechanical seals rated for 175-psig minimum working pressure and a continuous water temperature of 225 degrees F.

1. Manufacturers:
   b. Amtrol, Inc.
   c. Armstrong Pumps, Inc.
   d. Bell & Gossett ITT; Div. of ITT Fluid Technology Corp.
   e. Burks Pumps, Inc.; Div. of Crane Pumps & Systems, Inc.
   f. Goulds Pumps, Inc.
   g. Grundfos Pumps Corp.
   h. MEPCO (Marshall Engineering Products Co.).
   i. PACO Pumps.
   j. Peerless Pump Co.
   k. Taco; Fabricated Products Div.

2. Casing: Cast iron, with threaded companion flanges for piping connections NPS 2 inches and smaller, and Class 125 flanges NPS 2-1/2 inches and larger, drain plug at low point of volute, and threaded gage tappings at inlet and outlet connections.
3. Impeller: ASTM B 584, cast bronze, statically and dynamically balanced, closed, overhung, single suction, and keyed to shaft.
4. Shaft and Sleeve: Ground and polished stainless-steel shaft with bronze sleeve.
5. Seals: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and flexible bellows and gasket.
6. Motor: Directly mounted to pump casing. Vertical pumps shall have lifting and supporting lugs in top of motor enclosure.

2.6 CLOSE-COUPLLED, END-SUCTION PUMPS

A. Centrifugal, close-coupled, end-suction, single-stage, bronze-fitted, back-pull-out, radially split case design; rated for 175-psig minimum working pressure and a continuous water temperature of 225 degrees F.

1. Manufacturers:
   b. Amtrol, Inc.
   c. Armstrong Pumps, Inc.
   d. Bell & Gossett ITT; Div. of ITT Fluid Technology Corp.
   e. Burks Pumps, Inc.; Div. of Crane Pumps & Systems, Inc.
   f. Goulds Pumps, Inc.
   g. MEPCO (Marshall Engineering Products Co.).
2. Casing: Cast iron, with threaded or flanged piping connections, drain plug at low point of volute, and threaded gage tappings at inlet and outlet connections.

3. Impeller: ASTM B 584, cast bronze, statically and dynamically balanced, closed, overhung, single suction, keyed to shaft, and secured by locking cap screw.

4. Shaft: Stainless-steel shaft, or carbon steel shaft with copper alloy shaft sleeve, close coupled to motor shaft.

5. Seals: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and flexible bellows and gasket.

6. Motor: Directly mounted to pump casing and with supporting legs as integral part of motor enclosure.

2.7 BASE-MOUNTED, FLEXIBLE-COUpled, END-SUCTION PUMPS

A. Centrifugal, base-mounted, flexible-coupled, end-suction, single-stage, bronze-fitted, back-pull-out, radially split case design; rated for 175-psig minimum working pressure and a continuous water temperature of 225 degrees F.

1. Manufacturers:
   b. Amtrol, Inc.
   c. Armstrong Pumps, Inc.
   d. Bell & Gossett ITT; Div. of ITT Fluid Technology Corp.
   e. Burks Pumps, Inc.; Div. of Crane Pumps & Systems, Inc.
   f. Goulds Pumps, Inc.
   g. MEPCO (Marshall Engineering Products Co.).
   h. PACO Pumps.
   i. Peerless Pump Co.
   j. Taco; Fabricated Products Div.
   k. Weil Pump Company, Inc.

2. Casing: Cast iron, with threaded or flanged piping connections, drain plug at low point of volute, and threaded gage tappings at inlet and outlet connections.

3. Impeller: ASTM B 584, cast bronze, statically and dynamically balanced, closed, overhung, single suction, keyed to shaft, and secured by locking cap screw.

4. Shaft: Stainless-steel shaft, or carbon steel shaft with copper alloy shaft sleeve, with 2, heavy-duty bearing assemblies. Provide flexible coupling and guard for connection to motor shaft.

5. Seals: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and flexible bellows and gasket.

6. Motor: Directly mounted to pump casing and with supporting legs as integral part of motor enclosure.

7. Base: Structural steel or fabricated steel channels with fully enclosed sides and ends with welded steel cross members. The base shall have a top opening for grouting.

2.8 PUMP SPECIALTY FITTINGS
A. Suction Diffuser: Angle pattern, 175-psig pressure rating, cast-iron body and end cap, pump-inlet fitting; with bronze startup and bronze or stainless-steel permanent strainers; bronze or stainless-steel straightening vanes; magnetic drain plug; and adjustable support foot.

B. Triple-Duty Valve: Angle or straight pattern, 175-psig pressure rating at 225 degrees F, cast-iron body, Class 125 flanged connections, with bronze-fitted shutoff, balancing, and silent check valve features.

2.9 AUTOMATIC CONDENSATE PUMP UNITS

A. Packaged units with corrosion-resistant pump, plastic tank with cover, and automatic controls. Include factory- or field-installed check valve and a 72-inch- minimum, electrical power cord with plug.

1. Manufacturers:
   a. Beckett Corp.
   c. Little Giant Pump Co.
   d. Marsh Manufacturing, Inc.

PART 3 - EXECUTION

3.1 PUMP INSTALLATION

A. Install pumps to provide access for periodic maintenance, including removing motors, impellers, couplings, and accessories.

B. Support pumps and piping separately so piping is not supported by pumps.

C. Suspend in-line pumps using continuous-thread hanger rod and vibration-isolation hangers. Install seismic bracing as required by authorities having jurisdiction.

D. Completely fill base of base-mounted pumps with non-shrinking grout.

E. Automatic Condensate Pump Units: Install units for collecting condensate and extend to open drain.

3.2 CONNECTIONS

A. Install piping adjacent to machine to allow service and maintenance.

B. Connect piping to pumps. Install valves that are the same size as piping connected to pumps.

C. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

D. Install check valve and throttling valve on discharge side of in-line circulators.

E. Install wye strainer and shutoff valve on suction side of in-line pumps.
1. Install blowdown piping with ball valve at each wye strainer or suction diffuser. Extend piping to nearest drain.

F. Install triple-duty valve, or non-slam check valve and throttling valve, on discharge side of in-line, close-coupled and base-mounted pumps, as applicable.

G. Install suction diffuser, or wye strainer, and shutoff valve on suction side of close-coupled and base-mounted pumps.

1. Install blowdown piping with ball valve at each wye strainer or suction diffuser. Extend piping to nearest drain.

H. Install flexible pump connectors on suction and discharge sides of close-coupled and base-mounted pumps between pump casing and valves.

I. Install a single pressure gages at each pump. Connect to pump suction and discharge with isolation valves. Install at integral pressure-gage tappings where provided.

J. Install check valve and ball valve on each condensate pump unit discharge.

K. Install electrical connections for power, controls, and devices. Electrical power and control wiring and connections are specified in Division 16.

L. Ground equipment according to Division 16.

3.3 FIELD QUALITY CONTROL

A. Alignment: Align flexible coupled pumps to within 0.003-inches.

END OF SECTION
SECTION 232300 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SUMMARY
A. This Section includes refrigerant piping used for split system air-conditioning applications.

B. Refrigerant piping indicated is schematic only. Size piping and design the actual piping layout, including oil traps, double risers, and specialties, in accordance with the air-conditioning equipment manufacturer's written instructions to ensure proper operation and compliance with warranties of connected equipment.

C. Refrigerant type shall be consistent with refrigeration equipment specified in other Sections.

1.2 SUBMITTALS
A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for thermostatic expansion valves, solenoid valves, and pressure-regulating valves.

B. Pipe Sizing Criteria: Air-conditioning manufacturer's refrigerant pipe sizing criteria.

C. Piping Layouts: For each split-type air conditioning system with a total equivalent pipe length greater than 75 feet, submit a sketch showing the following:
   1. System identification.
   2. Isometric drawing of refrigerant liquid and vapor piping showing straight piping lengths, Indicate total equivalent length of liquid and vapor piping.

D. Operation and maintenance data.

1.3 QUALITY ASSURANCE

B. ASME Standard: Comply with ASME B31.5, "Refrigeration Piping."

C. UL Standard: Provide products complying with UL 207, "Refrigerant-Containing Components and Accessories, Nonelectrical"; or UL 429, "Electrically Operated Valves."

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Refrigerants:
   a. Allied Signal, Inc./Fluorine Products; Genetron Refrigerants.
   b. DuPont Company; Fluorochemicals Div.
   d. ICI Americas Inc./ICI KLEA; Fluorochemicals Bus.

2. Refrigerant Valves and Specialties:
   a. Climate & Industrial Controls Group; Parker-Hannifin Corp.; Refrigeration & Air Conditioning Division.
   b. Danfoss Electronics, Inc.
   c. Emerson Electric Company; Alco Controls Div.
   d. Henry Valve Company.
   e. Sporlan Valve Company.

2.2 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tube: ASTM B 280, Type ACR.

B. Annealed-Temper Copper Tube: ASTM B 280, Type ACR.

C. Wrought-Copper Fittings: ASME B16.22.

D. Brazing Filler Metals:
   1. Copper-to Copper Joints: BCuP-5 or BCuP-6 without flux.
   2. Copper-to Steel or Brass Joints: BAg-28 with non-acid flux.

2.3 VALVES

A. Diaphragm Packless Valves: 500- psig working pressure and 275 degrees F working temperature; globe design with straight-throug or angle pattern; forged-brass or bronze body and bonnet, positive backseating, phosphor bronze and stainless-steel diaphragms, rising stem and handwheel, stainless-steel spring, nylon seat disc, and with solder-end connections.

B. Packed-Angle Valves: 500-psig working pressure and 275 degrees F working temperature; forged-brass or bronze body, forged-brass seal caps with copper gasket, back seating, rising stem and seat, molded stem packing, and with solder-end connections.

C. Packed Ball Valves: 500 psig working pressure and 300 degree F working temperature; two-piece, forged brass body with copper tube extensions, brass bonnet and seal cap, chrome-plated ball, Teflon seals, and neoprene ring stem seals.
D. Check Valves: 500 psig working pressure and 300 degree F working temperature; cast bronze or forged brass body, forged brass cap with neoprene seal, brass guide and disc holder, phosphor-bronze or stainless steel spring, and Teflon seat disc.

E. Solenoid Valves: Comply with ARI 760; 250 degrees F temperature rating and 400-psig working pressure; forged brass, with polytetrafluoroethylene valve seat, 2-way, straight-through pattern, and solder-end connections; manual operator; fitted with suitable NEMA 250 enclosure of type required by location, with 1/2-inch conduit adapter and holding coil.

F. Pressure Relief Valves: Straight-through or angle pattern, brass body and disc, neoprene seat, factory sealed and ASME labeled for standard pressure setting.

G. Thermostatic Expansion Valves: Comply with ARI 750; brass body with stainless-steel parts; thermostatic-adjustable, modulating type; size and operating characteristics as recommended by manufacturer of evaporator, and factory set for superheat requirements; solder-end connections; with sensing bulb, distributor having side connection for hot-gas bypass line, and external equalizer line.

H. Hot-Gas Bypass Valve: Pulsating-dampening design, stainless-steel bellows and polytetrafluoroethylene valve seat; adjustable; sized for capacity equal to last step of compressor unloading; with solder-end connections.

2.4 REFRIGERANT PIPING SPECIALITIES

A. Moisture/Liquid Indicators: 500-psig maximum working pressure and 200 degrees F operating temperature; all-brass body with replaceable, polished, optical viewing window with color-coded moisture indicator; with solder-end connections.

B. Permanent Filter-Dryer: 500-psig maximum operating pressure and 225 degrees F maximum operating temperature; steel shell and wrought-copper fittings for solder-end connections; molded-felt core surrounded by desiccant.

C. Flexible Connectors: 500-psig (3450-kPa) minimum operating pressure; seamless tin-bronze core, high-tensile bronze-braid covering, and solder-joint end connections; dehydrated, pressure tested, minimum 7 inches (180mm) long.

D. Mufflers: 500-psig operating pressure, welded-steel construction with fusible plug; sized for refrigeration capacity.

E. Straight- or Angle-Type Strainers: 500-psig working pressure; forged-brass or steel body with stainless-steel wire or brass-reinforced Monel screen of 80 to 100 mesh in liquid lines up to 1-1/8 inches, 60 mesh in larger liquid lines, and 40 mesh in suction lines; with screwed cleanout plug and solder-end connections.

2.5 RECEIVERS

A. Receivers, 6-Inch Diameter and Smaller: ARI 495, UL listed, steel, brazed, 400-psig pressure rating, with tappings for inlet, outlet, and pressure relief valve.
B. Receivers Larger Than 6-Inch Diameter: ARI 495, welded steel, tested and stamped according to ASME Boiler and Pressure Vessel Code: Section VIII; 400-psig pressure rating, with tappings for liquid inlet and outlet valves, pressure relief valve, and liquid-level indicator.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Aboveground: Type ACR drawn-copper tubing. Type ACR annealed-copper tubing may be used on refrigerant piping 1-1/8 inch o.d. and smaller.

B. Belowground: Type ACR annealed-copper tubing with no joints belowground.

3.2 PIPING INSTALLATION

A. Install refrigerant piping according to ASHRAE 15, American Refrigeration Institute (ARI), and refrigeration equipment manufacturer's written recommendations.

B. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for HVAC."

C. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

D. Install valves and specialties as indicated on Drawings. Each refrigerant circuit shall have a minimum of one field-installed moisture/liquid indicator and one field-installed permanent filter-dryer. Provide isolation valves for the replacement of each of these items.

E. Arrange piping to allow inspection and service of compressor and other equipment. Install valves and specialties in accessible locations to allow for service and inspection.

F. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation. Use sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.

G. Pitch refrigerant piping and install oil traps, properly sized and located, to ensure that oil in any part of the system will return to the compressor under all system operating conditions.

H. Belowground, install copper tubing in Schedule 40 PVC protective conduit. Size conduit to permit easy replacement of largest refrigerant line. Vent conduit outdoors.

I. Install copper tubing in rigid or flexible conduit in locations where copper tubing will be exposed to mechanical injury.

J. When brazing, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion valve bulb.
K. Hanger, support, and anchor products are specified in Division 22 Section "Hangers and Supports for HVAC Piping and Equipment." Comply with requirements below for maximum spacing of pipe supports.

L. Install hangers with the following maximum spacing and minimum rod sizes:

1. 5/8 Inch O.D.: Maximum span, 5 feet; minimum rod size, 1/4 inch.
2. 3/4 Inch O.D.: Maximum span, 5 feet; minimum rod size, 1/4 inch.
3. 7/8 Inch O.D.: Maximum span, 6 feet; minimum rod size, 1/4 inch.
4. 1-1/8 Inch O.D.: Maximum span, 6 feet; minimum rod size, 1/4 inch.
5. 1-3/8 Inch O.D.: Maximum span, 8 feet; minimum rod size, 3/8 inch.
6. 1-5/8 Inch O.D.: Maximum span, 8 feet; minimum rod size, 3/8 inch.
7. 2-1/8 Inch O.D.: Maximum span, 8 feet; minimum rod size, 3/8 inch.
8. 2-5/8 Inch O.D.: Maximum span, 9 feet; minimum rod size, 3/8 inch.

M. Support vertical runs at each floor.

3.3 PIPE JOINT CONSTRUCTION

A. Braze joints according to Division 22 Section "Common Work Results for HVAC."

B. Flow an inert gas (nitrogen or carbon dioxide) through pipe and fittings during brazing to prevent scale formation.

3.4 FIELD QUALITY CONTROL

A. Test and inspect refrigerant piping according to ASME B31.5, Chapter VI.

1. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure.
2. Test high- and low-pressure side piping of each system at not less than the lower of the pressure specified in Chapter "Refrigeration" of the applicable edition of the International Mechanical Code or the setting of pressure relief device protecting high and low side of system.
   a. System shall maintain test pressure at the manifold gage throughout the test.
   b. Test joints and fittings by brushing a small amount of soap and glycerine solution over joint.
   c. Fill system with nitrogen to raise to test pressure.

3.5 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Evacuate with a vacuum pump to 500 micrometers. Hold for 12 hours, then charge.
2. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
3. Charge system with a full-operating charge.

END OF SECTION
SECTION 232500 - HVAC WATER TREATMENT

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following HVAC water-treatment systems:
   1. Open Loop Chemical Treatment Systems.
   2. Closed Loop Chemical Treatment Systems.
   3. Chemical treatment test equipment.
   4. HVAC water-treatment chemicals.

1.2 PERFORMANCE REQUIREMENTS

A. Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or the environment.

B. Base HVAC water treatment on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.

C. Closed hydronic systems, including [hot-water heating] [and] [chilled water] [system water] [dual-temperature water], shall have the following water qualities:
   1. pH: Maintain a value within 9.0 to 10.5.
   2. "P" Alkalinity: Maintain a value within 100 to 500 ppm.
   3. Boron: Maintain a value within 100 to 200 ppm.
   4. Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.
   5. Soluble Copper: Maintain a maximum value of 0.20 ppm.
   6. TDS: Maintain a maximum value of 20 ppm.
   9. Microbiological Limits:
      a. Total Aerobic Plate Count: Maintain a maximum value of 1000 organisms/ml.
      b. Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/ml.
      c. Nitrate Reducers: Maintain a maximum value of 100 organisms/ml.
      d. Sulfate Reducers: Maintain a maximum value of 0 organisms/ml.
      e. Iron Bacteria: Maintain a maximum value of 0 organisms/ml.

D. Open hydronic systems, including [condenser] [fluid-cooler spray] water, shall have the following water qualities:
   1. pH: Maintain a value within 8.4 to 9.0.
   2. "P" Alkalinity: Maintain a maximum value of 100 ppm.
   3. Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.
   4. Soluble Copper: Maintain a maximum value of 0.20 ppm.
5. TDS: Maintain a maximum value of 10 ppm.
6. Ammonia: Maintain a maximum value of 20 ppm.
7. Free "OH" Alkalinity: Maintain a maximum value of 0 ppm.
8. Microbiological Limits:
   a. Total Aerobic Plate Count: Maintain a maximum value of 10,000 organisms/ml.
   b. Total Anaerobic Plate Count: Maintain a maximum value of 1000 organisms/ml.
   c. Nitrate Reducers: Maintain a maximum value of 100 organisms/ml.
   d. Iron Bacteria: Maintain a maximum value of 0 organisms/ml.

1.3 SUBMITTALS

A. Product Data: Include plan describing methods and chemicals proposed for use in system(s) cleaning and treatment. Include treatment system schematics showing connection locations to loop systems, testing procedures, manufacturer's literature for controllers, chemical feed pumps and chemicals. Include Material Safety Data Sheets for all proposed chemicals.

B. Field quality-control test reports.

C. Operation and maintenance data.

1.4 QUALITY ASSURANCE

A. Chemicals: Treatment chemicals used in systems that are "bled" to sewer on a regular basis shall comply with all applicable waste control standards. All biocides must be EPA registered in the name of the Water Treatment Firm for application into the HVAC water system(s). All products shall have all ingredients listed on the storage container label and Material Safety Data Sheets.

B. HVAC Water-Treatment Service Provider Qualifications: An HVAC water-treatment service provider with a minimum of five years local experience, capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section. Approved water treatment firms:


C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.5 WARRANTY

A. Special Guarantee: Provide a guarantee that the treated systems will remain scale and algae free for a period of one year when the provided chemicals are used as directed. If scaling or fouling occurs when the provided chemicals are used as directed the Water Treatment Firm shall clean the system(s) at no cost to the Owner.

B. Provide all parts and labor required to maintain the chemical treatment systems in good working order during the warranty period.
2.1 OPEN LOOP (COOLING TOWER) SYSTEMS

A. Chemical Controller: Bleed-and-feed type conductivity controller complete with watertight enclosure, 2 electrode, 0-5,000 µS conductivity sensor, plumbing, dry contact for flow switch, power cord and relays for chemical feed pumps and bleed valve. Controller shall be 120 VAC.

1. Products: Subject to compliance with requirements, provide the following:
   a. Lakewood Model 101.
   b. Approved Equal.

B. Chemical Controller: Microprocessor based pH and conductivity controller with watertight enclosure, 4-electrode 0-5,000 µS conductivity sensor with fouling compensation and alarm, differential 0-14 pH sensor with diagnostics, plumbing, flow switch, power cord and relays for control of bleed valve and chemical feed pumps, LCD display, interface for pH and conductivity monitoring by building control system. Controller shall be 120 VAC.

1. Products: Subject to compliance with requirements, provide the following:
   a. Lakewood Model 2412.
   b. Approved equal.

C. Chemical Solution Tanks:

1. Chemical-resistant reservoirs fabricated from high-density opaque polyethylene with minimum 110 percent containment vessel.
2. Molded cover with recess for mounting pump.
3. Capacity: 50 gal.

D. Chemical Solution Injection Pumps:

1. Products: Subject to compliance with requirements provide one of the following:
   a. IWAKI EZ series.
   b. LMI Model 151.
   c. Pulsafeeder Model C Plus.

2. Electronic metering pump.
3. Self-priming, positive-displacement; rated for intended chemical with minimum 25 percent safety factor for design pressure and temperature.
4. Minimum Capacity: 0.5 gallons per hour.
5. Adjustable flow rate.
6. Metal and thermoplastic construction.
8. Fully enclosed, continuous-duty, single-phase motor. Comply with requirements in Division 22 Section "Common Motor Requirements for HVAC Equipment."

E. Chemical Solution Tubing: Polyethylene tubing with compression fittings and joints.
F. Injection Assembly:
   1. Quill: Minimum NPS 1/2 with insertion length sufficient to discharge into at least 25 percent of pipe diameter.
   2. Ball Valve: Two-piece, stainless steel; selected to fit quill.
   3. Packing Gland: Mechanical seal on quill of sufficient length to allow quill removal during system operation.
   4. Assembly Pressure/Temperature Rating: Minimum 600 psig at 200 deg F.

G. Test Kit: Manufacturer-recommended equipment and chemicals in a wall-mounting cabinet for testing pH, TDS, inhibitor, chloride, alkalinity, hardness; and oxidizing biocide test.
   1. Provide TDS meter with 0-5,000 µS range.
   2. Provide daily test log sheets with recommended ranges for use by plant personnel.

H. Corrosion Test-Coupon Assembly: Constructed of corrosive-resistant material, complete with piping, valves, 2 pre-weighed C1010 mild steel coupons and 2 pre-weighed CDA 110 copper coupons. Locate copper coupon downstream from mild steel coupon in the test-coupon assembly.

I. Chemicals shall be as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment, and that can attain water quality specified in Part 1 “Performance Requirements” Article.
   1. Scale Inhibitor: Liquid organo-phosphate maintained between 8 and 10 ppm concentration in open loop system.
   2. Biocide: EPA registered, non-chlorine type, maintained at sufficient concentrations to prevent formation of slime and growth of algae.
   3. Acid: Sulfuric acid to maintain tower water pH between 8.4 and 9.0.

J. Bleed Valve: Solenoid controlled, tower water bleed valve with built-in flow control. Provide one valve per controller.

2.2 CLOSED LOOP SYSTEMS

A. Test Kit: Manufacturer-recommended equipment and chemicals in a wall mounted cabinet for testing inhibitor concentrations.

B. Corrosion Test-Coupon Assembly: Constructed of corrosive-resistant material, complete with piping, valves, 1 pre-weighed C1010 mild steel coupon, and 1 pre-weighed CDA 110 copper coupon.

C. Chemicals:
   1. Cleaner: Alkaline based cleaner designed for the removal of oil, corrosion and other contaminants from closed loop piping systems and equipment.
   2. Corrosion Inhibitor: Boron-nitrate type, designed to prevent corrosion in closed loop piping.
PART 3 - EXECUTION

3.1 WATER ANALYSIS

A. Perform an analysis of supply water to determine quality of water available at Project site.

3.2 INSTALLATION

A. Install chemical storage tanks on 4-inch thick, reinforced concrete bases, level and plumb. Bases shall extend 6 inches beyond tank on all sides. Anchor chemical tanks to nearest wall or support to prevent tipping.

B. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible.

C. Furnish to and coordinate with Mechanical Contractor all items specified herein that are installed in piping systems.

D. Install water testing equipment on wall near water chemical application equipment.

E. Install interconnecting control wiring for chemical treatment controls and sensors. Coordinate conduit requirements with Electrical Contractor.

F. Mount sensors and injectors in piping circuits. Coordinate with Mechanical Contractor.

G. Install test-coupon assembly in bypass circuit around circulating pumps, unless otherwise indicated on Drawings.

H. Install automatic chemical-feed equipment for [condenser] fluid-cooler spray water and include the following:

1. Install chemical controller in bypass circuit around pumps.
2. Install inhibitor injection pumps and solution tanks.
   a. Pumps shall be controlled by chemical controller. Injection pump shall discharge into condenser water return piping to cooling tower.
   b. Bleed valves shall cycle to maintain maximum TDS concentration.
3. Install test equipment and provide test-kit to Owner. Install test-coupon assembly in bypass circuit around circulating pumps, unless otherwise indicated on Drawings.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Unless otherwise indicated, connect piping with unions and shut-off valves to allow equipment to be disconnected without draining piping.
D. Confirm applicable electrical requirements in Division 16 Sections for connecting electrical equipment.

E. Ground equipment according to Division 16.

F. Connect wiring according to Division 16.

G. Interconnect flow switch dry contactors in Controller with condenser water pump starter. Open loop system bleed and chemical pump to be disabled when condenser pumps are not operating.

3.4 CLEANING

A. Provide cleaner as required to maintain the manufacturer's recommended concentration for cleaning of the closed loop systems.

B. Circulate the cleaning solution for a minimum of 48 hours.

C. Drain and flush the system until all cleaning chemicals and suspended materials have been flushed from the system.

3.5 CHEMICAL ADDITION

A. Open Loop Systems:
   1. Add the required amount of scale inhibitor to reach an initial concentration of 8-10 ppm.
   2. Add the required amount of biocide to reach the manufacturer's recommended concentration to prevent the formation of slime and the growth of algae.
   3. [Add the required amount of acid to set the pH between 8.4 and 9.0.]
   4. Install the corrosion coupons in the coupon rack after the initial chemical addition.

B. Closed Loop Systems:
   1. Immediately after system testing, cleaning and flushing, add the required amount of corrosion inhibitor to reach the manufacturer's recommended concentration.
   2. Install the corrosion coupons in the coupon rack after the initial chemical addition.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:
   1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
   2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
   3. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
4. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

5. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.

6. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.

7. Repair leaks and defects with new materials and retest piping until no leaks exist.

C. Operational Test: After the systems have been filled with water and the condenser pump(s) are operating, measure chemical treatment levels and verify proper operation of controller, chemical pumps and automatic bleed valve. Set the bleed and chemical feed rates to maintain the appropriate chemical levels.

D. Remove and replace malfunctioning units and retest as specified above.

E. At one-week intervals following Substantial Completion, perform separate water analyses on hydronic systems to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section. Submit written reports of water analysis after each test. Advise Owner of changes necessary to adhere to Part 1 “Performance Requirements” Article.

F. Comply with ASTM D 3370 and with the following standards:


G. Corrosion Coupons:

1. Remove and replace the corrosion coupons at 90 day intervals.
2. Deliver the removed coupons to a certified laboratory for testing.
3. Return the coupons and certified analysis to the Owner’s representative.
4. [If the coupon(s) from the closed loop system(s) show any noticeable metal loss the system water shall be tested and the appropriate action taken to prevent additional metal loss.]
5. [If the coupon(s) from the open loop system show a metal loss of greater the 3.0 mils per year for steel and/or 0.5 mils per year for copper the system water shall be tested and the appropriate action taken to reduce the metal loss below those values.]

3.7 TRAINING

A. Train the Owner’s representative(s) in the proper methods for testing the system(s)’ water, chemical handling, adding chemicals to the system(s), adjustment, and use and maintenance of the controller(s) and chemical feed pumps. Training may be done during each of the regularly required visits.
SECTION 233113 - METAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Rectangular ducts and fittings.
2. Round ducts and fittings.
4. Sealants and gaskets.
5. Hangers and supports.

B. Related Sections:

1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Section 233116 "Nonmetal Ducts" for fibrous-glass ducts, thermoset fiber-reinforced plastic ducts, thermoplastic ducts, PVC ducts, and concrete ducts.
3. Section 233119 "HVAC Casings" for factory- and field-fabricated casings for mechanical equipment.
4. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.2 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Structural Performance: Duct hangers and supports shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems"

1. Seismic Hazard Level A: Seismic force to weight ratio, 0.48.
2. Seismic Hazard Level B: Seismic force to weight ratio, 0.30.
3. Seismic Hazard Level C: Seismic force to weight ratio, 0.15.

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.
B. Shop Drawings:

1. Factory- and shop-fabricated ducts and fittings.
2. Duct layout indicating sizes, configuration, and static-pressure classes.
3. Fittings.
4. Penetrations through fire-rated and other partitions.
5. Equipment installation based on equipment being used on Project.
6. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
7. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.

C. Delegated-Design Submittal:

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.
5. Design Calculations: Calculations for selecting hangers and supports and seismic restraints.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:


B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA’s "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Elbow: **Elbows shall have a set of single thickness turning vanes with extended trailing edges.** Rectangular or sweep elbows without turning vanes are not permitted.
2.2 ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Lindab Inc.
   b. McGill AirFlow LLC.
   c. SEMCO Incorporated.
   d. Sheet Metal Connectors, Inc.
   e. Spiral Manufacturing Co., Inc.

B. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Elbows: **Radius of the elbow must be at least 1.5 x D (diameter of round duct).** Radius < 1.5xD will be rejected.

2.3 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   1. Galvanized Coating Designation: G60.
   2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.

D. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

E. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

2.4 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:

   1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
   2. Tape Width: 3 inches.
   5. Mold and mildew resistant.
   6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
   7. Service: Indoor and outdoor.
   8. Service Temperature: Minus 40 to plus 200 deg F.
   9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
   10. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   11. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Water-Based Joint and Seam Sealant:

   1. Application Method: Brush on.
   2. Solids Content: Minimum 65 percent.
   5. Mold and mildew resistant.
   6. VOC: Maximum 75 g/L (less water).
   7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
   8. Service: Indoor or outdoor.
   9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Flanged Joint Sealant: Comply with ASTM C 920.

   2. Type: S.
   3. Grade: NS.
5. Use: O.
6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

F. Round Duct Joint O-Ring Seals:
1. Seal shall provide maximum 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.5 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: All-thread or cadmium-plated steel rods and nuts.

B. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

C. Steel Cables for Galvanized-Steel Ducts: Not permitted

D. Steel Cables for Stainless-Steel Ducts: Not permitted

E. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

F. Trapeze and Riser Supports:
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

2.6 SEISMIC-RESTRAINT DEVICES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Cooper B-Line, Inc.; a division of Cooper Industries.
2. Ductmate Industries, Inc.
B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by \textit{an agency acceptable to authorities having jurisdiction}.

1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

C. Channel Support System: Shop- or field-fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to braced component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.

D. Restraint Cables: Steel cables with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for restraining cable service; and with an automatic-locking and clamping device or double-cable clips.

E. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or Reinforcing steel angle clamped to hanger rod.

F. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.
E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers.


3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 ADDITIONAL INSTALLATION REQUIREMENTS FOR COMMERCIAL KITCHEN HOOD EXHAUST DUCT

A. Install commercial kitchen hood exhaust ducts without dips and traps that may hold grease, and sloped a minimum of 2 percent to drain grease back to the hood.
B. Install fire-rated access panel assemblies at each change in direction and at maximum intervals of 20 feet in horizontal ducts, and at every floor for vertical ducts, or as indicated on Drawings. Locate access panel on top or sides of duct a minimum of 1-1/2 inches from bottom of duct.

C. Do not penetrate fire-rated assemblies except as allowed by applicable building codes and authorities having jurisdiction.

3.4 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
   1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   2. Outdoor, Supply-Air Ducts: Seal Class A.
   3. Outdoor, Exhaust Ducts: Seal Class A.
   4. Outdoor, Return-Air Ducts: Seal Class A.
   5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 3-Inch wg and Lower: Seal Class B.
   6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 3-Inch wg: Seal Class B.
   7. Unconditioned Space, Exhaust Ducts: Seal Class B
   8. Unconditioned Space, Return-Air Ducts: Seal Class B.
   9. Conditioned Space, Supply-Air Ducts in Pressure Classes 3-Inch wg and Lower: Seal Class A.
   10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 3-Inch wg: Seal Class A.
   11. Conditioned Space, Exhaust Ducts: Seal Class A.
   12. Conditioned Space, Return-Air Ducts: Seal Class A.

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
   1. Where practical, install concrete inserts before placing concrete.
   2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
   3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.6 SEISMIC-RESTRAINT-DEVICE INSTALLATION

A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."

1. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.

2. Brace a change of direction longer than 12 feet.

B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install cable restraints on ducts that are suspended with vibration isolators.

E. Install seismic-restraint devices using methods approved by [an evaluation service member of the ICC Evaluation Service] [the Office of Statewide Health Planning and Development for the State of California] [an agency acceptable to authorities having jurisdiction].

F. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.

G. Drilling for and Setting Anchors:
1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the Architect if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.

2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.

3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.

4. Set anchors to manufacturer's recommended torque, using a torque wrench.

5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

### 3.7 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

### 3.8 DUCT CLEANING

A. Clean new duct system(s) before testing, adjusting, and balancing.

B. Use service openings for entry and inspection.

1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 233300 "Air Duct Accessories" for access panels and doors.

2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.

3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.

2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

### 3.9 START UP

A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."
3.10 DUCT SCHEDULE

A. SMACNA Seal Class:
   1. C = seal only transverse joints
   2. B = seal transverse joints and longitudinal seams.
   3. A = seal above plus all applicable (wall) penetrations.

B. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:
   1. Underground Ducts: Concrete-encased, galvanized sheet steel.
   2. <Insert requirements>.

C. Supply Ducts:
   1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units
      <Insert equipment>:
      a. Pressure Class: Positive 3-inch wg.
      b. Minimum SMACNA Seal Class: A.
      c. SMACNA Leakage Class for Rectangular: 12.
      d. SMACNA Leakage Class for Round and Flat Oval: 6.
   2. Ducts Connected to Constant-Volume Air-Handling Units:
      a. Pressure Class: Positive 3-inch wg.
      b. Minimum SMACNA Seal Class: A.
      c. SMACNA Leakage Class for Rectangular: 12.
      d. SMACNA Leakage Class for Round and Flat Oval: 6.
   3. Ducts Connected to Variable-Air-Volume Air-Handling Units:
      a. Pressure Class: Positive 3-inch wg.
      b. Minimum SMACNA Seal Class A
      c. SMACNA Leakage Class for Rectangular: 12.
      d. SMACNA Leakage Class for Round and Flat Oval: 6.
   4. Ducts Connected to Equipment Not Listed Above:
      a. Pressure Class: Positive 3-inch wg.
      b. Minimum SMACNA Seal Class: A.
      c. SMACNA Leakage Class for Rectangular: 12.
      d. SMACNA Leakage Class for Round and Flat Oval: 6.

D. Return Ducts:
   1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
      a. Pressure Class: Positive or negative 1-inch wg.
      b. Minimum SMACNA Seal Class: A.
      c. SMACNA Leakage Class for Rectangular: 12.
2. Ducts Connected to Equipment Not Listed Above:
   a. Pressure Class: Positive or negative 3-inch wg.
   b. Minimum SMACNA Seal Class: A.
   c. SMACNA Leakage Class for Rectangular: 12
   d. SMACNA Leakage Class for Round and Flat Oval: 6.

E. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
   a. Pressure Class: Negative [1-inch wg] [2-inch wg].
   b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
   c. SMACNA Leakage Class for Rectangular: 12.
   d. SMACNA Leakage Class for Round and Flat Oval: 6.

2. Ducts Connected to Air-Handling Units:
   a. Pressure Class: Positive or negative [2-inch wg] [3-inch wg] <Insert value>.
   b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
   c. SMACNA Leakage Class for Rectangular: 12.
   d. SMACNA Leakage Class for Round and Flat Oval: 6.

   a. Exposed to View: Type 304, stainless-steel sheet, [No. 4] [No. 3] finish.
   b. Concealed: Type 304, stainless-steel sheet, No. 2D finish.
   c. Welded seams and joints.
   d. Pressure Class: Positive or negative 3-inch wg.
   e. Minimum SMACNA Seal Class: Welded seams, joints, and penetrations.
   f. SMACNA Leakage Class: 3.

4. Ducts Connected to Dishwasher Hoods:
   a. Type 304, stainless-steel sheet.
   b. Exposed to View: [No. 4] [No. 3] finish.
   c. Concealed: No. 2D.
   d. Welded seams and flanged joints with watertight EPDM gaskets.
   e. Pressure Class: Positive or negative 3-inch wg.
   f. Minimum SMACNA Seal Class: Welded seams, joints, and penetrations.
   g. SMACNA Leakage Class: 3.

5. Ducts Connected to Fans Exhausting Laboratory and Process (ASHRAE 62.1, Class 3 and 4) Air:
   a. Type 304, stainless-steel sheet.
1) Exposed to View: [No. 4] [No. 3] finish.
2) Concealed: No. 2D finish.

b. PVC-coated, galvanized sheet steel with thicker coating on duct interior.
c. Pressure Class: Positive or negative 3-inch wg.
d. Minimum SMACNA Seal Class: A.
e. SMACNA Leakage Class: 3.

6. Ducts Connected to Equipment Not Listed Above:

a. Pressure Class: Positive or negative 3-inch wg.
b. Minimum SMACNA Seal Class: B if negative pressure, and A if positive pressure.
c. SMACNA Leakage Class for Rectangular: 12.
d. SMACNA Leakage Class for Round and Flat Oval: 6.

F. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:

a. Pressure Class: Positive or negative 1-inch wg.
b. Minimum SMACNA Seal Class: B
c. SMACNA Leakage Class for Rectangular: 12
d. SMACNA Leakage Class for Round and Flat Oval: 6.

2. Ducts Connected to Air-Handling Units:

a. Pressure Class: Positive or negative 2-inch wg.
b. Minimum SMACNA Seal Class: B.
c. SMACNA Leakage Class for Rectangular: 12.
d. SMACNA Leakage Class for Round and Flat Oval: 6.

3. Ducts Connected to Equipment Not Listed Above:

a. Pressure Class: Positive or negative 2-inch wg.
b. Minimum SMACNA Seal Class: B.
c. SMACNA Leakage Class for Rectangular: 12.
d. SMACNA Leakage Class for Round and Flat Oval: 6.

G. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel or carbon steel coated with zinc-chromate primer.
2. PVC-Coated Ducts:

a. Exposed to Airstream: Match duct material.
b. Not Exposed to Airstream: Match duct material.

3. Stainless-Steel Ducts:

a. Exposed to Airstream: Match duct material.
b. Not Exposed to Airstream: Match duct material.


H. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
   a. All Velocities:
      1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
      2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
      3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

   b. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
      a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
      b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
      c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
   a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
      1) Radius-to-Diameter Ratio: Greater than or equal to 1.5.
   b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
   c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam or Welded.

I. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
   a. Rectangular Main to Rectangular Branch: 45-degree entry.
   b. Rectangular Main to Round Branch: Conical (no spin-ins).
2. Round: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.

   a. All Velocities: Conical or 45-degree lateral (no spin-ins)

END OF SECTION
SECTION 233300 - DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Backdraft dampers.
2. Volume dampers.
3. Fire dampers.
4. Ceiling fire dampers.
5. Smoke and combination fire and smoke dampers.
6. Turning vanes.
7. Duct-mounting access doors.
8. Flexible connectors.
10. Domestic Clothes Dryer Connection Box
11. Duct silencers.
12. Duct accessory hardware.
13. Motorized dampers and actuators.

B. See Division 13 or 16 for duct-mounting fire and smoke detectors.

C. See Division 15 Section "HVAC Control System" for electric damper actuators.

1.2 SUBMITTALS

A. Product Data: For the following:

1. Backdraft dampers.
2. Volume dampers.
3. Fire dampers.
4. Ceiling fire dampers.
5. Combination fire and smoke dampers, including wiring diagrams.
6. Turning vanes.
7. Duct-mounting access doors.
8. Flexible connectors.
10. Domestic Clothes Dryer Connection Box
11. Duct silencers.
12. Motorized dampers and actuators.

B. Operating and maintenance data for fire dampers, ceiling fire dampers, and combination fire and smoke dampers, as applicable.

C. Test reports for combination fire and smoke dampers.
1.3 QUALITY ASSURANCE


PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 SHEET METAL MATERIALS

A. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G60 or G90 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.

B. Stainless Steel: ASTM A 480/A 480M.

C. Aluminum Sheets: ASTM B 209, alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.


E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 BACKDRAFT DAMPERS

A. Manufacturers:
   1. Air Balance, Inc.
   2. American Warming and Ventilating.
   3. Duro Dyne Corp.
   5. Penn Ventilation Company, Inc.
   6. Potorff.
   7. Prefco Products, Inc.
   8. Ruskin Company.

B. Description: Multiple-blade, parallel action gravity-type, counter-balanced, with blades of maximum 6-inch width, with sealed edges, assembled in rattle-free manner with 90-degree stop, steel ball bearings, and axles; adjustment device to permit setting for varying differential static pressure.
C. Frame: 0.052-inch thick, galvanized sheet steel, with welded corners and mounting flange as required for application.

D. Blades: 0.050-inch thick aluminum sheet.

E. Blade Seals: Vinyl or Neoprene.

F. Blade Axles: Galvanized steel.

G. Tie Bars and Brackets: Galvanized steel.

H. Adjustment Device: Adjustable counterweight or adjustable spring.

2.4 VOLUME DAMPERS

A. Manufacturers:

1. Air Balance, Inc.
2. American Warming and Ventilating.
3. Flexmaster U.S.A., Inc.
5. METALAIRE, Inc.
6. Nailor Industries Inc.
7. Penn Ventilation Company, Inc.
8. Pottorff.
10. Swartwout

B. General: Factory fabricated, with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.

C. Standard Volume Dampers: Multiple-opposed blade type in rectangular applications, and single-blade in round applications, standard leakage rating, and suitable for horizontal or vertical applications.

1. Steel Frames: Hat-shaped, galvanized sheet steel channels, minimum of 0.064 inch thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.

2. Roll-Formed Steel Blades: 0.064-inch thick, galvanized sheet steel.


5. Tie Bars and Brackets: Galvanized steel.

D. [Volume Dampers in Rectangular, Metal Product Conveying Ductwork: Multiple-opposed blade type, low leakage rating per AMCA 500, and suitable for horizontal or vertical applications.]

1. Frames: Hat-shaped, channels, same material as ductwork, with mitered and welded corners; frames with flanges for attaching to ducts.
2. Blades: Airfoil shaped, same material as ductwork.
3. Blade Axles: Same material as ductwork.
4. Bearings: Oil-impregnated bronze or molded synthetic.
5. Tie Bars and Brackets: Galvanized steel mounted outside of airstream.
6. Seals:
   a.) Blades Edge: Neoprene, extruded double edge design with inflatable pocket.
   b.) Jamb: Stainless steel, flexible, compressible type.

E. [Volume Dampers in Round, Metal Product Conveying Ductwork: Single-blade, low
leakage rating per AMCA 509, suitable for horizontal or vertical applications.]
1. Frames: Channels, same material as ductwork with welded seams; frames with flanges
   for attaching to ducts.
2. Blades: Stiffened, same material as ductwork.
3. Blade Axles: Same material as ductwork.
4. Bearings: Oil-impregnated bronze or grease lubricated ball bearings, bolted to frame.
5. Blade Stop: Same material as ductwork.
6. Seals: Neoprene on both blades and shafts.

F. Jackshaft for Multiple-Damper Assemblies: 1-inch diameter, galvanized-steel pipe rotating
within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-
damper assemblies.

G. Damper Hardware: Zinc-plated, die-cast core with dial and handle made of 3/32-inch- thick
zinc-plated steel, and a 3/4-inch hexagon locking nut. Include center hole to suit damper
operating-rod size. Include elevated platform for insulated duct mounting.

2.5 BLAST GATES (CUT-OFFS)

A. Manufacturers:
   1. Tate-Jones
   2. Approved Equal

B. General: Full cut-offs consisting of cast or fabricated housings with duct mounting collars and
slide gates suitable for air volume control in metal product conveying ducts.

C. Materials: Housing and slide gates constructed of same materials as attached ductwork.
Exception: Cast aluminum housings may be used in galvanized steel duct systems.

D. Features: Fully retractable slide gates with handles and set screws to maintain balanced
position.

2.6 FIRE DAMPERS

A. Manufacturers:
   1. Air Balance, Inc.
   2. Greenheck.
   4. METALAIRE, Inc.
5. Nailor Industries Inc.
7. Potterff.
8. Prefco Products, Inc.

B. General: Fire dampers shall be dynamic type and labeled according to UL 555.

C. Fire Rating: 1-1/2 hours.

D. Frame: Curtain type with blades outside airstream; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.

E. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
   1. Minimum Thickness: 18 gauge (0.052 inch thick) and of length to suit application.
   2. Exceptions: Omit sleeve where damper frame width permits direct attachment of perimeter mounting angles on each side of wall or floor, and thickness of damper frame complies with sleeve requirements.

F. Mounting Orientation: Vertical or horizontal as indicated.

G. Blades: Roll-formed, interlocking, 0.034-inch-thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.

H. Blade Lock/Closure Spring: Include blade lock and stainless-steel closure spring.

I. Fusible Links: Replaceable, 165 degrees F rated.

2.7 CEILING FIRE DAMPERS

A. Manufacturers:
   1. Air Balance, Inc.
   2. Greenheck.
   4. METALAIRE, Inc.
   5. Nailor Industries Inc.
   7. Potterff.
   8. Prefco Products, Inc.

B. General: Labeled according to UL 555C; comply with construction details for tested floor- and roof-ceiling assemblies as indicated in UL's "Fire Resistance Directory."

C. Frame: Galvanized sheet steel, round or rectangular, style to suit ceiling construction.

D. Blades: Galvanized sheet steel with refractory insulation.
E. Fusible Links: Replaceable, 165 degrees F rated.

2.8 SMOKE AND COMBINATION FIRE AND SMOKE DAMPERS

A. Damper Manufacturers:
   1. Air Balance, Inc.
   2. Greenheck.
   3. Nailor Industries Inc.
   4. Penn Ventilation Company, Inc.
   5. Potterff.
   6. Ruskin Company.

B. General Description: Damper and actuator tested and labeled according to UL 555S and UL 555. Rating as required for the application but not less than 1-1/2-hour rating.

C. Leakage classification shall be UL555S Class I or Class II.


E. Velocity and Pressure Rating: Minimum 2,000 FPM velocity and minimum 4 inches water gage pressure ratings in low velocity (less than or equal to 2,000 FPM) applications.

F. Thermal-Switch: Resetable, 165 degrees F rated.

G. Frame and Blades: 0.064-inch- thick, galvanized sheet steel.

H. Mounting Sleeve: Factory-installed, minimum 0.040-inch- thick, galvanized sheet steel; length to suit wall or floor application.

I. Damper Motors: Provide for two-position action.
   2. Outdoor Motors and Motors in Outside-Air Intakes: Equip with gaskets and seals designed to make motors weatherproof. Operating temperature range shall be minus 22 degrees F to plus 122 degrees F.
   3. Electrical Connection: 115 V, single phase, 60 Hz.

2.9 TURNING VANES

A. Manufactured Turning Vanes: Fabricate 1-1/2-inch- wide, single-vane, curved blades with extended trailing edge of galvanized sheet steel set 3/4 inch o.c.; support with bars perpendicular to blades set 2 inches o.c.; and set into vane runners suitable for duct mounting.

   1. Manufacturers:
      a. Ductmate Industries, Inc.
      b. Duro Dyne Corp.
c. METALAIRE, Inc.
d. Ward Industries, Inc.

2.10 DUCT-MOUNTING ACCESS DOORS

A. General: Fabricate doors airtight and suitable for duct pressure class.

B. Door in Rectangular Duct: Double wall, duct mounting, square or rectangular; fabricated of galvanized sheet metal with insulation fill to match adjacent ductwork and thickness as indicated for duct pressure class. Where used in metal product conveying ducts, use same material as duct. Include vision panel where indicated on Drawings. Include 1-by-1-inch butt or piano hinge and cam latches.

1. Manufacturers:
   a. American Warming and Ventilating.
   b. Ductmate Industries, Inc.
   c. Flexmaster U.S.A., Inc.
   d. Greenheck.
   f. Nailor Industries Inc.
   g. Ventfabrics, Inc.
   h. Ward Industries, Inc.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets. Where used in metal product conveying ducts, use same material as duct.

3. Provide number of hinges and locks as follows:
   a. Less Than 12 Inches Square: Secure with two sash locks.
   b. Up to 18 Inches Square: Two hinges and two sash locks.
   c. Up to 24 by 48 Inches: Three hinges and two compression latches with outside and inside handles.
   d. Sizes 24 by 48 Inches and Larger: One additional hinge.

C. Door in Round Duct: Double wall, duct mounting, and round; fabricated of galvanized sheet metal with insulation fill and 1-inch thickness. Where used in metal product conveying ducts, use same material as duct. Include cam latches.

1. Manufacturers:
   a. Ductmate Industries, Inc.
   b. Flexmaster U.S.A., Inc.

2. Frame: Galvanized sheet steel, with spin-in notched frame. Where used in metal product conveying ducts, use same material as duct.

D. Seal around frame attachment to duct and door to frame with neoprene or foam rubber.

E. Insulation: 1-inch-thick, fibrous-glass or polystyrene-foam board.

2.11 FLEXIBLE CONNECTORS
A. Manufacturers:

1. Ductmate Industries, Inc.
2. Duro Dyne Corp.
3. Ventfabrics, Inc.

B. General: Metal flanges connected by flame-retardant or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1. Provide with minimum 4-inches of exposed fabric.


1. Minimum Weight: 26 oz./sq. yd..
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 degrees F.

2.12 FLEXIBLE DUCTS

A. Manufacturers:

1. Atco Rubber Products, Inc.
2. Flexmaster U.S.A., Inc.
6. Thermaflex.

B. Insulated-Duct Connectors: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation with minimum R-value of 4.2; metallized, fiberglass-reinforced, film laminate.

1. Pressure Rating: 6-inch wg positive and 1.0-inch wg negative.
3. Temperature Range: Minus 10 to plus 160 degrees F.

C. Flexible Duct Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action, in sizes 3 through 18 inches to suit duct size.

2.13 DUCT SILENCERS

A. Manufacturers:

1. Commercial Acoustics Division
2. Industrial Acoustics Company
3. Rink Sound Control
4. Vibro-Acoustics

B. General: Silencers shall be of the size, configuration, capacity, and acoustic performance as scheduled on the drawings. All silencers shall be factory fabricated and supplied by the same manufacturer.
C. Construction: Silencers shall be constructed in accordance with ASHRAE and SMACNA standards for the pressure and velocity classification specified for the air distribution system in which they are installed. Silencer materials, including acoustic media, shall have a maximum flamespread classification of 25 and a maximum smoke development rating of 50 when tested in accordance with ASTM E84, NFPA 255 or UL 723. Silencers shall be tested in accord with ASTM-E477.

D. Rectangular Silencers:
   1. Outer casing: Minimum 22 gauge galvanized steel construction. All external seams shall be lockformed and filled with mastic and shall be airtight up to 8” W.G. differential pressure.
   2. Interior Baffles: Airfoil shape, constructed of not less than 26 gauge perforated galvanized steel. Baffles shall be designed for minimal pressure drop and maximum attenuation.

E. Acoustic Media:
   1. Natural Cotton Fiber Insulation: Media shall be 100% natural cotton fibers treated with an EPA registered, non-toxic borate solution, “flash dried” to provide resistance to mold mildew and fungi. Media shall comply with UL 181 and NFPA 90A. Media shall not cause or accelerate corrosion of aluminum or steel.
   2. Glass Fiber Insulation: Media shall be of acoustic quality, shot-free glass fiber insulation with long, resilient fibers bonded with a thermosetting resin. Glass fiber density and compression shall be as required to insure conformance with laboratory test data. Glass fiber shall be packed with a minimum of 5% compression during silencer assembly. Media shall be bacteria and fungus resistant, resilient such that it will not crumble or break, and conform to irregular surfaces. Media shall not cause or accelerate corrosion of aluminum or steel.
   3. No-Media Silencers: No-Media silencers shall not contain any absorptive media. Attenuation shall be achieved solely with controlled impedance membranes and broadly tuned resonators.

F. Media Protection: Acoustic media shall be completely wrapped with a non-erosive, non-pregnable, cleanable mylar film to help prevent shedding, erosion and impregnation of the acoustic media. The wrapped acoustic media shall be separated from the perforated metal by a factory installed ½” thick acoustically transparent spacer. The spacer shall be flame retardant and erosion resistant.

2.14 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct insulation thickness.

2.15 MOTORIZED DAMPERS

A. Damper Manufacturers:
   1. Air Balance, Inc.
   2. American Warming and Ventilating.
   3. Flexmaster U.S.A., Inc.
5. METALAIRE, Inc.
6. Nailor Industries Inc.
7. Penn Ventilation Company, Inc.
8. Ruskin Company.

B. Dampers: AMCA-rated, parallel or opposed-blade design; 0.1084-inch minimum, galvanized-steel frames with holes for duct mounting; damper blades shall not be less than 0.0635-inch galvanized steel with maximum blade width of 8 inches.

1. Blades shall be secured to 1/2-inch-diameter, zinc-plated axles using zinc-plated hardware, with nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
2. Operating Temperature Range: From minus 40 to plus 200 degrees F.
3. For standard applications, include optional closed-cell neoprene edging.
4. For low-leakage applications, use parallel- or opposed-blade design with inflatable seal blade edging, or replaceable rubber seals, rated for leakage at less than 10 cfm per sq. ft. of damper area, at differential pressure of 4 inches wg when damper is being held by torque of 50 in. x lbf; when tested according to AMCA 500D.

C. Actuator Manufacturer: Belimo.

D. Actuators: Direct-coupled type design for minimum 60,000 full-stroke cycles at rated torque.

1. Sizing: Size for running torque calculated as follows:
   b. Opposed-Blade Damper: 5 inch-pounds/sq. ft. of damper.
2. Coupling: V-bolt and V-shaped, toothed cradle.
3. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
5. Power Requirements (Two-Position Spring Return): 120-V ac.
6. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
7. Temperature Rating: Minus 22 to plus 122 degrees F.
8. Run Time: Not more than 15 seconds or less than 5 seconds.

PART 3 - EXECUTION

3.1 APPLICATION AND INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" or SMACNA's “Round Industrial Duct Construction Standards,” as applicable for metal ducts [and in SMACNA's, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts].
B. Provide duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel [and fibrous-glass] ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Provide duct accessories suitable for the pressure class of the ductwork to which it is attached.

D. Install backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.

E. In lined ducts install volume dampers in a manner that avoids damage to and, erosion of duct liner.

F. Provide balancing dampers at points on supply, return, outside air and exhaust systems where branches lead from larger ducts as required for air balancing. Install at a minimum of two duct widths from branch takeoff.

G. Install turning vanes in all rectangular duct elbows having a 45-degree or greater bend and not provided with radiused inside and outside corners.

H. [Provide test holes at fan inlets and outlets and elsewhere as indicated.]

I. Mount duct smoke detectors in strict conformance with manufacturer’s recommendations. Duct smoke detectors to be furnished and wired in Division 13 or 26.

J. Install fire and smoke dampers where required and where indicated on Drawings according to manufacturer's UL-approved written instructions.

K. Install duct access doors on sides of ducts where space permits to allow for inspecting, adjusting, and maintaining accessories and terminal units. Locate on side of duct with greatest clearance. Install as follows:

   1. On both sides of duct coils. (Minimum head and hand access.)
   2. Downstream from automatic control dampers. (Minimum two hand access.)
   3. Adjacent to fire dampers or combination fire and smoke dampers, providing access to reset or reinstall thermal-switch. (Minimum two hand access.)
   4. Downstream of duct mounted equipment, e.g., humidifier grids, duct heaters. (Minimum head and hand access.)
   5. To interior of ducts for cleaning; before and after each change in direction, at maximum 50-foot spacing. (Minimum two hand access.)

L. Install the following sizes for duct-mounting, rectangular access doors:

   1. Two-Hand Access: 12 by 6 inches.

M. Install the following sizes for duct-mounting, round access doors:

   2. Head and Hand Access: 12 inches in diameter.

N. Label access doors according to Division 22 Section "Identification for HVAC Piping and Equipment".
O. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators. Provide sheetmetal sunshields on exterior flexible connectors.

P. Connect terminal units to supply ducts with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.

Q. Connect air outlets to low pressure ducts with maximum 96-inch lengths of flexible duct where indicated on Drawings.

R. Secure inner liner of flexible ducts to metal ducts and collars with a stainless steel draw band.

S. Install duct test holes where indicated and required for testing and balancing purposes.

3.2 ADJUSTING

A. Adjust duct accessories for proper settings.

B. Test fire and smoke dampers for proper action. Repair or replace defective components or wiring.

C. Final positioning of manual-volume dampers is specified in Division 17 Section "Testing, Adjusting, and Balancing."

END OF SECTION
SECTION 233423 – HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Centrifugal roof ventilators.
2. Centrifugal wall ventilators.
3. Ceiling-mounting ventilators and cabinet fans.
4. In-line centrifugal fans.
5. Filtered supply fan.
7. Utility vent sets.

1.2 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:

1. Certified fan performance curves with system operating conditions indicated.
2. Certified fan sound-power ratings.
3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
4. Material gages and finishes, including color charts.
5. Dampers, including housings, linkages, and operators.
6. Dimensions and service clearance requirements.

B. Operation and maintenance data.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.

C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

D. UL Standard: Power ventilators shall comply with UL 705. Power ventilators for restaurant exhaust applications shall comply with UL 762.

PART 2 - PRODUCTS
2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 CENTRIFUGAL ROOF VENTILATORS

A. Description: Belt-driven or direct-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, curb base, and accessories.

1. Manufacturers:
   b. Cook, Loren Company.
   c. Greenheck Fan Corp.

B. Housing: Removable, spun-aluminum, down-discharge dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone. Provide upblast type where scheduled on Drawings.

C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

D. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:

   1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
   4. Fan and motor isolated from exhaust airstream.

E. Accessories:

   1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
   2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
   3. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
   4. Motorized Dampers: Where scheduled on Drawing, parallel-blade dampers mounted in curb base with Belimo 2-position, line-voltage electric actuator; wired to close when fan stops.

F. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.

   1. Configuration: Self-flashing without a cant strip, with mounting flange.
   2. Overall Height: 12 to 14 inches.
   4. Damper Tray: Provide damper tray in roof curb where dampers are indicated to be provided with ventilators.
   5. Sound Curb: Curb with sound-absorbing insulation matrix.
   7. Burglar Bars: 1/2-inch thick steel bars welded in place to form 6-inch squares.
10. Grease Trough: Continuously welded aluminum with removable lid mounted on subbase or curb.

2.3 CENTRIFUGAL WALL VENTILATORS

A. Description: Belt-driven or direct-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and accessories.

1. Manufacturers:
   b. Cook, Loren Company.
   c. Greenheck Fan Corp.

B. Housing: Heavy-gage, removable, spun-aluminum, dome top and outlet baffle; venturi inlet cone.

C. Fan Wheel: Aluminum hub and wheel with backward-inclined blades.

D. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:
   1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
   4. Fan and motor isolated from exhaust airstream.

E. Accessories:
   1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through internal aluminum conduit.
   2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
   3. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in wall sleeve; factory set to close when fan stops.
   4. Motorized Dampers: Parallel-blade dampers mounted in curb base with 2-position, line voltage, electric actuator; wired to close when fan stops, where scheduled on Drawings.

2.4 CEILING-MOUNTING VENTILATORS AND CABINET FANS

A. Description: Centrifugal fans designed for installing in ceiling or wall, or for concealed in-line applications.

1. Manufacturers:
   a. Cook, Loren Company.
   b. Greenheck Fan Corp.

B. Housing: Steel, lined with acoustical insulation.
C. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.

D. Grille: Aluminum, louvered grille with flange on intake and thumbscrew attachment to fan housing.

E. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.

F. Accessories:
   1. Isolation: Rubber-in-shear vibration isolators.
   2. Manufacturer's standard roof cap with curb or wall cap, and transition fittings.

2.5 IN-LINE CENTRIFUGAL FANS

A. Description: In-line, belt-driven centrifugal fans consisting of housing, wheel, outlet guide vanes, fan shaft, bearings, motor, drive assembly, mounting brackets, and accessories.

   1. Manufacturers:
      a. Cook, Loren Company.
      b. Greenheck Fan Corp.
      c. Hartzell Fan, Inc.

B. Housing: Square, galvanized steel frame with galvanized removable side panels, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or suspended mounting.

C. Direct-Driven Units: Motor encased in housing outside of airstream, factory wired to disconnect switch located on outside of fan housing.

D. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing. Extended lubricating tubes are not required if permanently lubricated ball bearings are provided.

E. Fan Wheels: Aluminum, backward-inclined blades welded to aluminum hub.

F. Accessories:
   1. Companion Flanges: For inlet and outlet duct connections.
   2. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
   3. Motor and Drive Cover (Belt Guard): Coated steel to match cabinet.

2.6 FILTERED SUPPLY FANS

A. Description: Factory-fabricated, -assembled, -tested, and –finished, direct or belt driven, centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly and accessories.
1. Manufacturers:
   b. Cook, Loren Company.
   c. Greenheck Fan Corp.

B. Housing: Formed and reinforced, removable, galvanized steel panels, attached to a galvanized steel fan base, with insulated top cover, outside-air hood and washable aluminum filter.

C. Fan: DWDI, centrifugal, forward curved type of painted steel with scroll housing.

D. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:
   1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
   4. Fan and motor isolated from exhaust airstream.

E. Accessories:
   1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.

F. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch-thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.
   1. Configuration: Self-flashing without a cant strip, with mounting flange.
   2. Overall Height: 12 to 14 inches.

2.7 PROPELLER FANS

A. Description: Belt-driven or direct-driven propeller fans consisting of a fan support frame, venturi, propeller, fan shaft, bearings, motor, drive assembly, and accessories.

1. Manufacturers:
   b. Cook, Loren Company.
   c. Greenheck Fan Corp.

B. Venturi: Heavy-gage, painted steel, with welded corners; formed venturi inlet cone.

C. Support Frame: Heavy-gage steel designed to securely support the motor and propeller.

D. Propeller: Formed Steel or aluminum, or cast aluminum blades as indicated, securely fastened to a steel or aluminum hub. Entire propeller assembly to be statically and dynamically balanced.

E. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:
1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.

F. Accessories:
1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through internal aluminum conduit.
2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
3. Shutter: Counterbalanced, parallel-blade, backdraft shutter mounted in wall sleeve; factory set to close when fan stops.
4. Motorized Shutter: Parallel-blade shutter mounted in wall sleeve with 2-position, line voltage, electric actuator; wired to close when fan stops, where scheduled on Drawings.
5. Wall Sleeve: Galvanized steel or aluminum, as indicated, sleeve with fixed exterior flange and adjustable interior flange for mounting fan through wall.
6. OSHA Wire Guard: Painted steel designed to provide OSHA compliant protection from fan.
7. Weather Hood: Galvanized steel hood with bird screen sized to prevent moisture entrainment on intake applications.
8. Shutter Guard: Painted steel or aluminum, as indicated on drawings, designed to protect shutter from vandalism or damage.

2.8 UTILITY VENT SETS

A. Description: Factory-fabricated, -assembled, -tested, and –finished, direct- or belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, support structure, and accessories.

1. Manufacturers:
   a. Aerovent; a Twin City Fan Company.
   b. Buffalo Forge Co./Howden Fan Co.
   c. Cook, Loren Company.
   d. New York Blower Company (The).

B. Housing: Formed and reinforced galvanized steel or aluminum as schedules on Drawings, curved scroll housings with shaped cutoff, spun-metal inlet bell, and doors or panels to allow access to internal parts and components.

1. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
2. Fabrication Class: AMCA 99, Class I.
3. Special Coatings: [Thermoplastic vinyl][Epoxy][Synthetic resin][Phenolic][Color-match enamel][Polytetrafluoroethylene][Vinyl ester][Hot-dip galvanized][Powder-baked enamel]; [None]<Insert manufacturer and trade name.>

C. Wheels:

1. Backward-Inclined Fan Wheels: Steel or aluminum, as scheduled on Drawings, construction with curved inlet flange, back plate, backward-inclined blades welded or riveted to flange and back plate; cast-iron or cast-steel hub riveted to back plate and fastened to keyed shaft with set screws.
2. Forward-Curved Fan Wheels: Black-enamed or galvanized steel construction with inlet flange, back plate, shallow blades with inlet and tip curved forward in direction of airflow, mechanically secured to flange and back plate; cast-steel hub swaged to back plate and fastened to keyed shaft with set screws.
3. Special Coatings: [Thermoplastic vinyl][Epoxy][Synthetic resin][Phenolic][Color-match enamel][Polytetrafluoroethylene][Vinyl ester][Hot-dip galvanized][Powder-baked enamel]; [None]<Insert manufacturer and trade name.>

D. Shafts:
1. Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
2. Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.
3. Designed to operate at no more than 70 percent of first critical speed to top of fan’s speed range.

E. Bearings: Prelubricated and sealed shaft bearings, self-aligning, pillow-block-type.
1. Ball-Bearing Rating Life: ABMA 9, L_{10} of 100,000 hours.
2. Roller-Bearing Rating Life: AMBA 11, L_{10} of 100,000 hours.

F. Belt Drives:
1. Description: Factory mounted, with final alignment and belt adjustment made after installation, 1.5 service factor.
2. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
3. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with motors larger than 5 hp. Select pulleys so pitch adjustment is at the middle of adjustment range at fan design conditions.
4. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.

G. Accessories:
1. Weather Cover/Belt Guard: Galvanized-steel or aluminum sheet with ventilation slots, bolted to housing. Weather cover shall also serve as an OSHA-complaint belt guard.
2. Scroll Access Doors: Shaped to conform to scroll, with quick-opening latches and gaskets.
3. Scroll Drain Connection: NPS 1 steel pipe coupling welded to low point of fan scroll.
5. Companion Flanges: Galvanized steel, for duct connections.

2.9 MOTORS

A. Comply with requirements in Division 15 Section "Common Motor Requirements for HVAC Equipment."

B. Enclosure Type: Guarded dripproof, unless indicated otherwise on Drawings.

2.10 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install power ventilators level and plumb.

B. Support cabinet fans, in-line centrifugal fans and utility vent sets using vibration isolators as indicated on Drawings. Vibration- [and seismic]-control devices are specified in Division 15 Section "Vibration [and Seismic] Controls for HVAC Piping and Equipment."

C. Install floor-mounting units on concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

D. Secure roof-mounting fans to roof curbs with cadmium-plated hardware. Refer to Division 7 for installation of roof curbs.

E. Ceiling Mounting Ventilators: Suspend units from structure; use steel wire or metal straps.

F. Install units with clearances for service and maintenance, minimum 36-inches on all sides.

G. Label units according to requirements specified in Division 15 Section "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of ducts and duct accessories.

B. Make final duct connections to cabinet fans, in-line centrifugal fans, and utility vent sets with flexible connectors. Flexible connectors are specified in Division 15 Section "Duct Accessories."

C. Install ducts adjacent to power ventilators to allow service and maintenance.

3.3 FIELD QUALITY CONTROL

A. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
C. Shut unit down and reconnect automatic temperature-control operators.

D. Refer to Division 17 Section "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing procedures.

E. Replace fan and motor pulleys as required to achieve design airflow.

F. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

END OF SECTION
SECTIONS 233433 - AIR CURTAINS

PART 1 - GENERAL

1.1 SUMMARY
   A. This Section includes air curtains with electric heat and fuel-fired heater.

1.2 SUBMITTALS
   A. Product Data: For each model indicated, provide dimensions, weights, capacities at scheduled conditions, required clearances, electrical requirements, components, and location and size of each field connection.
   B. Operation and maintenance data.

1.3 QUALITY ASSURANCE
   A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
   B. Comply with NSF 37, "Air Curtains for Entranceways in Food and Food Service Establishments."

1.4 WARRANTY
   A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace air curtains that fail in materials and workmanship within two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1. Berner International.
      2. Biddle Air Systems Limited.
      3. Cambridge Engineering, Inc.
      4. Disco Engineering, Inc.; Part of Tucson Transatlantic Trade, Inc.
      5. Fantech.
      6. King Company; a company of Mestek, Inc.
      7. Loren Cook Company.
      8. Marley Engineered Products.
9. Mars Air Products; Dynaforce Division.
10. Mars Air Products; Mars Air Door Division.
11. Mestek, Inc.; L. J. Wing Division.
13. Powered Aire, Inc.

2.2 MATERIALS

A. Housing Materials: Galvanized steel or aluminum with electrostatically applied epoxy enamel finish over powdered mirror or heavy-gage, electroplated-zinc steel with welded construction and polyester coated finish.

B. Intake Louvers: Integral part of the housing, mechanically field adjustable and capable of reducing air-outlet velocity by 60 percent with louver in totally closed position.

C. Discharge Nozzle: Integral part of the housing, wedge shaped, containing adjustable air-directional vanes with 40-degree sweep front to back.

2.3 FANS

A. Fans: Galvanized steel or aluminum, centrifugal, forward curved, double width, double inlet; statically and dynamically balanced.

B. Fan Drives: Direct.

2.4 MOTORS

A. Comply with the requirements in Division 15 Section "Common Motor Requirements for HVAC Equipment."

B. Motor Type: Resiliently mounted, continuous duty, totally enclosed, air over or totally enclosed, fan cooled, with integral thermal-overload protection.

C. Bearings: Permanently sealed, life-time, prelubricated, ball bearings.

D. Disconnect: Internal power cord with plug and receptacle.

2.5 ELECTRIC HEATING COILS

A. Coil Assembly: Comply with UL 1096.

B. Frame: Galvanized-steel frame.

C. Heating Elements: Coiled resistance wire of 80 percent nickel and 20 percent chromium; surrounded by compacted magnesium-oxide powder in tubular-steel sheath; with spiral-wound, copper-plated, steel fins continuously brazed to sheath.
D. Heating Elements: Open-coil resistance wire of 80 percent nickel and 20 percent chromium, supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame.

E. Overtemperature Protection: Disk-type, automatically reset, thermal-cutout, safety device; serviceable through terminal box without removing heater from duct or unit.

   1. Secondary Protection: Load-carrying, manually reset or manually replaceable, thermal cutouts; factory wired in series with each heater stage.

F. Control Panel: [Unit] [Remote] mounted with disconnecting means and overcurrent protection. Include the following controls:

   1. Magnetic contactor.
   3. Solid-state stepless pulse controller.
   4. Toggle switches; one per step.
   5. Step controller.
   6. Time-delay relay.
   7. Pilot lights; one per step.
   8. Airflow proving switch.

2.6 FUEL-FIRED HEATERS

A. Comply with AGA Z83.8, "Gas Unit Heaters."

   1. AGA Approval: Bear AGA label.
   2. Type of Gas: [Natural] [LP].

B. Assembly and Wiring: Heaters factory assembled, piped, wired, and tested for 120-V ac.

C. Housing: Steel, with integral draft hood and inserts for suspension-mounting rods.

   1. External Casings and Cabinets: Baked enamel over corrosion-resistant-treated surface.

D. Heat Exchanger: [Aluminized] [Stainless] steel.

E. Burners: Cast iron or aluminized steel with stainless-steel inserts.

F. Venting Provision: Gravity.

G. Power Venter: 120-V ac, with stainless-steel shaft.

H. Automatic Gas Control: [Single-] [2]-stage, 24-V ac valve.

I. Ignition: [Standing pilot] [Electronically controlled spark with flame sensor].

2.7 FILTERS

A. Disposable Panel Filters: Factory-fabricated, viscous-coated, flat-panel-type, disposable air filters with holding frames.

B. Washable Panel Filters: Removable, stainless-steel, baffle-type filters with spring-loaded fastening; with minimum 0.0781-inch- thick, stainless-steel filter frame.

C. Mounting Frames: Welded, galvanized steel with gaskets and fasteners and suitable for bolting together into built-up filter banks.

2.8 ACCESSORIES

A. **[Built-in]** **[Field-Installed]** Thermostat: Line voltage, factory installed and wired to the junction box on air curtain.

B. Automatic Door Switch: Remotely installed in door area to activate air curtain when door opens and to deactivate air curtain when door closes.

C. Start-Stop, Push-Button Switch: Manually activates and deactivates air curtain.

D. Time-Delay Relay: Factory installed and adjustable to allow air curtain to operate from 1 to 300 seconds after door closes.

E. Motor-Control Panel: Complete with motor starter, 115-V ac transformer with primary and secondary fuses, terminal strip, and NEMA 250, Type [1] [12] enclosure.

F. Mounting Brackets: Adjustable mounting brackets for drum-type roll-up doors.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install air curtains with clearance for equipment service and maintenance.

3.2 CONNECTIONS

A. **[Install piping adjacent to air curtain to allow service and maintenance.]**

B. **[Breaching: Comply with applicable requirements in Division 15 Section, "Breechings, Chimneys, and Stacks."
Connect breaching to full size at flue outlet.]**

C. Ground equipment according to Division 16.

D. Connect wiring according to Division 16.

3.3 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control testing:
1. After installing air curtains completely, perform visual and mechanical check of individual components.
2. After electrical circuitry has been energized, start unit to confirm motor rotation and unit operation. Certify compliance with test parameters.

B. Repair or replace malfunctioning units. Retest units until satisfactory results are achieved. Operate electric element through each stage and verify proper operation of electrical connection.

C. Test gas train and verify that there are no gas leaks.

D. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

END OF SECTION
3.8 SUPPLIES

A. Provide all chemicals, testing supplies, log sheets, laboratory analysis, and other consumables required to maintain the proper chemical balance in the system(s) during the warranty period.

END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Fan-powered air terminal units.
   2. Shutoff, single-duct air terminal units.

1.2 PERFORMANCE REQUIREMENTS

A. Structural Performance: Hangers and supports shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA’s "HVAC Duct Construction Standards - Metal and Flexible" and ASCE/SEI 7.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For air terminal units. Include plans, elevations, sections, details, and attachments to other work.

C. Delegated-Design Submittal:
   1. Materials, fabrication, assembly, and spacing of hangers and supports.
   2. Design Calculations: Calculations for selecting hangers and supports and seismic restraints.

D. Field quality-control reports.

E. Operation and maintenance data.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."
PART 2 - PRODUCTS

2.1 PARALLEL FAN-POWERED AIR TERMINAL UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Carnes.
   2. Krueger
   3. Barber Coleman.
   4. Titus.
   5. Stafa.

B. Configuration: Volume-damper assembly and fan in parallel arrangement inside unit casing with control components inside a protective metal shroud.

C. Casing: 0.034-inch steel, [single] wall.
   1. Casing Lining: Adhesive attached, 1/2-inch thick, coated, fibrous-glass duct liner complying with ASTM C 1071, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
      a. Cover liner with nonporous foil.
      b. Cover liner with nonporous foil and perforated metal.
   2. Casing Lining: Adhesive attached, 1/2-inch thick, polyurethane foam insulation complying with UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
   3. Air Inlets: Round stub connections or S-slip and drive connections for duct attachment.
   5. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket and quarter-turn latches.
   6. Fan: Forward-curved centrifugal, located at plenum air inlet.
   7. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Volume Damper: Galvanized steel with flow-sensing ring and peripheral gasket and self-lubricating bearings.
   1. Maximum Damper Leakage: ARI 880 rated 3 percent of nominal airflow at 3-inch wg inlet static pressure.

E. Velocity Sensors: Multipoint array with velocity sensors in cold- and hot-deck air inlets and air outlets.

F. Motor:
1. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

2. Fan-Motor Assembly Isolation: Rubber isolators.

3. Enclosure Materials: [Cast iron] [Cast aluminum] [Rolled steel].

4. Efficiency: Premium efficient.

5. Service Factor: <Insert value>.

6. Motor Speed: [Single speed] [Multispeed].
   a. Speed Control: Infinitely adjustable with electronic controls.

7. Electrical Characteristics:
   a. Volts: [120/208] Phase: [Single] [Poly].
   b. Hz: 60.

G. Filters: Minimum arrestance according to ASHRAE 52.1 and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
   1. Material: Pleated cotton-polyester media having 90 percent arrestance and 7 MERV.
   2. Thickness: 1 or 2 inch.

H. Attenuator Section: 0.034-inch steel aluminum] sheet.
   1. Lining: Adhesive attached, 1/2-inch thick, coated, fibrous-glass duct liner complying with ASTM C 1071, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
      a. Cover liner with nonporous foil.
      b. Cover liner with nonporous foil and perforated metal.
   2. Lining: Adhesive attached, 3/4-inch- thick, polyurethane foam insulation complying with UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
   3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

I. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.
   1. Location: Plenum air inlet.

   1. Location: Plenum air inlet.
   2. Stage(s): [1] [2].
   3. Access door interlocked disconnect switch.
4. Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable.)
5. Nickel chrome 80/20 heating elements.
6. Airflow switch for proof of airflow.
7. Fan interlock contacts.
8. Fuses in terminal box for overcurrent protection (for coils more than 48 A).
10. Magnetic contactor for each step of control (for three-phase coils).

K. Factory-Mounted and -Wired Controls: Electrical components mounted in control box with removable cover. Incorporate single-point electrical connection to power source.

1. Control Transformer: Factory mounted for control voltage on electric and electronic control units with terminal strip in control box for field wiring of thermostat and power source.
2. Wiring Terminations: Fan and controls to terminal strip. Terminal lugs to match quantities, sizes, and materials of branch-circuit conductors. Enclose terminal lugs in terminal box that is sized according to NFPA 70.
3. Disconnect Switch: Factory-mounted, fuse type.

L. Control Panel Enclosure: NEMA 250, Type 1, with access panel sealed from airflow and mounted on side of unit.

M. Electric Controls: 24-V damper actuator with wall-mounted electric thermostat and appropriate mounting hardware.

N. Electronic Controls: Bidirectional damper operator and microprocessor-based controller with integral airflow transducer and room sensor. Control devices shall be compatible with temperature controls specified in Section 230900 "Instrumentation and Control for HVAC" and shall have the following features:

1. Occupied and unoccupied operating mode.
2. Remote reset of airflow or temperature set points.
3. Adjusting and monitoring with portable terminal.
4. Communication with temperature-control system specified in Section 230900 "Instrumentation and Control for HVAC."

2.2 SERIES FAN-POWERED AIR TERMINAL UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Carnes.
   2. Krueger
   3. Barber Coleman.
   4. Titus.
   5. Stafa.

B. Configuration: Volume-damper assembly and fan in series arrangement inside unit casing with control components inside a protective metal shroud for installation above a ceiling.
C. Casing: 0.034-inch steel [single] wall.

1. Casing Lining: Adhesive attached, 1/2-inch thick, coated, fibrous-glass duct liner complying with ASTM C 1071, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
   a. Cover liner with nonporous foil.
   b. Cover liner with nonporous foil and perforated metal.

2. Casing Lining: Adhesive attached, 1/2-inch thick, polyurethane foam insulation complying with UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.

3. Air Inlets: Round stub connections or S-slip and drive connections for duct attachment.
5. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket and quarter-turn latches.
7. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Volume Damper: Galvanized steel with flow-sensing ring and peripheral gasket and self-lubricating bearings.

1. Maximum Damper Leakage: ARI 880 rated, 3 percent of nominal airflow at 3-inch w inlet static pressure.

E. Velocity Sensors: Multipoint array with velocity sensors in cold- and hot-deck air inlets and air outlets.

F. Motor:

1. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
2. Fan-Motor Assembly Isolation: Rubber isolators.
3. Enclosure Materials: [Cast iron] [Cast aluminum] [Rolled steel].
4. Efficiency: Premium efficient.
5. Service Factor: <Insert value>.
6. Motor Speed: [Single speed] [Multispeed].
   a. Speed Control: Infinitely adjustable with electronic controls.
7. Electrical Characteristics:
   a. Volts: [120/208] Phase: [Single] [Poly].
   b. Hz: 60.

G. Filters: Minimum arrestance according to ASHRAE 52.1 and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
1. Material: Pleated cotton-polyester media having 90 percent arestance and 7 MERV.
2. Thickness: 1 or 2 inch.

H. Attenuator Section: 0.034-inch aluminum sheet.

1. Lining: Adhesive attached, 1/2-inch thick, coated, fibrous-glass duct liner complying with ASTM C 1071, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
   a. Cover liner with nonporous foil.
   b. Cover liner with nonporous foil and perforated metal.

2. Lining: Adhesive attached, 3/4-inch thick, polyurethane foam insulation complying with UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.

3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

I. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.


1. Stage(s): \([1][2]\).
2. Access door interlocked disconnect switch.
3. Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable.)
5. Airflow switch for proof of airflow.
6. Fan interlock contacts.
7. Fuses in terminal box for overcurrent protection (for coils more than 48 A).
8. Mercury contactors.
9. Magnetic contactor for each step of control (for three-phase coils).

K. Factory-Mounted and -Wired Controls: Electrical components mounted in control box with removable cover. Incorporate single-point electrical connection to power source.

1. Control Transformer: Factory mounted for control voltage on electric and electronic control units with terminal strip in control box for field wiring of thermostat and power source.
2. Wiring Terminations: Fan and controls to terminal strip. Terminal lugs to match quantities, sizes, and materials of branch-circuit conductors. Enclose terminal lugs in terminal box that is sized according to NFPA 70.
3. Disconnect Switch: Factory-mounted, fuse type.

L. Control Panel Enclosure: NEMA 250, Type 1, with access panel sealed from airflow and mounted on side of unit.

M. Electric Controls: 24-V damper actuator with wall-mounted electric thermostat and appropriate mounting hardware.

N. Electronic Controls: Bidirectional damper operator and microprocessor-based controller with integral airflow transducer and room sensor. Control devices shall be compatible with temperature controls specified in Section 230900 "Instrumentation and Control for HVAC" and shall have the following features:

1. Occupied and unoccupied operating mode.
2. Remote reset of airflow or temperature set points.
3. Adjusting and monitoring with portable terminal.
4. Communication with temperature-control system specified in Section 230900 "Instrumentation and Control for HVAC."

2.3 SHUTOFF, SINGLE-DUCT AIR TERMINAL UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carnes.
2. Krueger
3. Barber Coleman.
4. Titus.
5. Stafa.

B. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.

C. Casing: 0.034-inch steel [single] wall.

1. Casing Lining: Adhesive attached, 1/2-inch thick, coated, fibrous-glass duct liner complying with ASTM C 1071, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
   a. Cover liner with nonporous foil.
   b. Cover liner with nonporous foil and perforated metal.

2. Casing Lining: Adhesive attached, 1/2-inch thick, polyurethane foam insulation complying with UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.

3. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
4. Air Outlet: S-slip and drive connections[, size matching inlet size].
5. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Regulator Assembly: System-air-powered bellows section incorporating polypropylene bellows for volume regulation and thermostatic control. Bellows shall operate at temperatures from 0 to 140 deg F, shall be impervious to moisture and fungus, shall be suitable for 10-inch wg static pressure, and shall be factory tested for leaks.

E. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
   1. Maximum Damper Leakage: ARI 880 rated,[3] percent of nominal airflow at 3-inch wg inlet static pressure.

F. Attenuator Section: 0.034-inch steel sheet.
   1. Lining: Adhesive attached, 1/2-inch- thick, coated, fibrous-glass duct liner complying with ASTM C 1071, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
      a. Cover liner with nonporous foil.
      b. Cover liner with nonporous foil and perforated metal.
   2. Lining: Adhesive attached, 3/4-inch- thick, polyurethane foam insulation complying with UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
   3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

G. Multioutlet Attenuator Section: With [two] [three] [four] [6-inch-] [8-inch-] [10-inch-] diameter collars, each with locking butterfly balancing damper.

H. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.

   1. Access door interlocked disconnect switch.
   2. Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable.)
   3. Nickel chrome 80/20 heating elements.
   4. Airflow switch for proof of airflow.
5. Fan interlock contacts.
6. Fuses in terminal box for overcurrent protection (for coils more than 48 A).
7. Mercury contactors.
8. Magnetic contactor for each step of control (for three-phase coils).

J. Electric Controls: Damper actuator and thermostat.

1. Damper Actuator: 24 V, powered closed, spring return open.
2. Thermostat: Wall-mounted electronic type with clock display, temperature display in Fahrenheit and Celsius, and space temperature set point.

K. Electronic Controls: Bidirectional damper operator and microprocessor-based thermostat with integral airflow transducer and room sensor. Control devices shall be compatible with temperature controls specified in Section 230900 "Instrumentation and Control for HVAC" and shall have the following features:

1. Damper Actuator: 24 V, powered closed, spring return open.
2. Velocity Controller: Factory calibrated and field adjustable to minimum and maximum air volumes; shall maintain constant airflow dictated by thermostat within 5 percent of set point while compensating for inlet static-pressure variations up to 4-inch wg; and shall have a multipoint velocity sensor at air inlet.
3. Thermostat: Wall-mounted electronic type with temperature set-point display in Fahrenheit and Celsius.

L. Direct Digital Controls: Single-package unitary controller and actuator specified in Section 230900 "Instrumentation and Control for HVAC."

M. Direct Digital Controls: Bidirectional damper operators and microprocessor-based controller and room sensor. Control devices shall be compatible with temperature controls specified in Section 230900 "Instrumentation and Control for HVAC" and shall have the following features:

1. Damper Actuator: 24 V, powered closed, [spring return open.
2. Terminal Unit Controller: Pressure-independent, variable-air-volume controller with electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes, and having the following features:
   a. Occupied and unoccupied operating mode.
   b. Remote reset of airflow or temperature set points.
   c. Adjusting and monitoring with portable terminal.
   d. Communication with temperature-control system specified in Section 230900 "Instrumentation and Control for HVAC."
3. Room Sensor: Wall mounted, with temperature set-point adjustment and access for connection of portable operator terminal.

2.4 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Steel Cables: [Galvanized steel complying with ASTM A 603] [Stainless steel complying with ASTM A 492].

D. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

E. Air Terminal Unit Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

F. Trapeze and Riser Supports: Steel shapes and plates for units with steel casings; aluminum for units with aluminum casings.

2.5 SOURCE QUALITY CONTROL

A. Factory Tests: Test assembled air terminal units according to ARI 880.

1. Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, [coil type,] and ARI certification seal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

B. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

C. Install wall-mounted thermostats.

3.2 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.

2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.

3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes and for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes and for slabs less than 4 inches thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hangers Exposed to View: Threaded rod and angle or channel supports.

D. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.3 SEISMIC-RESTRAINT-DEVICE INSTALLATION

A. Install hangers and braces designed to support the air terminal units and to restrain against seismic forces required by applicable building codes. Comply with ASCE/SEI 7.

B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install cable restraints on air terminal units that are suspended with vibration isolators.

E. Install seismic-restraint devices using methods approved by [an evaluation service member of the ICC Evaluation Service] [the Office of Statewide Health Planning and Development for the State of California] [an agency acceptable to authorities having jurisdiction].

F. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.

G. Drilling for and Setting Anchors:
   1. Identify position of reinforcing steel and other embedded items before drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the Architect if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
   2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
   3. Wedge Anchors: Protect threads from damage during anchor installation. Install heavy-duty sleeve anchors with sleeve fully engaged in the structural element to which anchor is to be fastened.
   4. Set anchors to manufacturer's recommended torque, using a torque wrench.
   5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.
3.4 CONNECTIONS

A. Install piping adjacent to air terminal unit to allow service and maintenance.

B. Hot-Water Piping: In addition to requirements in Section 232113 "Hydronic Piping," connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union or flange.

C. Connect ducts to air terminal units according to [Section 233113 "Metal Ducts."] [Section 233116 "Nonmetal Ducts."]

D. Make connections to air terminal units with flexible connectors complying with requirements in Section 233300 "Air Duct Accessories."

3.5 IDENTIFICATION

A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.

2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.

3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Air terminal unit will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.7 STARTUP SERVICE

A. Perform startup service.
1. Complete installation and startup checks according to manufacturer’s written instructions.
2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
3. Verify that controls and control enclosure are accessible.
4. Verify that control connections are complete.
5. Verify that nameplate and identification tag are visible.
6. Verify that controls respond to inputs as specified.

3.8 TRAINING

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

END OF SECTION
SECTION 233713 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 SUMMARY
A. This Section includes ceiling- and wall-mounted diffusers, registers, and grilles.

1.2 SUBMITTALS
A. Product Data: For each product indicated, include materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Anemostat; a Mestek Company.
   2. Carnes.
   4. METALAIRE, Inc.; Metal Industries Inc.
   5. Nailor Industries of Texas, Inc.
   7. Titus.
   8. Tuttle & Bailey.

2.2 MATERIALS
A. Material: Steel, aluminum, or stainless steel as indicated on Drawings.
B. Finish: Baked enamel, white unless otherwise indicated.
C. Mounting: As indicated on Drawings. Provide countersunk screws on surface mounted outlets.
D. Damper: Provide damper where indicated on Drawings.
   1. Opposed-blade type on square or rectangular neck outlets.
   2. Radial type on round neck outlets.
E. Accessories: As indicated on Drawings.
2.3 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practicable. Coordinate exact location with Architectural Reflected Ceiling Plan, where applicable. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.2 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION
SECTION 233723 - HVAC GRAVITY VENTILATORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Louvered-penthouse ventilators.
   2. Roof hoods.

1.2 PERFORMANCE REQUIREMENTS

A. Structural Performance: Ventilators shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of ventilator components, noise or metal fatigue caused by ventilator blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.
   1. Wind Loads: Determine loads based on pressures as indicated on Drawings.

B. Seismic Performance: Ventilators, including attachments to other construction, shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.4 COORDINATION

A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Aluminum Extrusions: ASTM B 221, Alloy 6063-T5 or T-52.
B. Aluminum Sheet: ASTM B 209, Alloy 3003 or 5005 with temper as required for forming or as otherwise recommended by metal producer for required finish.

C. Galvanized-Steel Sheet: ASTM A 653/A 653M, G90 zinc coating, mill phosphatized.

D. Fasteners: Same basic metal and alloy as fastened metal or 300 Series stainless steel unless otherwise indicated. Do not use metals that are incompatible with joined materials.
   1. Use types and sizes to suit unit installation conditions.
   2. Use [Phillips flat] [hex-head or Phillips pan]-head screws for exposed fasteners unless otherwise indicated.

E. Post-Installed Fasteners for Concrete and Masonry: Torque-controlled expansion anchors made from stainless-steel components, with capability to sustain without failure a load equal to 4 times the loads imposed for concrete, or 6 times the load imposed for masonry, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.

F. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.2 LOUVERED-PENTHOUSE VENTILATORS

A. Manufacturers: Subject to compliance with requirements, [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
   2. Aerovent.
   3. Carnes.
   5. JencoFan.
   7. PennBarry.

C. Construction: All-welded assembly with [4-inch] [6-inch]-deep louvers, mitered corners, and [aluminum] [galvanized-steel] sheet roof.

D. Frame and Blade Material and Nominal Thickness: Extruded aluminum, of thickness required to comply with structural performance requirements, but not less than 0.080 inch for frames and 0.060 inch for blades.
   1. AMCA Seal: Mark units with the AMCA Certified Ratings Seal.
   2. Exterior Corners: Prefabricated corner units with mitered and welded blades and with mullions at corners.
E. Frame and Blade Material and Nominal Thickness: Galvanized-steel sheet, of thickness required to comply with structural performance requirements, but not less than 0.052 inch for frames and 0.040 inch for blades.

1. AMCA Seal: Mark units with the AMCA Certified Ratings Seal.
2. Exterior Corners: Prefabricated corner units with mitered and welded blades and with mullions at corners.

F. Roof Curbs: Galvanized-steel sheet; with mitered and welded corners; 1-1/2-inch-thick, rigid fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to fit roof opening and ventilator base.

2. Overall Height: 8 inches

G. Bird Screening: Aluminum, 1/2-inch-square mesh, 0.063-inch wire

H. Insect Screening: Aluminum, 18-by-16 mesh, 0.012-inch or Stainless-steel, 18-by-18 mesh, 0.009-inch wire.

I. Galvanized-Steel Sheet Finish:

1. Surface Preparation: Clean surfaces of dirt, grease, and other contaminants. Clean welds, mechanical connections, and abraded areas and repair galvanizing according to ASTM A780. Apply a conversion coating suited to the organic coating to be applied over it.
2. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply an air-dried primer immediately after cleaning and pretreating.
3. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil for topcoat and an overall minimum dry film thickness of 2 mils.
   a. Color and Gloss: As selected by Architect from manufacturer's full range.

2.3 ROOF HOODS

A. Manufacturers: Subject to compliance with requirements, [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

2. Aerovent.
3. Carnes.
5. JencoFan.
7. PennBarry.

C. Factory fabricated according to SMACNA’s "HVAC Duct Construction Standards - Metal and Flexible," Figures 6-6 and 6-7.

D. Materials: Galvanized-steel sheet or Aluminum sheet; suitably reinforced.

E. Roof Curbs: Galvanized-steel sheet; with mitered and welded corners; 1-1/2-inch-thick, rigid fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to fit roof opening and ventilator base.
   2. Overall Height: 8 inches.

F. Bird Screening: Galvanized-steel, 1/2-inch- square mesh, 0.041-inch wire or Aluminum, 1/2-inch- square mesh, 0.063-inch wire.

G. Insect Screening: Aluminum, 18-by-16 mesh, 0.012-inch or Stainless-steel, 18-by-18 mesh, 0.009-inch wire.

H. Galvanized-Steel Sheet Finish:
   1. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply an air-dried primer immediately after cleaning and pretreating.
   2. Baked-Enamel Finish: Apply manufacturer's standard finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil for topcoat and an overall minimum dry film thickness of 2 mils.
      a. Color and Gloss: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install gravity ventilators level, plumb, and at indicated alignment with adjacent work.

B. Secure gravity ventilators to roof curbs with cadmium-plated hardware. Use concealed anchorages where possible. Refer to Section 077200 "Roof Accessories."

C. Install gravity ventilators with clearances for service and maintenance.

D. Install perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

E. Install concealed gaskets, flashings, joint fillers, and insulation as installation progresses. Comply with Section 079200 "Joint Sealants" for sealants applied during installation.
F. Label gravity ventilators according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

G. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.

H. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

END OF SECTION
SECTION 235700 – HYDRONIC HEAT EXCHANGERS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY
A. This Section includes shell-and-tube heat exchangers and plate heat exchangers for HVAC applications.

1.2 SUBMITTALS
A. Product Data: For each model indicated, provide dimensions, weights, capacities at scheduled conditions, required clearances, field assembly method, components, and location and size of each field connection.
B. Operation and maintenance data.

1.3 QUALITY ASSURANCE
A. ASME Compliance: Fabricate and label heat exchangers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1; if applicable due to temperature and pressure requirements.
B. ANSI: Liquid to Liquid heat exchangers shall be tested and performance certified in accordance with ANSI/AHRI Standard 400.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 SHELL-AND-TUBE HEAT EXCHANGERS
A. Manufacturers:

1. Armstrong Pumps, Inc.
2. Bell & Gossett.
3. Taco, Inc.
4. Thrush Company, Inc.
B. Configuration: Straight tube with removable bundle and heads.
C. Shell Materials: Steel.
D. Head:
1. **Materials:** Cast iron.
2. **Flanged and bolted to shell.**

**E. Tube:**

1. Seamless copper tubes.
2. Tube diameter is determined by manufacturer based on service.

**F. Tube sheet Material:** Steel.

**G. Baffles:** Steel.

**H. Piping Connections:**

1. Inlet and outlet fluid connections, threaded drain, and vent connections.

**I. Support Saddles:**

1. Fabricated of material similar to shell.
2. Foot mount with provision for anchoring to support.
3. Fabricate attachment of saddle supports to pressure vessel with reinforcement strong enough to resist heat-exchanger movement during a seismic event when heat-exchanger saddles are anchored to building structure.

### 2.3 GASKETED PLATE HEAT EXCHANGERS

**A. Manufacturers:**

1. Alfa Laval Thermal, Inc.
2. Bell & Gossett
4. Tranter PHE, Inc.

**B. Configuration:** Freestanding assembly consisting of frame support, top and bottom carrying and guide bars, fixed and movable end plates, tie rods, plates, individually removable plates and one-piece gaskets.

**C. Frame:**

1. Capacity to accommodate 20 percent additional plates.
2. Painted carbon steel with provisions for anchoring to support.

**D. Top and Bottom Carrying and Guide Bars:** Painted carbon steel, aluminum, or stainless steel.

1. Fabricate attachment of heat-exchanger carrying and guide bars with reinforcement strong enough to resist heat-exchanger movement during a seismic event when heat-exchanger carrying and guide bars are anchored to building structure.

**E. End-Plate Material:** Painted carbon steel.

**F. Tie Rods and Nuts:** Steel or stainless steel.
G. Plate Material: 0.020 inch thick before stamping; Type 316 Stainless Steel.

H. Gasket Material: EDPM.

I. Piping Connections:
   1. Threaded port for NPS 2 and smaller. For larger sizes, furnish end-plate port with threaded studs suitable for flanged connection.

J. Enclose plates in a solid aluminum removable shroud.

PART 3 - EXECUTION

3.1 HEAT EXCHANGER INSTALLATION

   A. Maintain manufacturer's recommended clearances for service and maintenance. Install piping connections to allow service and maintenance of heat exchangers.

   B. Install shell-and-tube heat exchangers on, and anchor to, saddle supports.

   C. Install plate heat exchangers on, and anchor to, concrete base.

3.2 CONNECTIONS

   A. Install shutoff valves at all heat exchanger inlet and outlet connections.

   B. Install relief valves on each circuit between the heat-exchanger and the heat exchanger shutoff valves. The relief pipe shall be full size from valve connection to floor sink.

   C. Install full size drain with shutoff valve in-line with the lowest connection of each circuit of plate heat exchangers.

   D. If a plate heat exchanger is connected to an open loop system, a full sized backflush crossover must be provided.

END OF SECTION
SECTION 236100 – EVAPORATIVE COOLERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes evaporative coolers consisting of a blower section and cooling section(s).

1.2 SUBMITTALS

A. Product Data:
   1. Provide dimensions, weights, capacities at scheduled conditions, required clearances, components, accessories, and Electrical requirements,
   2. Location and size of each field connection.
   3. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
   4. Design of the support structure

B. Operation and Maintenance data

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Evaporative Coolers: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning" and Section 10 - "Other Equipment."

D. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

1.4 WARRANTY

A. Manufacturer's standard warranty form in which manufacturer agrees to repair or replace components of evaporative coolers that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
   a. Fan, motor, drive shaft, bearings, and motor supports.
   b. Tube bundle.
   c. External-circuit circulating pump.

2. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 COMMERCIAL STYLE EVAPORATIVE COOLERS
   A. Manufacturers:
      2. Phoenix Manufacturing, Inc.
      3. United Metal Products, Inc.

   B. Cabinet Design:
      1. Discharge Openings: Standard unit construction is to include horizontal or vertical air discharge as indicated on Drawings.
      2. Cabinet to be fabricated of 20 gauge hot dipped galvanized steel with electrostatically-applied polyester-epoxy powder-based coating.
      3. Each standard model is to include one (1) removable panel providing access to blower motor drive.

   C. Blower Section:
      1. Fan: Forward-curved or backward-inclined type, rated according to AMCA 210; statically and dynamically balanced, galvanized-steel, centrifugal fan mounted on solid-steel shaft with one (1) set of heavy-duty, self-aligning, prelubricated ball bearings on each side of the fan wheel and an adjustable V-belt drive with matching motor sheaves and belts.
         a. Fan wheel and fan pulley shall be keyed to shaft.
      3. Controls: Switches on thermostat as indicated on Drawings or as required per the sequence of operations.
D. Cooling Section:
   1. Tank: 18 gauge, 304 stainless steel or hot dipped galvanized steel with
      electrostatically-applied polyester-epoxy powder-based coating.
   2. Media: Glas-dek – 12” deep glass mat, fluted, high efficiency evaporative media.
      Matched 2” thick distribution pad to aid in water dispersal. Media shall be U.L.
      approved with a UL 900 class 2 rating.
   3. Water Distribution Header: Copper or PVC header pipe with ports drilled for
      proper water flow.
   4. Pump: Heavy duty submersible pump with balancing valve on discharge for
      proper water flow and carry-over prevention.
   5. Float Valve: Cast brass 3/8” float valve; commercial grade.
   6. Saturating Efficiency: 88% minimum rated at 700 FPM maximum face velocity;
      91% efficiency rated at 500 FPM face velocity.

2.3 INDUSTRIAL STYLE EVAPORATIVE COOLERS

A. Manufacturers:
   1. AZ Evap
   2. Energy Labs, Inc.
   3. United Metal Products, Inc.
   4. Or equivalent upon written approval of Architect/Engineer and SRP O&M
      Management using substitution procedures in Specification 012500.

B. Cabinet & Frame:
   1. Single wall, minimum 16-gauge, 304/316 stainless steel construction with
      stainless steel industrial hex-head fasteners to secure to the tubular steel
      frame.
   2. Weather-tight roof assembly.
   3. Supply air discharge as shown on the Drawings.
   4. Provide one GFI receptacle on exterior of the unit.
   5. Provide internal marine light in each section with weatherproof switch.
   6. Base frame shall be full perimeter, 10 gauge stainless/galvanized steel with
      C-channel steel cross members for supporting floor and major components.
      Integral steel frame shall be constructed so that all exterior panels are not
      load bearing members.
   7. Provide lifting lugs attached to frame as needed.
   8. No part of the base frame shall be used as a reservoir to contain water.
   9. Unit’s roof curbs, when needed, shall be furnished by the manufacturer and
      fabricated of 14-gauge stainless steel, welded, with an integral wood nailer.
      Cant strip and insulation by others.

C. Floor:
   1. Provide 14 gauge, continuously welded 304/316 stainless steel floor that
      spans the entire length and width of the evaporative cooler. All unit
components such as reservoirs, sumps, fan and motor bases shall be mounted above the flooring.

2. The floor shall be designed with adequate underbracing to eliminate any “oil canning” from foot traffic inside the unit.

D. Access Door:

1. Provide hinged, double wall, thermally insulated and gasketed 304/316 stainless steel access doors.
2. Provide a minimum of two heavy-duty compression latches on each door, Ventlock 260 or equal, so that each door can be opened from the inside for safety of O&M personnel.
3. Access doors shall be sized so as to easily remove the largest piece of internal equipment without dismantling that piece of equipment.

E. Supply Fan:

1. Fan Shaft: Shaft shall be made of stress-relieved, ground and polished stainless steel. Shaft critical speed shall be 20 percent higher than the maximum operating speed.
2. Fan Wheel: Mild steel, baked epoxy-coated or baked phenolic-coated.
3. Fan Type: Airfoil centrifugal, AMCA Class 1.
4. Bearings: Anti-friction, self-aligning, pillow block greaseable ball bearings, rated for 200,000 hours L-10 life, with extended lube lines for easy access.
5. Drives: Belt drive with minimum horsepower capacity of 150% of nameplate horsepower. Sheave of non-adjustable type with removable machined bushings and keyed shaft, dynamically balanced at factory.
7. Entire fan, motor and drive assembly shall be mounted on a steel base and supported with spring vibration isolators.
8. Fan shall be tested and rated in accordance with AMCA standard 210.

F. Fan Motor & Drives:

1. Motor for supply fan shall be furnished and installed by the evaporative cooler manufacturer.
2. Motor speed shall be 1800 RPM maximum.
3. Service factor shall be 1.15 or greater and rated for continuous operation at full load amps.
4. Motor shall be cast iron “high efficiency” design and rated in accordance with NEMA test standard MG1-12.53a (1IEEE 112 test standard, method B).
5. Ball bearings shall be cool running, anti-friction bearings with double-shielded lubrication parts on each side. Bearing life shall be 200,000 hours (AFBMNA “FF”, L-10).
6. Name plates shall be stamped with NEMA Standard information, bearing I.D. and lubrication instruction.
7. All sheaves, fixed or variable, shall not exceed the hp rating of the motor.

G. Vibration Control:
1. Install fan/motor assembly on open-spring vibration isolators having a minimum of 1-inch static deflection and side snubbers.

2. Provide flexible connector between fan housing and cabinet.

H. Direct Evaporative Cooling Section:

1. Media:
   a. Media shall be GLASdek as manufactured by Munters Corp., or equal. UL 900, Class 2 rating, with a minimum evaporative effectiveness of 88 percent, designed for maximum entering air velocity of 500 feet per minute.
   b. Media shall be cross-fluted design, self-cleaning and unaffected by atmospheric dust or sand.
   c. Thickness shall be 12-inches in the direction of airflow, including 4-inch removable pre-evaporative section.
   d. Provide Type 304L stainless steel media holding rack.
   e. Design shall allow for no water carry over to the fan section at any time.

2. Recirculating water pump, self priming:
   a. Recirculating water pump shall be centrifugal, submersible type constructed of cast bronze with bronze or stainless steel trim.
   b. Pump capable of delivering 1.5 GPM per square foot of horizontal media area.
   c. Pump shall have suction strainer, thermal and low water cut-off protection.

3. Sump tank:
   a. Sump tank shall be made of minimum 16 gauge, Type 304 or 316 stainless steel with fill, drain and overflow connections.
   b. The reservoir/sump shall not be integral to the base frame or flooring. The sump shall be constructed as a separate component and secured in place on top of the unit flooring.
   c. Provide an adjustable float-operated brass valve for controlling the water level in the sump tank.

4. Water distribution piping:
   a. Distribution piping for recirculating water shall be Type L copper throughout the entire unit.
   b. Distribution headers shall have manual valves for balancing of water flow over evaporative media.

5. Flushing System:
   a. Provide a factory wired and plumbed, distribution header flushing system. The automated flush shall be fully adjustable, utilizing a low
电压时间时钟 sequenced flush cycles. Time clock shall be mounted in the Unit Control Panel.

b. The flushing system shall provide means of preventing clogging of the header and an adjustable method of bleed off. A timed drain event from the sump is not an acceptable means of bleed.

c. Provide a dedicated, internally mounted and wired normally closed solenoid valve for flushing, with manual ball valve for isolation.

6. Protection of Dissimilar Metals

a. All stainless material shall be properly isolated to prevent dissimilar metal contact.

I. Intake Louvers:

1. Type 304 or 316 stainless steel, or aluminum outside air intake with 4-inch deep, 45 degree rainproof, drainable louvers.
2. Provide 1/2-inch mesh, bird screen mounted in a frame.

J. All bolts, nuts and washers utilized shall be Type 410 stainless steel.

K. Unit Control Panel & Electrical:

1. Provide NEMA 3R type panel factory-mounted and wired.
2. Control and power wiring shall be in accordance with UL and NEC requirements.
3. Provide single point power connection.
4. Provide unit thermal magnetic disconnect switch, required 120 volt power transformers and 24 volt control transformers, fuses and fuse clips, marked terminal strips and NEMA rated or IEC magnetic starters with overload protection in each phase for all three phase motors.
5. Provide a safety switch at fan access door to automatically deenergize fan upon opening door.
6. Provide a manual switch on exterior of unit adjacent to fan access door to enable maintenance personnel to deenergize fan prior to entering fan section.
7. Provide a remote-mounted low voltage HIGH-COOL/LOW-COOL/HIGH-VENT/LOW-VENT/OFF mode switch. Furnish cabling of sufficient wire size to enable the mode switch to be installed up to 150 feet away from the Unit Control Panel.

a. When the mode switch is placed in the HIGH or LOW COOL position, the fan and pump shall both operate. The fan speed shall be high or low depending on the switch setting.
b. When the mode switch is placed in HIGH or LOW VENT position, the fan shall operate and the pump shall be deenergized. The fan speed shall be high or low depending on the switch setting.
c. When the mode switch is placed in OFF position, fan and pump shall be deenergized.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Install [ground] [roo]f-mounted units on neoprene pads with 0.15 inch static deflection; refer to Division 15 Section “Mechanical Vibration and Seismic Controls.”

B. Install roof-mounted units on curbs complying with requirements in Division 7.

C. Install coolers on concrete base. Concrete base is specified in Division 15 Section “Common Work Results for HVAC,” and concrete materials and installation requirements are specified in Division 3.

D. Concrete Bases: Anchor coolers to concrete bases with stainless steel anchor bolts.
   1. Install dowel rods to connect concrete base to concrete floor, where applicable. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of the base.
   2. For equipment supported on structural slab, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   4. Cast-in-place concrete materials and placement requirements are specified in Division 3.
   5. Concrete base shall be level prior to setting cleaning system. If required, use grout to assure a level surface.

3.2 CONNECTIONS

A. Maintain manufacturer’s recommended clearances for service and maintenance.

B. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

C. Install piping adjacent to coolers to allow services and maintenance.

D. Connect drain lines to nearest floor sink, or other location as indicated on Drawings.

E. Domestic Water Piping: Comply with applicable requirements in Division 15 Section “Domestic Water Piping.” Connect to water-level control with shut-off valve and union or flange at each connection.

F. Duct installation and connection requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of ducts and duct accessories.

G. Make final duct connections to evaporative coolers with flexible connectors. Flexible connectors are specified in Division 15 Section “Duct Accessories.”
H. Install ducts adjacent to evaporative coolers to allow service and maintenance.

I. Electrical System Corrections: Comply with applicable requirements in Division 16 Sections for power wiring, switches, and motor controls.

J. Ground equipment according to Division 16.

3.3 FIELD QUALITY CONTROL

A. Operation Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.

B. Test & adjust controls and safeties. Replace damaged & malfunctioning controls and equipment.

C. Shut unit down and reconnect automatic temperature-control operators.

D. Refer to Division 17 Section “Testing, Adjusting, and Balancing” for testing, adjusting, and balancing procedures.

E. Adjust or replace fan and motor pulleys as required to achieve design airflow.

END OF SECTION
SECTION 236200 - PACKAGED COMPRESSOR AND CONDENSER UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes packaged, air-cooled, refrigerant compressor and condenser units.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For compressor and condenser units. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Fabricate and label refrigeration system according to ASHRAE 15, "Safety Standard for Refrigeration Systems."

C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6, "Heating, Ventilating, and Air-Conditioning."

1.4 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of compressor and condenser units that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Compressor failure.

b. Condenser coil leak.

2. Warranty Period: Five years (all major components) from date of Substantial Completion.
PART 2 - PRODUCTS

2.1 COMPRESSOR AND CONDENSER UNITS, AIR COOLED, 1 TO 5 TONS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Lennox International Inc.
   2. Trane; a business of American Standard Companies.
   3. YORK; a Johnson Controls company.

B. Description: Factory assembled and tested; consisting of compressor, condenser coil, fan, motors, refrigerant reservoir, and operating controls.

C. Compressor: Scroll, hermetically sealed, with rubber vibration isolators.
   1. Motor: Two speed, and includes thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
   2. Two-Speed Compressor: Include manual-reset, high-pressure switch and automatic-reset, low-pressure switch.

D. Refrigerant: R-407C or R-410A.

E. Condenser Coil: Seamless copper-tube, aluminum-fin coil; circuited for integral liquid subcooler, with removable drain pan and brass service valves with service ports.

F. Condenser Fan: Direct-drive, aluminum propeller fan; with permanently lubricated, totally enclosed fan motor with thermal-overload protection.

G. Accessories:
   2. Honeywell VisionPRO 8000.
      a. Night setback operation with single-stage heating control with seven-day time clock with battery backup or capacitor for retaining programmed information for not less than 48 hours following a power outage
   3. Evaporator Freeze Thermostat: Temperature-actuated switch that stops unit when evaporator reaches freezing temperature.
   5. High-Pressure Switch: Automatic-reset switch cycles compressor off on high refrigerant pressure.
   7. Low-Ambient Controller: Cycles condenser fan to permit operation down to 30 deg F with time-delay relay to bypass low-pressure switch.
   8. Low-Pressure Switch: Automatic-reset switch cycles compressor off on low refrigerant pressure.
   9. PE mounting base.
   11. Sound Hood: Wraps around sound attenuation cover for compressor.
   12. Thermostatic expansion valve.
13. Time-Delay Relay: Continues operation of evaporator fan after compressor shuts off.

H. Unit Casing: Galvanized steel, finished with baked enamel; with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Mount service valves, fittings, and gage ports on exterior of casing.

2.2 COMPRESSOR AND CONDENSER UNITS, AIR COOLED, 6 TO 120 TONS

A. Manufacturers: Subject to compliance with requirements, [provide products by one of the following:
   1. Lennox International Inc.
   2. Trane; a business of American Standard Companies.
   3. YORK; a Johnson Controls company.

B. Description: Factory assembled and tested, air cooled; consisting of casing, compressors, condenser coils, condenser fans and motors, and unit controls.

C. Compressor: Hermetic scroll compressor designed for service with crankcase sight glass, crankcase heater, and backseating service access valves on suction and discharge ports.

   1. Capacity Control: On-off compressor cycling or Variable-frequency controller


E. Condenser Coil: Seamless copper-tube, aluminum-fin coil, including subcooling circuit and backseating liquid-line service access valve. Factory pressure test coils, then dehydrate by drawing a vacuum and fill with a holding charge of nitrogen or refrigerant.

F. Condenser Fan: Propeller-type vertical discharge; either directly or belt driven. Include the following:

   1. Permanently lubricated, ball-bearing totally enclosed motors.
   2. Separate motor for each fan.
   3. Dynamically and statically balanced fan assemblies.

G. Operating and safety controls include the following:

   1. Manual-reset, high-pressure cutout switches.
   2. Automatic-reset, low-pressure cutout switches.
   3. Low-oil-pressure cutout switch.
   4. Compressor-winding thermostat cutout switch.
   5. Three-leg, compressor-overload protection.
   6. Control transformer.
   7. Magnetic contactors for compressor and condenser fan motors.
   8. Timer to prevent excessive compressor cycling.

H. Accessories:
1. Honeywell VisionPRO 8000.
   a. Night setback operation with single-stage heating control with seven-day
      time clock with battery backup or capacitor for retaining programmed
      information for not less than 48 hours following a power outage
2. Low-Ambient Controller: Cycles condenser fan to permit operation down to 0
   deg F with time-delay relay to bypass low-pressure switch.
5. Part-winding-start timing relay, circuit breakers, and contactors.
6. Reversing valve.

2.3 SOURCE QUALITY CONTROL

   A. Energy Efficiency: Equal to or greater than prescribed by ASHRAE/IESNA 90.1,
      Section 6, "Heating, Ventilating, and Air-Conditioning."

PART 3 - EXECUTION

3.1 INSTALLATION

   A. Install units level and plumb, firmly anchored in locations indicated; maintain
      manufacturer's recommended clearances.
   B. Install compressor and condenser units on PE mounting base.
   C. Install compressor and condenser units on concrete base. Concrete materials and
      installation requirements are specified in Section 033000 "Cast-in-Place Concrete."
   D. Install roof-mounting units on equipment supports specified in Section 077200 "Roof
      Accessories."
   E. Vibration Isolation: Mount compressor and condenser units on rubber pads with a
      minimum deflection of 1/4 inch. Vibration isolation devices and installation
      requirements are specified in Section 230548 "Vibration and Seismic Controls for
      HVAC Piping and Equipment."
   F. Maintain manufacturer's recommended clearances for service and maintenance.
   G. Loose Components: Install electrical components, devices, and accessories that are
      not factory mounted.

3.2 CONNECTIONS

   A. Comply with requirements for piping in Section 232113 "Hydronic Piping." Drawings
      indicate general arrangement of piping, fittings, and specialties.
B. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

C. Connect precharged refrigerant tubing to unit's quick-connect fittings. Install tubing so it does not interfere with access to unit. Install furnished accessories.

D. Connect refrigerant piping to air-cooled compressor and condenser units; maintain required access to unit. Install furnished field-mounted accessories. Refrigerant piping and specialties are specified in Section 232300 "Refrigerant Piping."

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test. Certify compliance with test parameters.

2. Leak Test: After installation, charge system with refrigerant and oil and test for leaks. Repair leaks, replace lost refrigerant and oil, and retest until no leaks exist.

3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor operation and unit operation, product capability, and compliance with requirements.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

5. Verify proper airflow over coils.

C. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

END OF SECTION
SECTION 236313 - AIR-COOLED REFRIGERANT CONDENSERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes packaged, air-cooled refrigerant condensers for [outdoor] [indoor] installation.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For air-cooled refrigerant condensers. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

2. Wiring Diagrams: For power, signal, and control wiring.

C. Operation and maintenance data.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carrier Corporation; Commercial HVAC Systems.
2. Trane; a business of American Standard Companies.
3. YORK; a Johnson Controls company.
2.2 MANUFACTURED UNITS

A. Description: Factory assembled and tested; consisting of casing, condenser coils, condenser fans and motors, and unit controls.

B. Refrigerant: R-407C or R-410A

C. Condenser Coil: Factory tested at 425 psig.
   1. Coil Fin: Aluminum
   2. Circuit: To match compressors with liquid subcooling coil.

D. Condenser Fans and Drives: Propeller fans with aluminum fan blades, for vertical air discharge; directly driven with permanently lubricated ball-bearing motors with integral current- and thermal-overload protection.
   1. Weather-proof motors with rain shield and shaft slinger.
   2. Extend grease lines to outside of casing.

E. Operating and Safety Controls: Include condenser fan motor thermal and overload cutouts; 115-V control transformer, if required; magnetic contactors for condenser fan motors and a nonfused factory-mounted and wired disconnect switch for single external electrical power connection.
   1. Fan Cycling Control: [Head pressure switches] [Ambient thermostats].

F. Casings: Galvanized or zinc-coated steel treated and finished with manufacturer's standard paint coating, Aluminum, or stainless steel, designed for outdoor installation with weather protection for components and controls, and with the following:
   1. Removable panels for access to controls, condenser fans, motors, and drives.
   2. Plated or Stainless-steel fan guards.
   3. Lifting eyes.
   4. Removable legs, [20 inches] [30 inches] [36 inches] [42 inches] high.

2.3 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
   1. Enclosure Type: Totally enclosed, fan cooled.
   2. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.4 SOURCE QUALITY CONTROL

A. Testing Requirements: Factory test sound-power-level ratings according to ARI 270.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb, firmly anchored in locations indicated; maintain manufacturer's recommended clearances.

B. Equipment Mounting: Install air-cooled condenser refrigerant condensers using [elastomeric pads] [elastomeric mounts]. Comply with requirements for vibration isolation devices specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."

C. Maintain manufacturer's recommended clearances for service and maintenance.

D. Loose Components: Install electrical components, devices, and accessories that are not factory mounted.

3.2 CONNECTIONS

A. Piping installation requirements are specified in Section 232113 "Hydronic Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Refrigerant Piping: Connect piping to unit with pressure relief, service valve, filter-dryer, and moisture indicator on each refrigerant-circuit liquid line. Refrigerant piping and specialties are specified in Section 232300 "Refrigerant Piping."

3.3 QUALITY CONTROL

A. Complete the manufacturer's installation and startup checklists and resolve all discrepancies.

B. Provide the Commission Agent and SRP PM with the completed checklists/test results.

3.4 TRAINING

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION
SECTION 236333 - EVAPORATIVE REFRIGERANT CONDENSERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Factory-assembled and -tested, [forced] [induced]-draft evaporative refrigerant condensers.

1.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design evaporative refrigerant condenser support structure, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Evaporative refrigerant condenser support structure shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

C. Wind-Restraint Performance:
   1. Basic Wind Speed: <Insert value>.
   2. Building Classification Category: [I] [II] [III] [IV].
   3. Minimum 10 lb/sq. ft. multiplied by the maximum area of the mechanical component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.

D. Seismic Performance: Evaporative refrigerant condenser shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, pressure drop, fan performance data, installation instructions, furnished specialties, and accessories.

B. Shop Drawings: For evaporative refrigerant condensers. Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field piping and wiring connection.
   2. Wiring Diagrams: Power, signal, and control wiring.

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C. Delegated-Design Submittal: For evaporative refrigerant condensers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
2. Wind and Seismic Restraint Details: Detail fabrication and attachment of restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.
3. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include handrails, ladders, and equipment mounting frame.
4. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For evaporative refrigerant condensers, accessories, and components, from manufacturer.

B. Warranties.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASME Compliance: Fabricate and label heat-exchanger coils to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

C. Comply with NFPA 70.

D. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning" and Section 10 - "Other Equipment."

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of evaporative refrigerant condensers that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
   a. Fan, motor, drive shaft, bearings, and motor supports.
   b. Tube bundle.
   c. External-circuit circulating pump.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 FORCED-DRAFT EVAPORATIVE REFRIGERANT CONDENSERS

A. Products: Subject to compliance with requirements, provide one of the following:
   1. Baltimore Aircoil Company; Series V.
   2. EVAPCO, Inc.; Models LSCB.
   3. Recold; Series JC.

B. Fabricate evaporative refrigerant condenser mounting base with reinforcement strong enough to resist evaporative refrigerant condenser movement during a seismic event when evaporative refrigerant condenser is anchored to field support structure.

C. Evaporative refrigerant condenser designed to resist wind load of 30 lbf/sq. ft.

D. Casing and Frame:
   2. Fasteners: [Galvanized] [Stainless] steel.

E. Collection Basin:
   1. Material: [FRP with UV inhibitors] [Galvanized steel, ASTM A 653/A 653M, G210 coating] [Galvanized steel, ASTM A 653/A 653M, G235 coating] [Polymer-coated galvanized steel] [Stainless steel].
   2. Strainer: Removable strainer with openings smaller than nozzle orifices.
   3. Overflow and drain connections.

F. Mechanically Operated, Collection Basin Water-Level Control: Manufacturer's standard adjustable, mechanical float assembly and valve.

G. Water Distribution Piping: Main header and lateral branch piping designed for even distribution over heat exchanger coil throughout the flow range without the need for balancing valves and for connecting individual, removable, nonclogging spray nozzles.
   1. Pipe Material: PVC
2. Spray Nozzle Material: [Plastic] [Polypropylene] [PVC].
3. Piping Supports: Corrosion-resistant hangers and supports designed to resist movement during operation and shipment.

H. Spray Pump: Close-coupled, end-suction, single-stage, bronze-fitted centrifugal pump; with suction strainer and flow balancing valve, and mechanical seal suitable for outdoor service.

1. General Requirements for Spray Pump Motor: Comply with NEMA designation and temperature-rating requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment" and not indicated below.

I. Heat-Exchanger Coils:

1. Tube and Tube Sheet Materials: [Copper tube with stainless-steel sheet] [Stainless-steel tube and sheet]
2. Heat-Exchanger Arrangement: [Serpentine tubes] [Serpentine tubes with removable cover plate on inlet and outlet headers] [Straight tubes with removable header cover plate on both ends of heat exchanger for straight-through access to each tube]; and sloped for complete drainage of fluid by gravity.
3. ASME Compliance: Designed, manufactured, and tested according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, and bearing ASME "U" stamp; and sloped for complete drainage of fluid by gravity.

J. [Removable] Drift Eliminator:

1. Material: [FRP] [PVC] [FRP or PVC]; with maximum flame-spread index of [5] [25] according to ASTM E 84.
2. UV Treatment: Inhibitors to protect against damage caused by UV radiation.
3. Configuration: Multipass, designed and tested to reduce water carryover to achieve performance indicated.

K. [Removable] Air-Intake Screens: [Polymer-coated, galvanized] [Stainless]-steel wire mesh.

L. Centrifugal Fan: Double-width, double-inlet fan with forward-curved blades; and statically and dynamically balanced at the factory after assembly.

M. Belt Drive:

1. Service Factor: 1.5 based on motor nameplate horsepower.
2. Sheaves: Fan and motor shafts shall have taper-lock sheaves fabricated from corrosion-resistant materials.
4. Belt Material: Oil resistant, nonstatic conducting, and constructed of neoprene polyester cord.
5. Belt-Drive Guard: Comply with OSHA regulations.
N. Fan Motor:
   1. General Requirements for Fan Motors: Comply with NEMA designation and temperature-rating requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment" and not indicated below.

O. Discharge Hoods:
   1. Hood Configuration: [Tapered] [Straight]; totally surrounding drift eliminators and constructed of same material as casing; and having factory-installed access doors.
   2. Discharge Dampers: Positive-closure, automatic, isolation dampers with electric actuators.
      a. Provide field power and controls to open dampers when pump is energized and close dampers when pump is de-energized.

P. Capacity-Control Dampers: [Galvanized-steel] [Stainless-steel] dampers, with linkages, electric operator, controller, limit switches, transformer, and weatherproof enclosure.

Q. Vibration Switch: For each fan drive.
   1. Enclosure: NEMA 250, [Type 4].
   2. Provide switch with manual-reset button for hardwired connection to fan motor electrical circuit.
   3. Switch shall, on sensing excessive vibration, shut down the fan.

R. Controls: Comply with requirements in Section 230900 "Instrumentation and Control for HVAC."

S. Control Package: Factory installed and wired, and functionally tested at factory before shipment.
   1. NEMA 250, Type 4 enclosure with removable internally mounted backplate.
   2. Control-circuit transformer with primary and secondary side fuses.
   3. Terminal blocks with numbered and color-coded wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment.
   4. Microprocessor-based controller for automatic control of fan and spray pump based on evaporative refrigerant condenser leaving-water temperature with control features to improve operating efficiency based on outdoor ambient wet-bulb temperature by using adaptive logic.
   5. Fan motor sequencer for multiple-cell and two-speed applications with automatic lead-stage rotation.
7. Vibration switch for each fan, complying with requirements in "Vibration Switch" Paragraph.
8. Controls and wiring for "two-motor, single-fan drives" shall be same as two-speed, two-winding motor.
9. Power and controls to open discharge hood dampers when pump is energized and close dampers when pump is de-energized.
10. Single-point, field-power connection to a fused disconnect switch
   a. Branch power circuit to each motor and electric basin heater and to controls with a disconnect switch or circuit breaker.
   b. NEMA-rated motor controller, hand-off-auto switch, and overcurrent protection for each motor. Provide variable frequency controller with manual bypass and line reactors for each variable-speed motor indicated.
11. Factory-installed wiring outside of enclosures shall be in metal raceway, except make connections to each motor and electric basin heater with liquidtight conduit.
12. Visual indication of status and alarm for each motor.
13. Audible alarm and silence switch.
14. Visual indication of elapsed run time, graduated in hours for each motor.

T. Personnel Access Components:

1. Doors: Large enough for personnel to access evaporative refrigerant condenser internal components from evaporative refrigerant condenser end walls.
2. External Ladders with Safety Cages: Aluminum, galvanized- or stainless-steel, fixed ladders with ladder extensions to access external platforms and top of evaporative refrigerant condenser from adjacent grade without the need for portable ladders. Comply with 29 CFR 1910.27.
3. External Platforms with Handrails: Aluminum, FRP, or galvanized-steel bar grating at evaporative refrigerant condenser access doors when evaporative refrigerant condensers are elevated and not accessible from grade.

U. Capacities and Characteristics:

1. Number of Cells: <Insert quantity>.
2. Maximum Drift Loss: [0.005] <Insert number> percent of design water flow.
3. Heat-Exchanger Coil(s):
   a. Refrigerant Type [R-407C] [R-410A] [HFC-134a].
   c. Condensing Temperature: <Insert deg F>.
   d. Entering-Air Wet-Bulb Temperature: <Insert deg F>.
4. Fan Location: [Bottom] [Side].
5. Fan Motor:
a. Type: [Single speed] [Two speed, single winding] [Two speed, two winding] [Variable speed].

6. Spray Pump and Motor:
   c. Full-Load Ampacity: <Insert value>.
   d. Minimum Circuit Ampacity: <Insert value>.
   e. Maximum Overcurrent Protection Device: <Insert amperage>.
   f. Electrical Characteristics: [120] [208] [240] [277] [480] <Insert value>-V ac, [single] [3] phase, 60 Hz.

7. Sound Pressure Level: <Insert dBA> at <Insert distance in feet> [when measured according to CTI ATC 128].

2.2 EVAPORATIVE REFRIGERANT CONDENSERS

A. Products: Subject to compliance with requirements, provide one of the following:
   1. Baltimore Aircoil Company; Series CXV.
   2. EVAPCO, Inc.; Models ATC.
   3. Recold; Series MC.

B. Fabricate evaporative refrigerant condenser mounting base with reinforcement strong enough to resist evaporative refrigerant condenser movement during a seismic event when evaporative refrigerant condenser is anchored to field support structure.

C. Evaporative refrigerant condenser designed to resist wind load of 30 lbf/sq. ft.

D. Casing and Frame:
   2. Fasteners: [Galvanized] [Stainless] steel.

E. Collection Basin:
   2. Overflow and drain connections.

F. Mechanically Operated, Collection Basin Water-Level Control: Manufacturer's standard adjustable, mechanical float assembly and valve.
G. Retain first paragraph below to require basin heaters for projects subject to freezing conditions. See Evaluations.

H. Pressurized Water Distribution Piping: Main header and lateral branch piping designed for even distribution over heat-exchanger coil throughout the flow range without the need for balancing valves and for connecting individual, removable, nonclogging spray nozzles.

1. Pipe Material: [Fiberglass] [PVC] [Galvanized steel] <Insert material>.
2. Spray Nozzle Material: [Plastic] [Polypropylene] [PVC] <Insert material>.
3. Piping Supports: Corrosion-resistant hangers and supports to resist movement during operation and shipment.

I. Recirculating Piping: PVC.

J. Spray Pump: Close-coupled, end-suction, single-stage, bronze-fitted centrifugal pump; with suction strainer and flow balancing valve, and mechanical seal suitable for outdoor service.

1. General Requirements for Spray Pump Motor: Comply with NEMA designation and temperature-rating requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment" and not indicated below.

K. Heat-Exchanger Coils:

1. Tube and Tube Sheet Materials: [Copper tube with stainless-steel sheet] [Stainless-steel tube and sheet] [Prime-coated steel tube and sheet with outer surface of tube and sheet hot-dip galvanized after fabrication].
2. Heat-Exchanger Arrangement: [Serpentine tubes] [Serpentine tubes with removable cover plate on inlet and outlet headers] [Straight tubes with removable header cover plate on both ends of heat exchanger for straight-through access to each tube]; and sloped for complete drainage of fluid by gravity.
3. ASME Compliance: Designed, manufactured, and tested according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, and bearing ASME "U" stamp; and sloped for complete drainage of fluid by gravity.

L. [Removable] Drift Eliminator:

1. Material: [FRP] [PVC] [FRP or PVC] <Insert material>; with maximum flame-spread index of 25 according to ASTM E 84.
2. Configuration: Multipass, designed and tested to reduce water carryover to achieve performance indicated.

M. Air-Intake Louvers:

1. Material: [FRP] [PVC] [Matching casing].
2. Louver Blades: Arranged to uniformly direct air into evaporative refrigerant condenser, to minimize air resistance, and to prevent water from splashing out during all modes of operation including operation with fans off.

N. Axial Fan: Balanced at the factory after assembly.
   1. Blade Material: [Aluminum] [FRP] [Galvanized steel].
   5. Fan Shaft Bearings: Self-aligning, grease-lubricated ball or roller bearings with moisture-proof seals and premium, moisture-resistant grease suitable for temperatures between minus 20 and plus 300 deg F. Bearings designed for an L-10 life of [40,000] [50,000] <Insert value> hours.
   6. Bearings Grease Fittings: Extended lubrication lines to an easily accessible location.

O. Belt Drive:
   1. Service Factor: [1.5] <Insert value> based on motor nameplate horsepower.
   2. Sheaves: Fan and motor shafts shall have taper-lock sheaves fabricated from corrosion-resistant materials.
   4. Belt Material: Oil resistant, nonstatic conducting, and constructed of neoprene polyester cord.
   5. Belt-Drive Guard: Comply with OSHA regulations.

P. Fan Motor:
   1. General Requirements for Fan Motors: Comply with NEMA designation and temperature-rating requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment" and not indicated below.
   5. Motor Base: Adjustable, or other suitable provision for adjusting belt tension.

Q. Fan Discharge Stack: Material shall match casing.
   1. Stack Extension: Fabricated to extend above fan deck <Insert distance> unless otherwise indicated.
   2. Stack Termination: Wire-mesh, galvanized-steel screens; complying with OSHA regulations.

R. Vibration Switch: For each fan drive.
   1. Enclosure: NEMA 250, Type 4.
2. Provide switch with manual-reset button for hardwired connection to fan motor electrical circuit.
3. Switch shall, on sensing excessive vibration, shut down the fan.

S. Controls: Comply with requirements in Section 230900 "Instrumentation and Control for HVAC."

T. Control Package: Factory installed and wired, and functionally tested at factory before shipment.
   1. NEMA 250, Type 4 enclosure with removable internally mount backplate.
   2. Control-circuit transformer with primary and secondary side fuses.
   3. Terminal blocks with numbered and color-coded wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment.
   4. Microprocessor-based controller for automatic control of fan and spray pump based on evaporative refrigerant condenser leaving-water temperature with control features to improve operating efficiency based on outdoor ambient wet-bulb temperature by using adaptive logic.
   5. Fan motor sequencer for multiple-cell and two-speed applications with automatic lead-stage rotation.
   7. Vibration switch for each fan, complying with requirements in "Vibration Switch" Paragraph.
   8. Single-point, field-power connection to a fused disconnect switch.
   9. Factory-installed wiring outside of enclosures shall be in metal raceway, except make connections to each motor and electric basin heater with liquidtight conduit.
10. Visual indication of status and alarm for each motor.
11. Audible alarm and silence switch.
12. Visual indication of elapsed run time, graduated in hours for each motor.

U. Personnel Access Components:
   1. Doors: Large enough for personnel to access evaporative refrigerant condenser internal components from both evaporative refrigerant condenser end walls. Doors shall be operable from both sides of the door.
   2. External Ladders with Safety Cages: Aluminum, galvanized- or stainless-steel, fixed ladders with ladder extensions to access external platforms and top of evaporative refrigerant condenser from adjacent grade without the need for portable ladders. Comply with 29 CFR 1910.27.
   3. External Platforms with Handrails: Aluminum, FRP, or galvanized-steel bar grating at evaporative refrigerant condenser access doors when evaporative refrigerant condensers are elevated and not accessible from grade.

V. Capacities and Characteristics:
   1. Number of Cells: <Insert quantity>.
   2. Maximum Drift Loss: [0.005] <Insert number> percent of design water flow.

VER:02/11  EVAPORATIVE REFRIGERANT CONDENSERS
3. Heat-Exchanger Coil:
   a. Refrigerant Type [R-407C] [R-410A] [HFC-134a]
   b. Refrigerant Type: R-407C, R-410A, or HFC-134a.
   d. Condensing Temperature: <Insert deg F>.
   e. Entering-Air Wet-Bulb Temperature: <Insert deg F>.

4. Fan Motor:
   a. Type: [Single speed] [Two speed, single winding] [Two speed, two winding] [Variable speed].

5. Spray Pump and Motor:
   c. Full-Load Ampacity: <Insert value>.
   d. Minimum Circuit Ampacity: <Insert value>.
   e. Maximum Overcurrent Protection Device: <Insert amperage>.
   f. Electrical Characteristics: [120] [208] [240] [277] [480] <Insert value>-V ac, [single] [3] phase, 60 Hz.

6. Sound Pressure Level: <Insert dBA> at <Insert distance in feet> [when measured according to CTI ATC 128].

PART 3 - EXECUTION

3.1 INSTALLATION

A. Equipment Mounting: Install evaporative refrigerant condensers on concrete base(s). Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete"

B. Maintain manufacturer's recommended clearances for service and maintenance.

C. Loose Equipment: Install electrical components, devices, and accessories that are not factory mounted.

D. Install piping adjacent to evaporative refrigerant condensers to allow service and maintenance.

E. Install flexible pipe connectors at final connection of evaporative refrigerant condensers mounted on vibration isolators.

F. Run overflow, drain, and bleed lines to sanitary sewage system.

G. Domestic Water Piping: Comply with requirements in Section 221116 "Domestic Water Piping." Connect to water-level control with shutoff valve and union or flange at each connection.
H. Refrigerant Piping: Comply with requirements in Section 232300 "Refrigerant Piping." Connect to evaporative refrigerant condenser coil with isolation valves at each connection.

I. Ducts: Comply with requirements in Section 233113 "Metal Ducts." Connect ducts to evaporative refrigerant condenser inlet and outlet, full size of outlet, with flexible duct connection.

3.2 STARTUP SERVICE

A. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.

B. Obtain performance tables from manufacturer.

C. Engage a factory-authorized service representative to perform installation check and startup service.

3.3 TRAINING

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain evaporative refrigerant condensers.

END OF SECTION
SECTION 236416 - CENTRIFUGAL WATER CHILLERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes packaged, water-cooled, electric-motor-driven, centrifugal water chillers with the following features:

1. Motor controller.
2. Microprocessor-based controls.

B. See Division 23 Section "Refrigerant Detection and Alarm" for refrigerant monitors, alarms, and ventilation equipment interlocks.

1.2 SUBMITTALS

A. Product Data: For each model indicated, provide the following:

1. Dimensioned prints of water chiller assemblies, including control panels, sections, and elevations, and unit isolation.
2. Structural support requirements.
3. Piping roughing-in requirements.
4. Wiring roughing-in requirements, including spaces reserved for electrical equipment.
5. Access requirements, including working clearances for mechanical controls and electrical equipment, and tube pull and service clearances.

B. Operation and maintenance data.

C. Warranties: Special warranties specified in this Section.

1.3 QUALITY ASSURANCE

A. ARI Certification: Signed by manufacturer certifying compliance with requirements in ARI 550/590, "Water Chilling Packages Using the Vapor Compression Cycle."

B. ASHRAE Certification: Signed by manufacturer certifying compliance with ASHRAE 15 for safety code for mechanical refrigeration. Comply with ASHRAE Guideline 3 for refrigerant leaks, recovery, and handling and storage requirements.

C. ASME Compliance: Fabricate and label water chiller heat exchangers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

D. Comply with NFPA 70.

E. Comply with UL 1995.
1.4 WARRANTY

A. Special Warranty: (5) five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. YORK International Corporation.

2.2 PACKAGED WATER CHILLERS

A. Description: Factory-assembled and -tested water chiller complete with compressor, evaporator, condenser, controls, interconnecting unit piping and wiring, indicated accessories, and mounting frame.

2.3 COMPRESSORS

A. Description: Variable displacement with gear- or direct-drive, [open or] hermetically sealed motor.
   1. Casing: Cast iron, precision ground.
   2. Impeller: High strength, cast-aluminum alloy on carbon or forged-steel shaft; dynamically balanced.

B. Capacity Control: Variable-inlet guide-vane assembly for stable operation that is free of surge, cavitation, or vibration throughout throttling range from 100 to 10 percent of full load.

C. Oil Lubrication System: Positive-displacement submersible pump with heater, oil filter, and sight glass.

D. Refrigerant and Oil: HFC-134a with compatible oil.

E. Refrigerant Compatibility: Seals, O-rings, motor windings on hermetic compressors, and internal water chiller parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.

2.4 HEAT EXCHANGERS

A. Evaporator:
   1. Description: Shell-and-tube design, ASME labeled.
   3. Tube Construction: Individually replaceable, expanded into tube sheets.
a. Material: Copper.
b. Minimum Size: 3/4-inch OD; 0.028-inch wall thickness.
c. Internal Finish: Enhanced.

4. Water Box: Standard, with design working pressure of 150 psig, and having flanged or grooved mechanical-joint coupling water-nozzle connections with a thermistor-type temperature sensor factory installed in each nozzle. Provide vent and drain connections with plugs.

B. Condenser:

1. Description: Shell-and-tube design, ASME labeled.
3. Tube Construction: Externally enhanced and individually replaceable, expanded into tube sheets.
   a. Material: Copper.
   b. Minimum Size: 3/4-inch OD; 0.028-inch wall thickness.
   c. Internal Finish: Enhanced.
4. Water Box: Standard, with design working pressure of 150 psig, and having flanged or grooved mechanical-joint coupling water-nozzle connections with a thermistor-type temperature sensor factory installed in each nozzle. Provide vent and drain connections with plugs.

2.5 INSULATION

A. Cold Surfaces: Closed-cell, flexible elastomeric, thermal insulation complying with ASTM C 534, Type II, for sheet materials.

2.6 PAINT

A. Paint: Factory coat all exposed surfaces with enamel primer and finish coat, or baked-on powder paint.

2.7 ACCESSORIES

A. Pressure Relief Devices.

1. Rupture Disc: Frangible carbon disc on HCFC-123 water chillers.
2. Relief Valve: Single or multiple-reseating-type, spring-loaded relief valve on HFC-134a water chillers.

B. Purge System: On water chiller which utilize HCFC-123 refrigerant, provide a factory mounted, air, water, or refrigerant cooled purge system; with operating controls, piping, elapsed-time meter, and refrigerant service valves to isolate the purge unit from the chilling unit.

2.8 CONTROLS
A. Control Panel: Stand-alone, microprocessor based, factory-wired to control transformer in starter.

B. Enclosure: Unit-mounted, NEMA 250, Type 1 enclosure, hinged and lockable.

C. Status Display: Multiple-character liquid-crystal display or light-emitting diodes and keypad. Display the following conditions:
   1. Date and time.
   2. Operating or alarm status.
   3. Operating hours.
   4. Temperature and pressure operating set points.
   5. Entering and leaving temperatures of chilled water and condenser water.
   6. Refrigerant pressures in evaporator and condenser.
   7. Saturation temperature in evaporator and condenser.
   8. Oil temperature and pressure.
  11. Number of compressor starts.
  12. Purge suction temperature if purge system is provided.
  13. Purge elapsed time if purge system is provided.

D. Control Functions:
   1. Manual or automatic startup and shutdown time schedule.
   2. Leaving chilled-water temperature, and motor load limit.
   3. Current limit and demand limit.
   4. External water chiller emergency stop.

E. Manually Reset Safety Controls: The following conditions shall shut down water chiller and require manual reset:
   1. Low evaporator pressure or temperature.
   2. High condenser pressure.
   3. Low chilled-water temperature.
   4. Low oil differential pressure.
   5. High or low oil pressure.
   6. High oil temperature.
   7. High compressor-discharge temperature.
   8. Loss of chilled or condenser-water flow.
  10. Sensor or detection-circuit fault.
  11. Processor communication loss.
  12. Starter fault.
  13. Extended compressor surge.
  14. Excessive air-leakage detection (for water chillers utilizing HCFC-123 refrigerant).
  15. Phase failure and undervoltage conditions.

F. Building Automation System Interface: Furnish terminal strip connections for the following:
   1. Chiller enable/disable.
   2. Leaving chilled water temperature setpoint adjustment (0-10 VDC 4-20mA).
   3. External demand limit setpoint adjustment (0-10 VC 4-20mA).
   4. General chiller alarm contact closure.
2.9 MOTORS

A. Comply with requirements in Division 15 Section "Common Motor Requirements for HVAC Equipment".

1. Open-drive motors shall have flanged or flexible coupling suitable for direct connection to compressor. Provide OSHA compliant guard over coupling.

2.10 MAGNETIC ENCLOSED STARTERS

A. Enclosure: [Unit mounted] [Floor mounting], NEMA 250, Type 1, with hinged access door with lock and key or padlock and key.

B. Control Circuit: 120 V; obtained from integral control power transformer of enough capacity to operate connected pilot and indicating and control devices.

C. Overload Relay: Shall be sized according to UL 1995 or shall be an integral component of water chiller control microprocessor.

D. Starter Type: Furnish a [star-delta starter] [or] [solid-state, reduced-voltage controller].

E. [Across-the-Line Starter: NEMA ICS 2, Class A, full voltage, nonreversing; include isolation switch and current-limiting fuses.]

F. Star-Delta Starter: NEMA ICS 2, closed transition.

G. Solid-State, Reduced-Voltage Controller: NEMA ICS 2.

1. Surge suppressor in solid-state power circuits providing 3-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.

2. Light-emitting-diode indicators showing motor and control status, including the following conditions:
   a. Controller on.
   b. Overload trip.
   c. Loss of phase.
   d. Starter fault.

H. Circuit Breaker: High interrupting circuit breaker with ground fault protection meeting all local short circuit withstand ratings. Short circuit withstand rating shall be stamped on breaker. Circuit breaker to be interlocked to disconnect line power from the starter when the starter door is open.

I. Accessories: Devices shall be factory installed in controller enclosure, unless otherwise indicated.


2. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

2.11 SOURCE QUALITY CONTROL

A. Factory test and rate water chillers, before shipping, according to ARI 550/590, "Water Chilling Packages Using the Vapor Compression Cycle." Stamp with ARI label.

B. Factory test heat exchangers hydrostatically at 1.50 times the design pressure.

C. Factory test and inspect evaporator and water-cooled-condenser according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. Stamp with ASME label.

D. Factory test and inspect water boxes at 150 percent of working pressure.

E. Rate sound power level according to ARI 575 procedure.

PART 3 - EXECUTION

3.1 WATER CHILLER INSTALLATION

A. Install water chillers on concrete base. Concrete base is specified in Division 15 Section "Common Work Results for HVAC," and concrete materials and installation requirements are specified in Division 3.

B. Concrete Bases: Anchor chiller mounting frame to concrete base.
   1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
   2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   4. Install anchor bolts to elevations required for proper attachment to supported equipment.
   5. Cast-in-place concrete materials and placement requirements are specified in Division 3.

C. Vibration Isolation: Neoprene pads furnished by the water chiller manufacturer with a minimum deflection of 0.25 inch. Vibration isolation devices and installation requirements are specified in Division 23 Section "Vibration [and Seismic] Controls for HVAC Piping and Equipment."

D. Maintain manufacturer's recommended clearances for service and maintenance.

E. Charge water chiller with refrigerant if not factory charged.

F. Install separate devices furnished by manufacturer.

3.2 CONNECTIONS

A. Chilled and condenser-water piping installation requirements are specified in Division 23 Section "Hydronic Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
B. Install piping adjacent to water chillers to allow service and maintenance.

C. Evaporator Connections: Connect inlet to evaporator with controller-bulb well, shutoff valve, thermometer and pressure gage. Connect outlet to evaporator with throttling valve, flow switch, thermometer, pressure gage, and drain line with shutoff valve.

D. Condenser Connections: Connect inlet to condenser with shutoff valve, thermometer, and pressure gage. Connect outlet to condenser with throttling valve, thermometer, pressure gauge, flow switch, and drain line with shutoff valve.

E. Refrigerant Pressure Relief Valve Connections: Extend vent piping to the outside without valves or restrictions.

F. Ground water chillers according to Division 26.

G. Connect wiring according to Division 26.

3.3 STARTUP SERVICE

A. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.

B. Engage a factory-authorized service representative to complete the installation and startup checks according to the manufacturer's written instructions and perform the following:

1. Verify that refrigerant charge is sufficient and water chiller has been leak tested.
2. Verify that pumps are installed and functional.
3. Verify that thermometers and gages are installed.
4. Operate water chiller for run-in period according to manufacturer's written instructions.
5. Check bearing lubrication and oil levels.
6. Verify that refrigerant pressure relief is vented outside.
7. Verify proper motor rotation.
8. Verify static deflection of vibration isolators, including during startup and shutdown.
11. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.

C. Prepare a written startup report that records results of tests and inspections.

D. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train the Owner's maintenance personnel adjust, operate and maintain the chiller. Provide not less than 4 hours of training.

END OF SECTION
SECTION 236426 - ROTARY-SCREW WATER CHILLERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes packaged, water cooled or air cooled as scheduled, electric-motor-driven, rotary-screw water chillers with the following features:
   1. Motor controller.
   2. Microprocessor-based controls.

1.2 SUBMITTALS

A. Product Data: For each model indicated, provide the following:

B. 1. Dimensioned prints of water chiller assemblies, including control panels, sections, and elevations, and unit isolation.
   2. Structural support requirements.
   3. Piping roughing-in requirements.
   4. Wiring roughing-in requirements, including spaces reserved for electrical equipment.
   5. Access requirements, including working clearances for mechanical controls and electrical equipment, and tube pull and service clearances.

C. Operation and maintenance data.

D. Warranties: Special warranties specified in this Section.

1.3 QUALITY ASSURANCE

A. ARI Certification: Signed by manufacturer certifying compliance with requirements in ARI 550/590, "Water Chilling Packages Using the Vapor Compression Cycle."

B. ASHRAE Certification: Signed by manufacturer certifying compliance with ASHRAE 15 for safety code for mechanical refrigeration. Comply with ASHRAE Guideline 3 for refrigerant leaks, recovery, and handling and storage requirements.

C. ASME Compliance: Fabricate and label water chiller heat exchangers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

D. Comply with NFPA 70.

E. Comply with UL 1995.

1.4 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to provide parts, labor and refrigerant to repair or replace components of water chillers that fail in materials or
workmanship within manufacturer’s standard warranty period, but not less than five years from
date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the
   following:
   1. Trane Company
   2. YORK International Corporation.
   3. Daikin

2.2 PACKAGED WATER CHILLERS

A. Description: Factory-assembled and -tested water-cooled, water chiller complete with
   compressor, evaporator, condenser, controls, interconnecting unit piping and wiring, indicated
   accessories, and mounting frame.

   –OR–

B. Description: Factory-assembled and -tested air-cooled, water chiller complete with casing,
   compressor, heat exchanger, condenser coils and fans, and controls integrated with compressor
   operation. Controls shall permit operation down to 25 degrees F.
   2. Fans: Propeller type, statically and dynamically balanced, with vertical air discharge for
      high efficiency and low sound; located in its own compartment to eliminate cross flow of
      condenser air during fan cycling; and equipped with heavy-gage, weather-protected fan
      guard.
   3. Fan Motor: Direct drive, weatherproof, with bearings permanently lubricated, and having
      built-in current- and thermal-overload protection.

2.3 COMPRESSORS

A. Description: Positive displacement, oil injected with direct-drive, semi-hermetically sealed
   motor/compressor assembly operating at 3,600 rpm and 60 Hz.
   1. Casing: Cast iron, precision machined for minimum clearance about periphery of rotors.
   2. Rotors: Twin screw.
   3. The motor is a suction gas cooled, hermetically sealed, squirrel cage induction motor.

B. Capacity Control: Modulating or stepped sliding valve to maintain chilled-water temperature set
   point without hunting within throttling range. Throttling range shall be from 100 to 20 percent of
   full load at the scheduled entering condenser water temperature.

C. Oil Lubrication System: Positive-displacement submersible pump with heater, oil filter, and sight
   glass.

D. Refrigerant and Oil: HFC-134a.
E. Refrigerant Compatibility: Seals, O-rings, motor windings on semi-hermetic compressors, and internal water chiller parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.

F. Refrigerant Circuit: Provide quantity of independent circuits, as indicated on Drawings. Each circuit shall include an electronic expansion valve, compressor suction and discharge shutoff valves, a liquid-line shutoff valve, a replaceable-core filter drier, a sight glass with moisture indicator, a liquid-line solenoid valve, and an insulated suction line.

2.4 HEAT EXCHANGERS

A. Evaporator:
1. Description: Shell-and-tube design, ASME labeled.
3. Tube Construction: Individually replaceable, expanded into tube sheets.
   a. Material: Copper.
   b. Minimum Size: 3/4-inch OD; 0.028-inch wall thickness.
   c. Internal Finish: Enhanced.
4. Water Box: Standard, with design working pressure of 150 psig, and having flanged or grooved mechanical-joint coupling water-nozzle connections with a thermistor-type temperature sensor factory installed in each nozzle. Provide vent and drain connections with plugs.

B. Condenser:
1. Description: Shell-and-tube design, ASME labeled.
3. Tube Construction: Externally enhanced and individually replaceable, expanded into tube sheets.
   a. Material: Copper.
   b. Minimum Size: 3/4-inch OD; 0.028-inch wall thickness.
   c. Internal Finish: Enhanced.
4. Water Box: Standard, with design working pressure of 150 psig, and having flanged or grooved mechanical-joint coupling water-nozzle connections with a thermistor-type temperature sensor factory installed in each nozzle. Provide vent and drain connections with plugs.

C. Air-Cooled Condenser: Copper tubes with mechanically bonded aluminum fins with corrosion-resistant coating, integral sub-cooling circuit, leak-tested at 400 psig.
1. Safety and Operating Options: Low-ambient controls for operation down to 25 degrees F.

2.5 INSULATION

A. Cold Surfaces: Closed-cell, flexible elastomeric, thermal insulation complying with ASTM C 534, Type II, for sheet materials.

2.6 ACCESSORIES

A. Pressure Relief Valve: Single- or multiple, spring-loaded relief valve.

B. Base rails suitable for forklifting the chiller assembly.
C. Flanged water connections.

2.7 CONTROLS

A. Control Panel: Stand-alone, microprocessor based, factory-wired to control transformer in starter.

B. Enclosure: Unit-mounted, NEMA 250, Type 12 enclosure, hinged and lockable.

C. Status Display: Multiple-character liquid-crystal display or light-emitting diodes and keypad. Display the following conditions:
   1. Date and time.
   2. Operating or alarm status.
   3. Operating hours.
   4. Temperature and pressure of operating set points.
   5. Entering and leaving temperatures of chilled water.
   6. Refrigerant pressures in evaporator and condenser.
   7. Saturation temperature in evaporator and condenser.
   8. Oil temperature and pressure.
  11. Number of compressor starts.

D. Control Functions:
   1. Manual or automatic startup and shutdown time schedule.
   2. Leaving chilled-water temperature and motor load limit.
   3. Current limit and demand limit.
   4. External water chiller emergency stop.

E. Manually Reset Safety Controls: The following conditions shall shut down water chiller and require manual reset:
   1. Low evaporator pressure or temperature.
   2. High condenser pressure.
   3. Low chilled-water temperature.
   4. Low oil differential pressure.
   5. High or low oil pressure.
   6. High oil temperature.
   7. High compressor-discharge temperature.
   8. Electrical overload.
   9. Sensor- or detection-circuit fault.
  11. Starter fault.

F. Building Automation System Interface: Provide a BACnet BCI-C interface for communication with the existing Building Automation System.

2.8 MOTORS

A. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment".
2.9 MAGNETIC ENCLOSED STARTERS

A. Enclosure: Unit mounted, NEMA 250, Type 12, with hinged access door with lock and key.

B. Control Circuit: 120 V; obtained from integral control power transformer of enough capacity to operate connected pilot and indicating and control devices.

C. Overload Relay: Shall be sized according to UL 1995 or shall be an integral component of water chiller control microprocessor.

D. Wye-Delta Starter: NEMA ICS 2, closed transition.

E. Solid-State, Reduced-Voltage Starter: NEMA ICS 2.
   1. Surge suppressor in solid-state power circuits providing 3-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
   2. Light-emitting-diode indicators showing motor and control status, including the following conditions:
      a. Controller on.
      b. Overload trip.
      c. Loss of phase.
      d. Starter fault.

F. Circuit Breaker: High interrupting circuit breaker with ground fault protection meeting all local short circuit withstand ratings. Short circuit withstand rating shall be factory-stamped on breaker. Circuit breaker to be interlocked to disconnect line power from the starter when the starter door is opened.

2.10 SOURCE QUALITY CONTROL

A. Factory test and rate water chillers, before shipping, according to ARI 550/590, "Water Chilling Packages Using the Vapor Compression Cycle." Stamp with ARI label.

B. Factory test heat exchangers hydrostatically at 1.50 times the design pressure.

C. Factory test and inspect evaporator and water-cooled condenser according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. Stamp with ASME label.

D. Factory test and inspect water boxes at 150 percent of working pressure.

E. Rate sound power level according to ARI 575 procedure.

F. Rate sound power level according to ARI 370 procedure.

PART 3 - EXECUTION

3.1 WATER CHILLER INSTALLATION

A. Install water chillers on concrete base. Concrete base is specified in Section 230515 "Common Work Results for HVAC".
B. Concrete Bases: Anchor chiller mounting frame to concrete base.
   1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
   2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   4. Install anchor bolts to elevations required for proper attachment to supported equipment.
   5. Cast-in-place concrete materials and placement requirements are specified in Division 3.

C. Install water chiller on steel support structure.
   1. Refer to Structural Drawings for steel support structure.
   2. Coordinate exact location of structural support members with General Contractor.
   3. Steel support structure shall be leveled prior to setting water chiller in place.
   4. Bolt water chiller to structural members or vibration isolators in strict conformance with manufacturer's recommendations.

D. Vibration Isolation: Neoprene pads with a minimum deflection of 0.25 inch. Vibration isolation devices and installation requirements are specified in Section 230548 "Vibration Controls for HVAC Piping and Equipment."

E. Vibration Isolation: Mount water chiller on vibration isolation equipment base as specified in Section 230540 "Vibration Controls for HVAC Piping and Equipment."

F. Installation shall comply with the manufacturer's installation instructions and applicable codes. Maintain manufacturer's recommended clearances for service and maintenance.

G. Charge water chiller with refrigerant if not factory charged.

H. Install separate devices furnished by manufacturer.

3.2 CONNECTIONS

A. Chilled and condenser water piping installation requirements are specified in Section 232113 "Hydronic Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to chiller to allow service and maintenance.

C. Evaporator Connections: Connect inlet to evaporator with controller-bulb well, shutoff valve, thermometer and pressure gage. Connect outlet to evaporator with throttling valve, flow switch, thermometer, pressure gage, and drain line with shutoff valve.

D. [Condenser Connections: Connect inlet to condenser with shutoff valve, thermometer, and pressure gage. Connect outlet to condenser with throttling valve, thermometer, pressure gauge, flow switch and drain line with shutoff valve.]

E. Refrigerant Pressure Relief Valve Connections: Extend vent piping to the outside without valves or restrictions (for water chillers mounted indoors) in accordance with ASHRAE Standard 15.

F. Ground water chillers according to Division 26.

G. Connect wiring according to Division 26.
3.3  STARTUP SERVICE

A. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.

B. Engage a factory-authorized service representative to complete the installation and startup checks according to the manufacturer's written instructions and perform the following:
   1. Verify that refrigerant charge is sufficient and water chiller has been leak tested.
   2. Verify that pumps are installed and functional.
   3. Verify that thermometers and gages are installed.
   4. Operate water chiller for run-in period according to manufacturer's written instructions.
   5. Check bearing lubrication and oil levels.
   6. Verify that refrigerant pressure relief is vented outside (for water chillers mounted indoors).
   7. Verify proper motor rotation.
   8. Verify static deflection of vibration isolators, including deflection during water chiller startup and shutdown.
   11. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.

C. Prepare a written startup report that records results of tests and inspections.

D. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose.

3.4  DEMONSTRATION

Engage a factory-authorized service representative to train the Owner’s maintenance personnel adjust, operate and maintain the chiller. Provide not less than 4 hours of training.

END OF SECTION
SECTION 236500 - COOLING TOWERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Open-circuit, induced-draft, cross-flow cooling towers.

1.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Cooling towers shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event.

1.3 SUBMITTALS

A. Product Data: For each model indicated, provide rated capacities at design conditions, pressure drop, fan performance data, physical dimensions, required clearances, weights, sizes and locations of field connections, electrical requirements, and accessories.

B. Seismic Qualification Certificates: For cooling towers, accessories, and components, from manufacturers.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Operation and maintenance data.

D. Warranty.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. ASHRAE/IESNA 90.1 for energy efficiency.

C. ASME Compliance: Fabricate and label heat-exchanger coils to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

D. CTI Certification: Cooling tower thermal performance according to CTI STD 201, "Certification Standard for Commercial Water-Cooling Towers Thermal Performance."

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace the following components of cooling towers that fail in materials or workmanship within specified warranty period:

1. Fan assembly including supports, fan, drive, and motor.
2. Fan shafts, bearings and sleeves.
4. Tube bundle.
5. External-circuit circulating pump.
6. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 OPEN-CIRCUIT, INDUCED-DRAFT, CROSSFLOW COOLING TOWERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

2. Evapco Inc.

B. Fabricate cooling tower mounting base with reinforcement strong enough to resist cooling tower movement during a seismic event when cooling tower is anchored to field support structure.

C. Cooling tower designed to resist wind load of 30 lbf/sq. ft.

D. Casing and Frame:

2. Fasteners: Galvanized or stainless steel to match casing and frame.

E. Collection Basin:
2. Removable stainless-steel strainer with openings smaller than nozzle orifices.
3. Overflow and drain connections.
6. Removable equalization flume plate between adjacent cells (for multiple-cell towers).
7. Equalizer connection for field-installed equalizer piping location and size as indicated on drawings (for multiple-cooling-tower systems).

F. Mechanically Operated, Collection Basin Water-Level Control: Manufacturer's standard adjustable, mechanical float assembly and valve.

G. Electric/Electronic, Collection Basin Water-Level Controller with Solenoid Valve:

1. Enclosures: NEMA 250, Type 4X.
2. Sensor: Solid-state controls with multiple electrode probes and relays factory wired to a terminal strip to provide control of water makeup valve, low- and high-level alarms
4. Water Stilling Chamber: Corrosion-resistant material.
5. Solenoid Valve: Slow closing with stainless-steel body, controlled and powered through level controller in response to water-level set point.
6. Electrical Connection Requirements: 120 V, single phase, 60 Hz.

H. Gravity Water Distribution Basin: Nonpressurized design with head of water level in basin adequate to overcome spray nozzle losses and designed to evenly distribute water over fill throughout the flow range indicated.

2. Location: Over each bank of fill with easily replaceable plastic spray nozzles mounted in bottom of basin.
5. Removable Panels: Same material as basin to completely cover top of basin. Secure panels to basin with removable corrosion-resistant hardware.
6. Single-Inlet, Field Pipe Connection: Galvanized-steel or PVC pipe arranged to provide balancing of flow within cooling tower cell without the need for additional balancing valves. Pipe each cooling tower cell internally to a single, field connection suitable for mating to ASME B16.5, Class 150 flange and located on the bottom or side unless otherwise indicated.

I. Fill:

1. Materials: PVC, with maximum flame-spread index of 5 according to ASTM E 84.
2. Fabrication: Fill-type sheets, fabricated, formed, and bonded together after forming into removable assemblies that are factory installed by manufacturer.
3. Fill Material Operating Temperature: Suitable for entering-water temperatures up through 120 deg F.

J. Drift Eliminator:
   1. Material: PVC; with maximum flame-spread index of 5 according to ASTM E 84.
   2. UV Treatment: Inhibitors to protect against damage caused by UV radiation.
   3. Configuration: Multipass, designed and tested to reduce water carryover to achieve performance indicated.

K. Air-Intake Louvers:
   1. Material: FRP, PVC, or stainless steel.
   2. UV Treatment: Inhibitors to protect FRP or PVC louvers against damage caused by UV radiation.
   3. Louver Blades: Arranged to uniformly direct air into cooling tower, to block sunlight in basin, to minimize air resistance, and to prevent water from splashing out of tower during all modes of operation including operation with fans off.

L. Axial Fan: Balanced at the factory after assembly.
   4. Fan Shaft Bearings: Self-aligning ball or roller bearings with moisture-proof seals and premium, moisture-resistant grease suitable for temperatures between minus 20 and plus 300 deg F. Bearings designed for an L-10 life of 50,000 hours.
   5. Bearings Grease Fittings: Extended lubrication lines to an easily accessible location.

M. Gear Drive: Right angle, reduced speed, and designed for cooling tower applications according to CTI STD 111. Motor and gear drive shall be aligned before shipment.
   1. Gear Drive and Coupling Service Factor: 2.0 based on motor nameplate horsepower.
   2. Housing: Cast iron, with epoxy or polyurethane finish, beveled high-strength steel gears continuously bathed in oil, and with lubrication to other internal parts at all operating speeds.
   3. Mounting: Directly mounted to fan hub and connected to motor so motor shaft is in horizontal position.
   4. Operation: Able to operate both forward and in reverse.
   5. Drive-to-Motor Connection: Close coupled to motor using a flexible coupling or connected to motor located outside of cooling tower casing by a full-floating drive shaft.
   6. Drive Shaft Material: Corrosion resistant or Stainless steel, and fitted with flexible couplings on both ends. Provide exposed shaft and couplings with guards according to OSHA regulations.
7. Extend oil fill, drain, and vent to outside of cooling tower casing using galvanized-steel piping. Provide installation with oil-level sight glass.

N. Fan Motor:

1. General Requirements for Fan Motors: Comply with NEMA designation and temperature-rating requirements specified in Division 15 Section "Common Motor Requirements for HVAC Equipment" and not indicated below.
5. Insulation: Class H.

O. Fan Discharge Stack: Material shall match casing, manufacturer's standard velocity recovery design.

1. Stack Termination: Wire-mesh, galvanized-steel screens; complying with OSHA regulations.

P. Vibration Switch: For each fan drive.

1. Enclosure: NEMA 250, Type 4X.
2. Vibration Detection: Sensor with a field-adjustable, acceleration-sensitivity set point in a range of 0 to 1 g and frequency range of 0 to 3000 cycles per minute. Cooling tower manufacturer shall recommend switch set point for proper operation and protection.
3. Provide switch with manual-reset button for field connection to a BMS and hardwired connection to fan motor electrical circuit.
4. Switch shall, on sensing excessive vibration, signal an alarm through the BMS and shut down the fan.

Q. Controls: Comply with requirements in Division 15 Section "HVAC Control System."

R. Personnel Access Components:

1. Doors: Large enough for personnel to access cooling tower internal components from both cooling tower end walls. Doors shall be operable from both sides of the door.
2. External Ladders with Safety Cages: Aluminum, galvanized- or stainless-steel, fixed ladders with ladder extensions to access external platforms and top of cooling tower from adjacent grade without the need for portable ladders. Comply with 29 CFR 1910.27.
3. External Platforms with Handrails: Aluminum, FRP, or galvanized-steel bar grating at cooling tower access doors when cooling towers are elevated and not accessible from grade.
4. Handrail: Aluminum, galvanized steel, or stainless steel complete with kneerail and toeboard, around top of cooling tower to safeguard personnel while accessing components located on top of cooling tower. Comply with 29 CFR 1910.23.

5. Internal Platforms: Aluminum, or galvanized-steel bar grating.
   a. Spanning the collection basin from one end of cooling tower to the other and positioned to form a path between the access doors. Platform shall be elevated so that all parts are above the high water level of the collection basin.
   b. Elevated internal platforms with handrails accessible from fixed vertical ladders to access the fan drive assembly when out of reach from collection basin platform.

2.2 SOURCE QUALITY CONTROL

A. Factory pressure test heat exchangers after fabrication and prove to be free of leaks.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cooling towers on support structure indicated.

B. Equipment Mounting: Install cooling tower on concrete base using elastomeric pads in the absence of instructions on the drawings. Comply with requirements for concrete base in Division 3. Comply with requirements for vibration isolation devices specified in Division 15 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

1. Minimum Deflection: see drawings.
2. Provide stainless-steel plate to equally distribute weight over elastomeric pad.
3. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
4. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
5. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

C. Install anchor bolts to elevations required for proper attachment to supported equipment.

D. Maintain manufacturer's recommended clearances for service and maintenance.

E. Loose Components: Install electrical components, devices, and accessories that are not factory mounted.
3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to cooling towers to allow service and maintenance.

C. Install flexible pipe connectors at pipe connections of cooling towers mounted on vibration isolators.

D. Provide drain piping with valve at cooling tower drain connections and at low points in piping.

E. Connect cooling tower overflows and drains, and piping drains to nearest floor sink or other location as indicated on Drawings.

F. Domestic Water Piping: Comply with applicable requirements in Division 15 Section "Domestic Water Piping." Connect to water-level control with shutoff valve and union, flange, or mechanical coupling at each connection.

G. Condenser-Water Supply and Return Piping: Comply with applicable requirements in Division 15 Section "Hydronic Piping." Connect to entering cooling tower connections with shutoff valve, balancing or flow control valve, thermometer, plugged tee with pressure gage, flow meter, and drain connection with valve. Connect to leaving cooling tower connection with shutoff valve. Make connections to cooling tower with a union or flange.

H. Equalizer Piping: Piping requirements to match supply and return piping. Connect an equalizer pipe, full size of cooling tower connection, between tower cells. Connect to cooling tower with shutoff valve.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Where field-assembly of major sections is required engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to perform startup service.

3.4 STARTUP SERVICE

A. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.

B. Obtain performance data from manufacturer.
1. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

   a. Clean entire unit including basins.
   b. Verify that accessories are properly installed.
   c. Verify clearances for airflow and for cooling tower servicing.
   d. Check for vibration isolation and structural support.
   e. Lubricate bearings.
   f. Verify fan rotation for correct direction and for vibration or binding and correct problems.
   g. Adjust belts to proper alignment and tension.
   h. Verify proper oil level in gear-drive housing. Fill with oil to proper level.
   i. Operate variable-speed fans through entire operating range and check for harmonic vibration imbalance. Set motor controller to skip speeds resulting in abnormal vibration.
   j. Check vibration switch setting. Verify operation.
   k. Verify water level in tower basin. Fill to proper startup level. Check makeup water-level control and valve.
   l. Verify operation of basin heater and control.
   m. Verify that cooling tower air discharge is not recirculating air into tower or HVAC air intakes. Recommend corrective action.
   n. Replace defective and malfunctioning units.

C. Start cooling tower and associated water pumps. Follow manufacturer's written starting procedures.

D. Prepare a written startup report that records the results of tests and inspections.

3.5 ADJUSTING

A. Set and balance water flow to each tower inlet.

B. Adjust water-level control for proper operating level.

3.6 TRAINING

A. Train Owner's maintenance personnel to adjust, operate, and maintain cooling towers.

END OF SECTION
SECTION 237313 - INDOOR CENTRAL STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes air-handling units with coils for indoor installations.

1.2 SUBMITTALS

A. Product Data: For each type of indoor air-handling unit indicated. Include the following:
   1. Dimensions, weights, required clearances, location and size of each field connection.
   2. Certified fan-performance curves with system operating conditions indicated.
   3. Certified fan-sound power ratings.
   4. Certified coil-performance ratings with system operating conditions indicated.
   5. Motor ratings and electrical requirements.
   6. Material gages and finishes.
   7. Dampers, including housings, linkages, and operators.
   8. Accessories.

B. Operation and maintenance data.

1.3 QUALITY ASSURANCE

A. NFPA Compliance: Indoor air-handling units and components shall be designed, fabricated, and installed in compliance with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."

B. ARI Certification: Indoor air-handling units and their components shall be factory tested according to ARI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by ARI.

C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Air Enterprises, Inc.
2. Airtherm; a Mestek company.
4. Carrier; Div. of United Technologies Corp.
5. CES Group Inc.; Governair, Mammoth, Temtrol, Venmar Ventrol, Webco Divisions.
6. Coil Company, LLC.
7. Dunham-Bush, Inc.
8. Engineered Air.
9. Mammoth Inc.
10. McQuay International
12. Trane Company (The); Worldwide Applied Systems Group.

2.2 MANUFACTURED UNITS

A. Indoor air-handling units shall be factory assembled and consist of fans, motor and drive assembly, coils, plenums, filters, condensate pans, dampers, control devices, and accessories.

2.3 CABINET

A. Materials: Formed and reinforced single-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.

1. Outside Casing: Galvanized steel, minimum 18 gage thick.
2. Inside Casing: Galvanized steel, minimum 20 gage thick.
3. Floor Plate: Galvanized steel, 0.1382 inch thick.
4. Base Rails or Legs: Galvanized steel.

B. Cabinet Insulation: Comply with NFPA 90A or NFPA 90B.

1. Materials: ASTM C 1071 with coated surface exposed to airstream to prevent erosion of glass fibers.
2. Thickness: 1 inch on single-wall units, 2 inch on double-wall units.
3. Thermal Conductivity (k-Value): 0.26 at 75 deg F mean temperature.
5. Liner Adhesive: Comply with NFPA 90A or NFPA 90B and ASTM C 916.
6. Mechanical Fasteners (Single-Wall Units): Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to panels without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
7. Location and Application (Single-Wall Units): Factory applied with adhesive and mechanical fasteners to the internal surface of panels in all sections.

C. Access Doors: Double-wall construction of same materials and finishes as cabinet, complete with hinges, latches, handles, and gaskets. Access doors shall be sized and located to allow periodic maintenance and inspections. Provide door handles on both sides of doors where required by OSHA for confined space access. Provide access doors in the following locations:

1. Fan Section.
2. Access Section.

D. Condensate Drain Pans: Formed sections of stainless-steel sheet complying with requirements in ASHRAE 62. Fabricate pans with slopes in two planes to collect condensate from cooling
coils (including coil piping connections and return bends) \textbf{and humidifiers} when units are operating at maximum catalogued face velocity across cooling coil.

1. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.
2. Drain Connections: One end of pan, same side as coil connections.
3. Units with stacked coils shall have an intermediate drain pan or drain trough to collect condensate from top coil. Provide drop tube(s) to guide condensate to the main drain pan.
4. Drain pans shall extend a sufficient distance downstream of coils \textbf{and humidifiers} to contain moisture carryover.

2.4 FAN SECTION

A. Fan-Section Construction: Belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure and equipped with formed-steel channel base for integral mounting of fan, motor, and casing panels. Mount fan and motor on a common structural steel base.

B. Centrifugal Fan Housings: Formed- and reinforced galvanized-steel panels to make curved scroll housings with shaped cutoff, and spun-metal inlet bell.

1. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, and accessories.
2. Performance Class: AMCA 99-2408, Class I.
3. Plenum Fans: On units with plenum fans fabricate without fan scroll and volute housing.

C. Fan Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and motor horsepower.

D. Forward-Curved Fan Wheels: Galvanized-steel construction with inlet flange, backplate, shallow blades with inlet and tip curved forward in direction of airflow and mechanically secured to flange and backplate; cast-steel hub swaged to backplate and fastened to shaft with set screws.

E. Backward-Inclined Fan Wheels: Steel construction with curved inlet flange, backplate, backward-inclined blades welded or riveted to flange and backplate; cast-steel hub riveted to backplate and fastened to shaft with set screws.

F. Airfoil Fan Wheels: Steel construction with curved inlet flange, backplate, airfoil blades welded or riveted to flange and backplate; cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.

G. Coatings: \textbf{[Alkyd enamel or baked-on powder coating][Thermoplastic vinyl] [Epoxy][Synthetic resin] [Phenolic][Polytetrafluoroethylene] [Vinyl ester] [Hot-dip galvanized][Powder-baked enamel]} \textbf{<Insert manufacturer's name; trade name>}

H. Shafts: Statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
1. Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.

2. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

I. Grease-Lubricated Shaft Bearings: Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing. Provide lubrication lines extended to drive side of fan. Exception: Bearings on forward-curved fans may be permanently lubricated.

   1. Ball-Bearing Rating Life: ABMA 9, L_{10} of 200,000 hours.
   2. Roller-Bearing Rating Life: ABMA 11, L_{10} of 200,000 hours.

J. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation and with 1.5 service factor based on fan motor.

   1. Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
   2. Motor Pulleys: Adjustable pitch for use with 5-hp motors and smaller; fixed pitch for use with motors larger than 5 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
   3. Belts: Oil resistant, nonsparking, and nonstatic; matched for multiple belt drives.

K. Vibration Control:

   1. Install fan/motor assembly on open-spring vibration isolators having a minimum of 1-inch static deflection and side snubbers.
   2. Provide flexible connector between fan housing and cabinet.

L. Fan-Section Source Quality Control:

   2. Factory test fan performance for flow rate, pressure, power, air density, rotation speed, and efficiency. Establish ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

2.5 MOTORS

A. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment".

2.6 COILS

A. Coil Sections: Common or individual, insulated, coil section for heating and cooling coils. Design and construct to facilitate removal and replacement of coil for maintenance and to ensure full airflow through coils.

B. Water Coils: Drainable coil fabricated according to ARI 410.
1. Piping Connections: On same end.
2. Tubes: Copper, complying with ASTM B75, 0.500 or 0.625 inch outside diameter.
3. Fins: Aluminum, maximum 144 fins per foot.
5. Headers: Cast iron with drain and air vent tappings or seamless copper tube with brazed joints, prime coated.
6. Frames: Galvanized-steel channel frame.
7. Ratings: Design tested and rated according to ASHRAE 33 and ARI 410 for working pressure of 200 psig at 200 degrees F.
8. Source Quality Control: Test to 300 psig and to 200 psig underwater.

C. Refrigerant Coils: Coil designed for use with R-22 refrigerant, fabricated according to ARI 410, connected with brazed fittings.

1. Capacity Reduction: Circuit for [face] [row] [interleaved] control.
2. Tubes: Copper, complying with ASTM B75, 0.500 or 0.625 inch outside diameter.
3. Fins: Aluminum, maximum 144 fins per foot.
5. Suction and Distributor: Seamless copper tube with brazed joints.
6. Frames: Galvanized-steel channel frame.
7. Ratings: Design tested and rated according to ASHRAE 33 and ARI 410 for working pressure of 300 psig.
8. Source Quality Control: Test to 450 psig and to 300 psig underwater.


2. Open Coil: Helix-wound resistance wire of 80 percent nickel and 20 percent chromium supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame. Watt density shall not exceed 35 watts per square inch of wire surface area.
3. Finned Tubular: Coiled resistance wire of 80 percent nickel and 20 percent chromium surrounded by compacted magnesium-oxide powder in tubular-steel sheath; with spiral-wound, copper-plated, steel fins continuously brazed to sheath.
4. Overtemperature Protection: Disk-type, automatically resetting, thermal-cutout, safety device; serviceable through terminal box without removing heater from unit. Provide secondary protection consisting of load-carrying, manually resetting or manually replaceable, thermal cutouts; factory wired in series with each heater stage.
5. Control Panel: Mounted on exterior of cabinet with disconnecting means and overcurrent protection. Include the following controls:
   c. SCR controller.

2.7 DAMPERS

A. General: Leakage rate, according to AMCA 500, "Laboratory Methods for Testing Dampers for Rating," shall not exceed 2 percent of air quantity at 2000-fpm face velocity through damper and 4-inch wg pressure differential.

B. Damper Operators: Electric specified in Division 15 Section "HVAC Control System."
C. Mixing Boxes: Parallel-blade galvanized-steel dampers mechanically fastened to steel operating rod in reinforced, galvanized-steel cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.

D. Combination Filter and Mixing Box: Parallel-blade galvanized-steel dampers mechanically fastened to steel operating rod in reinforced, galvanized-steel cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously. Cabinet support members shall hold 2-inch-thick filters. Provide hinged access panels or doors to allow removal of filters from both sides of unit.

E. Zone Dampers: Two single-blade galvanized-steel dampers offset 90 degrees from each other on steel operating rod rotating in sintered bronze or nylon bearings mounted in a single galvanized-steel frame. Break-form damper blades, provide gaskets and edge seals, and mechanically fasten to operating rod.

2.8 FILTER SECTION

A. Filter Section: Provide filter holding frames arranged for flat or angular orientation, with access door on drive side of unit. Filters shall be removable from one side. Refer to Drawings for filter efficiency and type.

2.9 ELECTRICAL ACCESSORIES

A. Power Center:
   1. Provide single power connection point to unit complete with fused disconnect, transformer sized to power 120 VAC accessories and unit mounted controllers.
   2. Fan motors shall be wired to individual disconnects within or outside the fan section.
   3. Provide fused disconnect for 120 VAC transformer.

B. Variable Frequency Drive: Provide VFD for each motor indicated.

C. Lights: Provide 100-watt, vapor-proof, marine-type service lights in each section provided with an access door. Space lights at a maximum of 15 feet on center within each lighted section. All lights shall be wired to a single toggle switch, centrally mounted on the exterior of the unit.

D. Convenience Outlets: Mount a 15 amp, duplex, weather proof, GFCI outlet on the exterior of the unit adjacent to the light switch. [On units over 50 feet long, provide additional outlets at 25 feet on center.]

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install indoor air-handling units as follows:
   1. Floor-Mounted Units: Support on 4-inch-high concrete bases using neoprene pads as specified in Division 15 Section “Vibration [and Seismic] Controls for HVAC Piping and Equipment.” Secure units to anchor bolts installed in concrete bases. See Division 15
Section “Common Work Results for HVAC” for concrete materials and fabrication requirements.

2. Suspended Units: Suspend units from structural-steel support frame using threaded steel rods and spring hangers.

B. Arrange installation of units to provide access space around indoor air-handling units for service and maintenance.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Connect condensate drain pans using copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

D. Hot- and Chilled-Water Piping: Comply with applicable requirements in Division 23 Section "Hydronic Piping." Connect to supply and return coil tappings with shutoff or balancing valve and union or flange at each connection.

E. Refrigerant Piping: Comply with applicable requirements in Division 23 Section "Refrigerant Piping." Connect to supply and return coil tappings with shutoff valve and union or flange at each connection.

F. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connections.

G. Electrical: Comply with applicable requirements in Division 26 Sections for power wiring, switches, and motor controls.

H. Ground equipment according to Division 26.

3.3 QUALITY CONTROL

A. Complete the manufacturer's installation and startup checklists and resolve all discrepancies.

B. Provide the Commission Agent and SRP PM with the completed checklists/test results.

3.4 TRAINING

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION
SECTION 237413 - PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes packaged, outdoor, central-station air-handling units (rooftop units) with the following components and accessories:

1. Direct-expansion cooling.
2. Electric-heating coils.
4. Economizer outdoor- and return-air damper section.
5. Integral, space temperature controls.
6. Roof curbs.

1.2 DEFINITIONS

A. Outdoor-Air Refrigerant Coil: Refrigerant coil in the outdoor-air stream to reject heat during cooling operations and to absorb heat during heating operations. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.

B. Outdoor-Air Refrigerant-Coil Fan: The outdoor-air refrigerant-coil fan in RTUs. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.

C. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, outdoor, central-station air-handling units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.

D. Supply-Air Fan: The fan providing supply-air to conditioned space. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

E. Supply-Air Refrigerant Coil: Refrigerant coil in the supply-air stream to absorb heat (provide cooling) during cooling operations and to reject heat (provide heating) during heating operations. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

F. VVT: Variable-air volume and temperature.

1.3 SUBMITTALS

A. Product Data: Include manufacturer's technical data for each RTU, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.
B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

C. Field quality-control test reports.

D. Operation and maintenance data.

1.4 QUALITY ASSURANCE

A. ASHRAE Compliance:
   1. Comply with ASHRAE 15 for refrigerant system safety.
   2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
   3. Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
   4. Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

B. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.


D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of RTUs that fail in materials or workmanship within specified warranty period.
   1. Warranty Period for Compressors & Gas Furnace Heat Exchangers: Manufacturer's standard, but not less than five years from date of Substantial Completion.
   2. Warranty Period for Solid-State Ignition Modules: Manufacturer's standard, but not less than three years from date of Substantial Completion.
   3. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of Substantial Completion.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Engineered Air.
   2. Lennox Industries Inc.
   3. Trane; American Standard Companies, Inc.
   4. YORK International Corporation.

2.2 CASING

A. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.

B. Exterior Casing Material: Galvanized steel with factory-painted finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.
   1. Exterior Casing Thickness: minimum 0.052 inch (18ga) thick.

C. Inner Casing Fabrication Requirements:
   1. Inside Casing: Galvanized steel, minimum 0.034 inch (21ga).

D. Casing Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
   1. Materials: ASTM C 1071, Type I.
   2. Thickness: 1 inch.
   3. Liner materials shall have air-stream surface coated with an erosion- and temperature-resistant coating or faced with a plain or coated fibrous mat or fabric.

E. Condensate Drain Pans: Formed sections of stainless-steel sheet, a minimum of 2 inches deep, and complying with ASHRAE 62.1.
   1. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.
   2. Drain Connections: Threaded nipple.
   3. Pan-Top Surface Coating: Corrosion-resistant compound.

2.3 FANS

A. Direct-Driven Supply-Air Fans: Double width, [forward curved] [backward inclined], centrifugal; with permanently lubricated, multispeed motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.
B. Belt-Driven Supply-Air Fans: Double width, forward curved, centrifugal; with permanently lubricated, single-speed motor installed on an adjustable fan base resiliently mounted in the casing. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.

C. Condenser-Coil Fan: Propeller, mounted on shaft of permanently lubricated motor.

D. Relief-Air Fan: [Propeller] [Forward curved] [Backward inclined], shaft mounted on permanently lubricated motor.

E. Seismic Fabrication Requirements: Fabricate fan section, internal mounting frame and attachment to fans, fan housings, motors, casings, accessories, and other fan section components with reinforcement strong enough to withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment" when fan-mounted frame and RTU-mounted frame are anchored to building structure.

F. Fan Motor: Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

2.4 COILS

A. Supply-Air Refrigerant Coil:
   1. [Aluminum] [Copper]-plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.
   2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.

B. Outdoor-Air Refrigerant Coil:
   1. [Aluminum] [Copper]-plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.
   2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.

C. Electric-Resistance Heating:
   1. Open Heating Elements: Resistance wire of 80 percent nickel and 20 percent chromium, supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.
   2. Overtemperature Protection: Disk-type, automatically reset, thermal-cutout, safety device; serviceable through terminal box.
   3. Overcurrent Protection: Manual-reset thermal cutouts, factory wired in each heater stage.
   4. Control Panel: Unit mounted with disconnecting means and overcurrent protection. Include the following controls:
a.  [Magnetic] [Mercury] contactors.
b.  Step Controller: Pilot lights and override toggle switch for each step.
c.  SCR Controller: Pilot lights operate on load ratio, a minimum of five steps.
d.  Time-delay relay.
e.  Airflow proving switch.

2.5 REFRIGERANT CIRCUIT COMPONENTS

A. Number of Refrigerant Circuits: One

B. Compressor: Hermetic/semihermetic: reciprocating, scroll, or screw, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief.

C. Refrigeration Specialties:
   1. Refrigerant: R-407C or R-410A.
   2. Expansion valve with replaceable thermostatic element.
   3. Refrigerant filter/dryer.
   5. Automatic-reset low-pressure safety switch.
   8. Brass service valves installed in compressor suction and liquid lines.

2.6 AIR FILTRATION

A. Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
   1. Glass Fiber: Minimum [80] percent arrestance, and MERV 7
   2. Pleated: Minimum 90 percent arrestance, and MERV 7

2.7 GAS FURNACE

A. Description: Factory assembled, piped, and wired; complying with ANSI Z21.47 and NFPA 54.
   1. CSA Approval: Designed and certified by and bearing label of CSA.

B. Burners: Stainless steel.
   1. Fuel: Natural gas.
   2. Ignition: Electronically controlled electric spark or hot-surface igniter with flame sensor.

C. Heat-Exchanger and Drain Pan: Stainless steel.

D. Venting: Gravity vented.
E. Power Vent: Integral, motorized centrifugal fan interlocked with gas valve.

F. Safety Controls:
   1. Gas Control Valve: [Single stage] [Two stage] [Modulating].

2.8 DAMPERS

A. Outdoor-Air Damper: Linked damper blades, for 0 to 25 percent outdoor air, with [manual] [motorized] damper filter.

B. Outdoor- and Return-Air Mixing Dampers: Parallel- or opposed-blade galvanized-steel dampers mechanically fastened to cadmium plated for galvanized-steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.
   1. Damper Motor: Modulating with adjustable minimum position.
   2. Relief-Air Damper: Gravity actuated or motorized, as required by ASHRAE/IESNA 90.1, with bird screen and hood.

2.9 ELECTRICAL POWER CONNECTION

A. Provide for single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

2.10 CONTROLS

A. Control equipment and sequence of operation are specified in Section 230900 "Instrumentation and Control for HVAC."

B. Basic Unit Controls:
   1. Control-voltage transformer.
   2. Wall-Mounted Thermostat: Honeywell VIsionPRO 8000

C. Electronic Controller:
   1. Controller shall have volatile-memory backup.
   2. Safety Control Operation:
      a. Smoke Detectors: Stop fan and close outdoor-air damper if smoke is detected. Provide additional contacts for alarm interface to fire alarm control panel.
b. Firestats: Stop fan and close outdoor-air damper if air greater than 130 deg F enters unit. Provide additional contacts for alarm interface to fire alarm control panel.

c. Fire Alarm Control Panel Interface: Provide control interface to coordinate with operating sequence described in Section 283111 "Digital, Addressable Fire-Alarm System" and Section 283112 "Zoned (DC Loop) Fire-Alarm System."

3. Scheduled Operation: Occupied and unoccupied periods on seven-day clock with a minimum of two programmable periods per day.

4. Unoccupied Period:

a. Heating Setback: 10 deg F.


c. Override Operation: Two hours.

5. Supply Fan Operation:

a. Occupied Periods: Run fan continuously.

b. Unoccupied Periods: Cycle fan to maintain setback temperature.

6. Refrigerant Circuit Operation:

a. Occupied Periods: Cycle or stage compressors to match compressor output to cooling load to maintain room temperature. Cycle condenser fans to maintain maximum hot-gas pressure.

b. Unoccupied Periods: Compressors off.

7. Gas Furnace Operation:

a. Occupied Periods: Modulate or cycle burner to maintain room temperature.

b. Unoccupied Periods: Cycle burner to maintain setback temperature.

8. Electric-Heating-Coil Operation:

a. Occupied Periods: Cycle coil to maintain room temperature.

b. Unoccupied Periods: Energize coil to maintain setback temperature.

c. Operate supplemental electric heating coil with compressor for heating with outdoor temperature below 25 deg F.

9. Fixed Minimum Outdoor-Air Damper Operation:

a. Occupied Periods: Open to 10 percent.

b. Unoccupied Periods: Close the outdoor-air damper.

10. Economizer Outdoor-Air Damper Operation:

a. Occupied Periods: Open to 10 percent fixed minimum intake, and maximum 100 percent of the fan capacity to comply with ASHRAE Cycle II. Controller shall permit air-side economizer operation when outdoor air is
less than 60 deg F. Use [outdoor-air enthalpy] [mixed-air temperature and select between outdoor-air and return-air enthalpy] to adjust mixing dampers. During economizer cycle operation, lock out cooling.

b. Unoccupied Periods: Close outdoor-air damper and open return-air damper.

11. VVT Relays:
   a. Provide heating- and cooling-mode changeover relays compatible with VVT terminal control system required in Section 233600 "Air Terminal Units" and Section 230900 "Instrumentation and Control for HVAC."

D. Interface Requirements for HVAC Instrumentation and Control System:
   1. Interface relay for scheduled operation.
   2. Interface relay to provide indication of fault at the central workstation and diagnostic code storage.
   3. Provide BACnet compatible interface for central HVAC control workstation for the following:
      a. Adjusting set points.
      b. Monitoring supply fan start, stop, and operation.
      c. Inquiring data to include outdoor-air damper position, supply- and room-air temperature and humidity.
      d. Monitoring occupied and unoccupied operations.

2.11 ACCESSORIES
   A. Electric heater with integral thermostat maintains minimum 50 deg F temperature in gas burner compartment.
   B. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required
   C. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.
   D. Coil guards of painted, galvanized-steel wire.
   E. Hail guards of galvanized steel, painted to match casing.
   F. Concentric diffuser with white louvers and polished aluminum return grilles, insulated diffuser box with mounting flanges, and interior transition.

2.12 ROOF CURBS
   A. Roof curbs with vibration isolators and wind or seismic restraints are specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."
B. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.

   1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
      a. Materials: ASTM C 1071, Type I or II.
      b. Thickness: 1-1/2 inches.

C. Wind and Seismic Restraints: Metal brackets compatible with the curb and casing, painted to match RTU, used to anchor unit to the curb, and designed for loads at Project site. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment" for wind-load requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Roof Curb: Install on roof structure or concrete base, level and secure. Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction specified in Section 077200 "Roof Accessories." Secure RTUs to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.

B. Unit Support: Install unit level on structural curbs. Coordinate wall penetrations and flashing with wall construction. Secure RTUs to structural support with anchor bolts.

C. Install wind and seismic restraints according to manufacturer's written instructions.

D. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain.

E. Duct installation requirements are specified in other HVAC Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:

   1. Install ducts to termination at top of roof curb.
   2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
   3. Connect supply ducts to RTUs with flexible duct connectors specified in Section 233300 "Air Duct Accessories."
   4. Install return-air duct continuously through roof structure.
   5. Install normal-weight, 3000-psi, compressive strength (28-day) concrete mix inside roof curb, 4 inches thick. Concrete, formwork, and reinforcement are specified with concrete.

3.2 QUALITY CONTROL

A. Complete the manufacturer's installation and startup checklists and resolve all discrepancies.
B. Provide the Commission Agent and SRP PM with the completed checklists/test results.

3.3 TRAINING

A. Engage a factory-authorized service representative to train Owner’s maintenance personnel to adjust, operate, and maintain units.

END OF SECTION
SECTION 238113 - PACKAGED TERMINAL AIR-CONDITIONERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes packaged terminal air conditioners and their accessories and controls, in the following configurations:

1. Through-the-wall and freestanding air conditioners.
2. Cooling-only units.
3. Heat-pump units.
4. Cooling units with electric heat.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For packaged terminal air conditioners. Include plans, elevations, sections, details for wall penetrations and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

C. Color Samples: For unit cabinet, discharge grille, and exterior louver, and for each color and texture specified.

D. Field quality-control reports.

E. Operation and maintenance data.

1.3 QUALITY ASSURANCE

A. Electrical Components Listed and labeled as defined in NFPA 70.

B. ASHRAE Compliance

1.4 WARRANTY

A. Special Warranty: Five years from date of Substantial Completion, including components and labor.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: provide products by one of the following:

1. Carrier Corporation; a United Technologies company.
2. ClimateMaster, Inc.
3. Friedrich Air Conditioning Co.
5. McQuay International.

2.2 MANUFACTURED UNITS

A. Description: Factory-assembled, tested, self-contained, packaged terminal air conditioner with room cabinet, electric refrigeration system, and temperature controls; fully charged with refrigerant and filled with oil; with [cord-connected] [hardwired] chassis.

2.3 CHASSIS

A. Cabinet: 0.052-inch thick steel with removable front panel with concealed latches.

1. Mounting: [Wall with wall sleeve] [Floor with subbase].
2. Access Door: Hinged door in top of cabinet for access to controls.
3. Cabinet Extension: Matching cabinet in construction and finish, allowing diversion of airflow to adjoining room; with grille.
4. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
5. Subbase: Enameled steel with adjustable leveling feet and adjustable end plates, with factory-installed and -wired, fused disconnect switch and receptacle sized for unit.
6. Wall Sleeves: [Galvanized steel with polyester finish] [Molded polymer] [Molded fiberglass-reinforced polyester].

B. Refrigeration System: Direct-expansion indoor coil with capillary restrictor; and hermetically sealed scroll compressor with vibration isolation and overload protection.

1. Indoor and Outdoor Coils: Seamless copper tubes mechanically expanded into aluminum fins.
2. Accumulator.
3. Constant-pressure expansion valve.
4. Reversing valve.
5. Charge: R-407C or R-410A.

C. Indoor Fan: Forward curved, centrifugal; with motor and positive-pressure ventilation damper with electric operator.
D. Filters: Washable polyurethane in molded plastic frame.

E. Condensate Drain: Drain pan [to direct condensate to outdoor coil for re-evaporation] [and piping to direct condensate to building waste and vent piping].
   1. Comply with ASHRAE 62.1 for drain pan construction and connections.

F. Outdoor Fan: [Forward curved, centrifugal or propeller] type [with separate] [driven by indoor fan] motor.
   1. Indoor and Outdoor Fan Motors: Two speed; comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."


2.4 CONTROLS

A. Control Module: Unit-mounted digital panel with touchpad temperature control and with touchpad for heating, cooling, and fan operation. Include the following features:
   1. Low Ambient Lockout Control: Prevents cooling-cycle operation below 40 deg F outdoor air temperature.
   2. Heat-Pump Ambient Control: Field-adjustable switch changes to heat-pump heating operation above 40 deg F and to supplemental heating below plus 25 deg F.
   3. Temperature-Limit Control: Prevents occupant from exceeding preset setup temperature.
   4. Reverse-Cycle Defrost: Solid-state sensor monitors frost buildup on outdoor coil and reverses unit to melt frost.

B. Remote Control: Standard unit-mounted controls with remote-mounted, low-voltage adjustable thermostat with heat anticipator, heat-off-cool-auto switch, and on-auto fan switch.

C. Outdoor Air: Motorized intake damper. Open intake when unit indoor air fan runs.


2.5 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Factory test to comply with ARI 300, "Sound Rating and Sound Transmission Loss of Packaged Terminal Equipment."

B. Unit Performance Ratings: Factory test to comply with ARI 310/380/CSA C744, "Packaged Terminal Air-Conditioners and Heat Pumps."
PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb, maintaining manufacturer’s recommended clearances and tolerances.

B. Install wall sleeves in finished wall assembly; seal and weatherproof. Joint-sealant materials and applications are specified in Section 079200 "Joint Sealants."

C. Install and anchor wall sleeves to withstand, without damage to equipment and structure, seismic forces required by building code.

3.2 QUALITY CONTROL

A. Complete the manufacturers installation and startup Inspections and Tests:

B. Provide completed installation and startup checklists/reports.

END OF SECTION
SECTION 238123 - COMPUTER-ROOM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Floor-mounted computer-room air conditioners, 6 tons and larger,
   2. Floor-mounted computer-room air conditioners, 5 tons and smaller.
   3. Ceiling-mounted computer-room air conditioners.
   4. Console computer-room air conditioners.

1.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Computer-room air conditioners shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.
B. Shop Drawings: For computer-room air conditioners. Include plans, elevations, sections, details, and attachments to other work.
C. Color Samples: For unit cabinet, discharge grille, and exterior louver and for each color and texture specified.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For computer-room air conditioners, accessories, and components, from manufacturer.
B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. ASHRAE Compliance:
   1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
   2. Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Ventilation Rate Procedures," and Section 7 - "Construction and Startup."
   3. Applicable requirements in ASHRAE/IESNA 90.1.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of computer-room air conditioners that fail in materials or workmanship within specified warranty period.
   1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.
   2. Warranty Period for Humidifiers: Manufacturer's standard, but not less than three years from date of Substantial Completion.
   3. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 FLOOR-MOUNTED UNITS 6 TONS AND LARGER

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings:
   1. Carrier Corporation; a United Technologies company.
   2. Liebert Corporation.
   3. Trane; a business of American Standard Companies.

B. Description: Packaged, factory assembled, prewired, and prepiped; consisting of cabinet, fans, filters, humidifier, and controls.

C. Cabinet and Frame: Welded steel, braced for rigidity, and supporting compressors and other mechanical equipment and fittings.
   2. Insulation: Thermally and acoustically insulate cabinet interior with 1-inch- thick duct liner.
   3. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
   4. Finish of Exterior Surfaces: Baked-on, textured vinyl enamel; color as selected from manufacturer's standard colors.
   5. Floor Stand: Welded tubular steel, with adjustable legs and vibration isolation pads.

D. Supply-Air Fan(s):
1. Double-inlet, forward-curved centrifugal fan(s); statically and dynamically balanced.
2. Drive: V-belt, with steel shaft with self-aligning ball bearings and cast-iron or steel sheaves, variable- and adjustable-pitch motor sheave, minimum of two matched belts, with drive rated at a minimum of two times the nameplate rating of motor.

E. Refrigeration System:
2. Refrigeration Circuits: Two; each with hot-gas mufflers, thermal-expansion valve with external equalizer, liquid-line solenoid valve, liquid-line filter-dryer, sight glass with moisture indicator, service shutoff valves, charging valves, and charge of refrigerant.
3. Refrigerant: R-407C or R-410A.
4. Refrigerant Evaporator Coil: Alternate-row or split-face-circuit, direct-expansion coil of seamless copper tubes expanded into aluminum fins.
   a. Mount coil assembly over stainless-steel drain pan[complying with ASHRAE 62.1] [and] [having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir].
5. Remote Air-Cooled Refrigerant Condenser: Corrosion-resistant cabinet, copper-tube aluminum-fin coils arranged for two circuits, multiple direct-drive propeller fans with permanently lubricated ball bearings, and single-phase motors with internal overload protection and integral electric control panel[and disconnect switch]. Control capacity by [cycling fans] [modulating fan speeds] [three-way refrigerant bypass with receiver and isolation valve].

F. Electric-Resistance Heating Coil: Enclosed finned-tube electric elements arranged for minimum of three stages, with thermal safety switches, manual-reset overload protection, and branch-circuit overcurrent protection.

G. Refrigerant Heating Coil: Hot-gas coil of seamless copper tubes expanded into aluminum fins with three-way solenoid valve on first-stage refrigerant circuit.

H. Extended-Surface, Disposable, Panel Filter: Pleated, lofted, nonwoven, reinforced cotton fabric; supported and bonded to welded-wire grid; enclosed in cardboard frame.

I. Infrared Humidifier: High-intensity quartz lamps mounted above stainless-steel evaporator pan, serviceable without disconnecting water, drain, or electrical connections; prepped and using condensate water from cooling coils with stainless-steel or brass float-valve mechanism; located in bypass airstream; with flush-cycle timer and solenoid drain valve.

J. Integral Electrical Controls: Unit-mounted electrical enclosure with piano-hinged door, grounding lug, combination magnetic starters with overload relays, circuit breakers and cover interlock, and fusible control-circuit transformer.

K. Disconnect Switch: Nonautomatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.
L. Electronic-Control System: Solid state, with start button, stop button, temporary loss of power indicator, manual-reset circuit breakers, temperature control, humidity control, and monitor panel.
   1. Monitor Panel: Backlighted, with no visible indicator lights until operating function is activated; indicators include cooling, humidification, loss of airflow, change filters, high temperature, low temperature, high humidity, low humidity, high head pressure (each compressor), and low suction pressure (each compressor).
   2. Temperature- and Humidity-Control Modules: Solid state, plug-in; with adjustable set point, push-to-test calibration check button, and built-in visual indicators to show mode of operation.

2.2 FLOOR-MOUNTED UNITS 5 TONS AND SMALLER

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings:
   1. Liebert Corporation.

B. Description: Self-contained, factory assembled, prewired, and prepiped; consisting of cabinet, fan, filters, and controls; for vertical floor mounting in upflow or downflow configuration.

C. Cabinet and Frame: Welded tubular-steel frame with removable steel panels with baked-enamel finish, insulated with 1-inch- thick duct liner.
   1. Floor Stand: Welded tubular steel, with adjustable legs and vibration isolation pads.
   2. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Supply-Air Fan: Forward curved, centrifugal, and with adjustable V-belt drive.

E. Refrigeration System:
   1. Compressor: Hermetic, with oil strainer, internal motor overload protection, resilient suspension system, and crankcase heater.
   2. Refrigeration Circuit: Low-pressure switch, manual-reset high-pressure switch, thermal-expansion valve with external equalizer, sight glass with moisture indicator, service shutoff valves, charging valves, and charge of refrigerant.
   3. Refrigerant: R-407C or R-410A.
   4. Refrigerant Evaporator Coil: Direct-expansion coil of seamless copper tubes expanded into aluminum fins, with two circuits, each with solenoid valve.
      a. Mount coil assembly over stainless-steel drain pan[complying with ASHRAE 62.1] [and] [having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir].
   6. Split system shall have suction- and liquid-line compatible fittings and refrigerant piping for field interconnection.

F. Electric-Resistance Heating Coil: Finned-tube electric elements with contactor and high-temperature-limit switches.
G. Filter: 2-inch-thick, disposable, glass-fiber media.

H. Infrared Humidifier: High-intensity quartz lamps mounted above stainless-steel evaporator pan, serviceable without disconnecting water, drain, or electrical connections; prepiped and located in bypass airstream; with flush-cycle timer and solenoid drain valve.

I. Disconnect Switch: Nonautomatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.

J. Control System: Unit-mounted panel with main fan contactor, compressor contactor, compressor start capacitor, control transformer with circuit breaker, solid-state temperature and humidity control modules, time-delay relay, heating contactor, and high-temperature thermostat.

2.3 CONSOLE UNITS

A. Manufacturers: Subject to compliance with requirements, [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings:
   1. Liebert Corporation.

C. Description: Split system consisting of evaporator section for floor or wall mounting and remote condensing section.

D. Evaporator Cabinet: Furniture-grade steel with baked-enamel finish; with front access and containing direct-drive centrifugal fans and two-speed motor.
   1. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

E. Condenser Cabinet: Steel with baked-enamel finish and containing compressor and condenser.

F. Refrigeration System:
   1. Compressor: Hermetic, with oil strainer, internal motor overload protection, resilient suspension system, and crankcase heater.
   2. Refrigeration Circuit: Filter/dryer, manual-reset high-pressure switch, thermal-expansion valve with external equalizer, sight glass with moisture indicator, service shutoff valves, charging valves, and charge of refrigerant.
   3. Refrigerant: R-407C or R-410A.
   4. Refrigerant Evaporator Coil: Direct-expansion coil of seamless copper tubes expanded into aluminum fins.
      a. Mount coil assembly over stainless-steel drain pan[complying with ASHRAE 62.1] [and] [having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir].
6. Split system shall have suction- and liquid-line compatible fittings and refrigerant piping for field interconnection.

G. Electric-Resistance Heating Coil: Finned-tube electric elements with contactor and high-temperature-limit switches.

H. Filter: Cleanable.

I. Filter: 1-inch thick, disposable, glass-fiber media.
   1. Initial Resistance: <Insert inches wg>.
   3. Arrestance (ASHRAE 52.1): 90 percent.

J. Disconnect Switch: Nonautomatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.

K. Control System: Unit-mounted panel with contactors, control transformer with circuit breaker, and solid-state temperature-[ and humidity-]control modules. Provide solid-state, unit-mounted control panel with start-stop switch[, adjustable humidity set point,] and adjustable temperature set point.

2.4 FAN MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
   1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.

B. <Insert unique motor characteristics>.

2.5 CAPACITIES AND CHARACTERISTICS

A. Unit Configuration:
   1. [Upflow] [Downflow].
   2. [Draw] [Blow] through.

B. Supply-Air Fan:
   1. Number of Fans: [One] [Two] <Insert number>.

C. Refrigeration System:
   1. Unit Energy Efficiency: <Insert COP or EER>.
   2. Refrigerant Compressor:
a. Total Unit Cooling Capacity: <Insert Btu/h>.
b. Sensible Unit Cooling Capacity: <Insert Btu/h>.
c. Number of Compressors: [One] [Two] <Insert number>.
d. Motor Size: <Insert number> hp.

3. Refrigerant Evaporator Coil:
   a. Cooling Capacity: <Insert Btu/h>.
   b. Entering-Air Dry-Bulb Temperature: <Insert deg F>.
   c. Entering-Air Wet-Bulb Temperature: <Insert deg F>.
   d. Leaving-Air Dry-Bulb Temperature: <Insert deg F>.
   e. Leaving-Air Wet-Bulb Temperature: <Insert deg F>.

4. Air-Cooled Refrigerant Condenser:
   a. Cooling Capacity: <Insert Btu/h>.
   b. Entering-Air Temperature: <Insert deg F>.
   c. Number of Condenser Fan Motors: <Insert number>.
   d. Condenser Fan Motors: <Insert number> hp.

D. Electric-Resistance Heating Coil:
   1. Total Capacity: <Insert >.

E. Humidifier:
   1. Total: <Insert lb/h>.
   2. Input: <Insert Btu/h>.

F. Electrical Characteristics:
   1. Volts: [120] [208] [240] [277] [480] <Insert value>.
   2. Phase: [Single] [Three].
   3. Hertz: 60.
   5. Minimum Circuit Ampacity: <Insert value>.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install computer-room air conditioners level and plumb, maintaining manufacturer's recommended clearances.[ Install according to ARI Guideline B.]

B. Computer-Room Air-Conditioner Mounting: Install using [elastomeric pads] [elastomeric mounts] [restrained spring isolators] <Insert device>. Comply with requirements for vibration isolation devices specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
   1. Minimum Deflection: [1/4 inch] [1 inch] <Insert dimension>.

C. Suspended Computer-Room Air Conditioners: Install using continuous-thread hanger rods and [elastomeric hangers] [spring hangers] [spring hangers with vertical-limit stop] of size required to support weight of computer-room air conditioner.
1. Comply with requirements for vibration isolation devices specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment." Fabricate brackets or supports as required.
2. Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

D. Air-Cooled Refrigerant Condenser Mounting: Install using [elastomeric pads] [elastomeric mounts] [restrained spring isolators] <Insert device>. Comply with requirements for vibration isolation devices specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."

3.2 CONNECTIONS

A. Piping installation requirements are specified in other heating, ventilating, and air-conditioning Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Water and Drainage Connections: Comply with applicable requirements in Section 221116 "Domestic Water Piping." Provide adequate connections for water-cooled units, condensate drain, and humidifier flushing system.

D. Refrigerant Piping: Comply with applicable requirements in Section 232300 "Refrigerant Piping." Provide shutoff valves and piping.

3.3 FIELD QUALITY CONTROL

A. Tests and Inspections:
1. Inspect for and remove shipping bolts, blocks, and tie-down straps.
2. After installing computer-room air conditioners and after electrical circuitry has been energized, test for compliance with requirements.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Computer-room air conditioners will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

D. After startup service and performance test, change filters and flush humidifier.

3.4 ADJUSTING

A. Adjust initial temperature[and humidity] set points.
B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Occupancy Adjustments: When requested within [12] <Insert number> months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [two] <Insert number> visits to Project during other-than-normal occupancy hours for this purpose.

END OF SECTION
SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 SUMMARY
A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.2 SUBMITTALS
A. Product Data: For each type of product indicated.
B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
C. Detail equipment assemblies and indicate, required clearances, method of field assembly, and location and size of each field connection.
D. Operation and maintenance data.
E. Certification documents for those technicians performing tasks involving refrigerants covered by Section 608 of the Clean Air Act.

1.3 QUALITY ASSURANCE
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70.
B. Standards Compliance:
   1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
   2. Furnish and install equipment and accessories in accordance with the International Mechanical Code.
   3. Furnish and install equipment and accessories in accordance with the International Energy Conservation Code.
   4. Units shall be listed in the applicable ARI Directory of Certified products
   5. Handling of refrigerants and components containing refrigerants shall comply with Section 608 of the Clean Air Act.

1.4 WARRANTY
A. Warranty Period:
   1. For Compressor: Five years from date of Substantial Completion.
   2. For Parts: Two years from date of Substantial Completion.
   3. For Labor: Two years from date of Substantial Completion.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Trane Company
   2. American Standard
   3. Daikin
   4. York, Johnson Controls Unitary Products
   5. Mitsubishi Electronics America, Inc.; HVAC Division. (Mini-splits only)

2.2 INDOOR UNITS

A. Full-size Evaporator-Fan Components:
   1. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
   2. Insulation: Faced, glass-fiber duct liner.
   5. Fan: Direct drive, centrifugal.
   6. Fan Motors:
      a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
      b. Multi-tapped, multispeed with internal thermal protection and permanent lubrication.
   7. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
   8. Condensate Drain Pans:
      a. Fabricated with one percent slope and 2 inches deep in at least two planes to collect condensate and to direct water toward drain connection.
      b. Single-wall, corrosion resistant sheet. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.
      c. General Requirements for Air Filtration Section:
         1) Factory-fabricated, viscous-coated, flat-panel type.
         2) Arrestance according to ASHRAE 52.1: 80.
         3) MERV according to ASHRAE 52.2: 7
         4) Media: Interlaced glass fibers sprayed with nonflammable adhesive and antimicrobial agent.

B. Mini-split, Evaporator-Fan Components:
   1. Cabinet: Enameled steel with removable panels on front and ends, and discharge drain pans with drain connection.
2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 210/240.
5. Fan Motors: Comply with Section 230513 "Common Motor Requirements for HVAC Equipment." Provide multispeed, permanent lubrication.
6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
7. Condensate Drain Pans:
   a. Fabricated with one percent slope to direct water toward drain connection.
   b. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.
8. Air Filtration Section:
   1) Factory-fabricated, viscous-coated, flat-panel type.
   2) Arrestance according to ASHRAE 52.1: 80.
   3) MERV according to ASHRAE 52.2: 5
   4) Media: Interlaced glass fibers sprayed with nonflammable adhesive and antimicrobial agent.

2.3 OUTDOOR UNITS

A. Air-Cooled, Compressor-Condenser Components:
   1. Casing: Steel, finished with baked enamel, with removable panels. Provide brass service valves, fittings, and gage ports on exterior of casing.
   2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
      a. Compressor Type: Scroll.
      b. Compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
      c. Refrigerant Charge R-407C or R-410A.
      d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 210/240.
   4. Fan: Aluminum-propeller type, directly connected to motor.
   5. Motor: Permanently lubricated, with integral thermal-overload protection.
   6. Low Ambient Kit: Permits cooling operation down to 0 deg F.
   7. Mounting Base: Concrete pad, 4 inches nominal thickness, extend 6 inches beyond all sides of equipment.

2.4 ACCESSORIES

A. Control equipment and sequence of operation are specified in Section 230900 "Instrumentation and Control for HVAC" and Section 230993 "Sequence and Operations for HVAC Controls."
B. Thermostat: Low voltage with subbase to control compressor and evaporator fan.

C. Thermostat: Control compressor and evaporator fan, with the following features:
   1. Compressor time delay.
   2. 24-hour time control of system stop and start.
   3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
   4. Fan-speed selection including auto setting.

D. Automatic-reset timer to prevent rapid cycling of compressor.

E. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

F. Liquid Line Filter Driers: 

G. Provide a sealed canister type liquid line filter drier with high water capacity for units with less than ten tons total cooling capacity. Provide a ball valve on each side.

H. Provide a replaceable core type liquid line filter drier with high water capacity for units with ten tons total cooling capacity or greater. Provide a ball valve on each side.

I. Defrost Controls: A time initiated, temperature terminated defrost system shall ship with a setting of 70-minute cycle, with a choice of 50- or 90-minute cycle. Timed override limits defrost cycle to 10 minutes shall be available on units 10 tons and above. Adaptive demand defrost shall be provided on units below 10 Tons.

J. Electrical: Provide single point unit power connection.

K. Unit control box shall be located within the unit and shall contain controls for compressor, reversing valve and fan motor operation and shall have a 50 VA 24-volt control circuit transformer and a terminal block for low voltage field wiring connections.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install unit level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to or from building structure.

C. Install ground-mounted, compressor-condenser components on 4-inch-thick, reinforced concrete base that is 6 inches larger, on each side, than unit. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete." Coordinate anchor installation with concrete base.
D. Install roof-mounted, compressor-condenser components on equipment supports specified in Section 077200 "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.

E. Install and connect pre-charged refrigerant tubing to component's quick-connect fittings, locations allowing. If not, fabricate and install tubing in accordance with the units' manufacturer's installation instructions and Section 232300 – Refrigerant Piping.

F. The refrigeration system shall be installed and tested in accordance with the International Mechanical Code. Afterwards, the refrigerant system shall pass a standing vacuum test at 500 microns for a minimum of 24 hours.

G. Connection and removal of tubing or gages to a refrigerant charged assembly must be done by a Certified Refrigerant Technician. Adding or removing refrigerant to an assembly must be done by a Certified Refrigerant Technician.

H. Install refrigerant and condensate drainage tubing to allow access to unit.

I. Provide a complete set of new air filters for each unit at Substantial Completion.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

3.3 QUALITY CONTROL

A. Complete the manufacturer's installation and startup checklists and resolve all discrepancies.

B. Provide the Commission Agent, SRP Inspector, and SRP PM with the completed checklists/test results.

3.4 TRAINING

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following types of water-source heat pumps:
   1. Concealed horizontal or vertical units.
   2. Rooftop units.

1.2 ACTION SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each model.

B. Field quality-control test reports.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.4 QUALITY ASSURANCE

A. ASHRAE Compliance:
   1. ASHRAE 15.
   2. Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
   3. Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning"

B. Comply with NFPA 70.

C. Comply with safety requirements in UL 484 for assembly of free-delivery water-source heat pumps.

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace refrigeration components of water-source heat pumps that fail in materials or workmanship within five years from date of Substantial Completion.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 CONCEALED WATER-SOURCE HEAT PUMPS

A. Approved Manufacturers:
   1. American Standard
   2. Trane.

B. Description: Packaged water-source heat pump with temperature controls; factory assembled, tested, and rated according to ARI-ISO-13256-1.

C. Cabinet and Chassis: Galvanized-steel casing with the following features:
   1. Access panel for access and maintenance of internal components.
   2. Cabinet Insulation: Glass-fiber liner, minimum 1/2 inch thick, passing UL 181.
   3. Condensate Drainage: Plastic or stainless-steel drain pan with condensate drain piping projecting through unit cabinet
   4. Sound Attenuation Package:
      a. Minimum 0.598-inch- thick compressor enclosure and front panel.

D. Fan: Direct driven, centrifugal with multispeed motor resiliently mounted in fan inlet.
   1. General requirements for motors are specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

E. Water Circuit:
   1. Refrigerant-to-Water Heat Exchangers: Coaxial heat exchangers with copper water tube with enhanced heat-transfer surfaces inside a steel shell; both shell and tube leak tested to 450 psig on refrigerant side and 400 psig on water side. Factory mount heat exchanger in unit on resilient rubber vibration isolators.
   2. Motorized Water Valve: Stop water flow through the unit when compressor is off.

F. Refrigerant-to-Air Coils: Copper tubes with aluminum fins, leak tested to 450 psig.

G. Refrigerant Circuit Components:
   2. Charging Connections: Service fittings on suction and liquid for charging and testing.
   3. Reversing Valve: Pilot-operated sliding-type valve designed to be fail-safe in heating position with replaceable magnetic coil.
4. Compressor: Hermetic [rotary] [reciprocating] [scroll] compressor installed on vibration isolators and housed in an acoustically treated enclosure with factory-installed safeties as follows:
   a. Antirecycle timer.
   b. High-pressure cutout.
   c. Low-pressure cutout or loss of charge switch.
   d. Internal thermal-overload protection.
   e. Freezestat to stop compressor if water-loop temperature in refrigerant-to-water heat exchanger falls below 35 deg F
   f. Condensate overflow switch to stop compressor with high condensate level in condensate drain pan.
6. Pipe Insulation: Refrigerant minimum 3/8-inch- thick, flexible elastomeric insulation on piping exposed to airflow through the unit. Maximum 25/50 flame-spread/smoke-development indexes according to ASTM E 84.
8. Refrigerant Metering Device: Thermal expansion valve to allow specified operation with entering-water temperatures from 25 to 125 deg F.

H. Electric Heating Coil: Helix-wound, nickel-chromium wire-heating elements in ceramic insulators mounted on steel supports. Energize on call for heating when entering-water-loop temperature is less than 60 deg F.

I. Hot-Gas Reheat: Reheat valve diverts refrigerant hot gas to reheat coil when remote humidistat calls for dehumidification.

J. Filters: Disposable, glass-fiber or pleated, 1 inch thick, with adhesive, shall have minimum efficiency reporting value (MERV) of 5.

K. Controls:
   1. Basic Unit Controls:
      a. Low- and high-voltage protection.
      b. Overcurrent protection for compressor and fan motor.
      c. Random time delay, three to ten seconds, start on power up.
      d. Time delay override for servicing.
      e. Control voltage transformer.
   2. Thermostat:
      a. Wall-Mounted Thermostat: Honeywell V1sonPRO 8000

L. Electrical Connection: Single electrical connection with fused disconnect.

2.3 ROOFTOP WATER-SOURCE HEAT PUMPS

A. Approved Manufacturers:
   1. American Standard
2. Trane.

B. Description: Packaged water-source heat pump with temperature controls; factory assembled, tested, and rated according to ARI-ISO-13256-1.

C. Cabinet and Chassis: Galvanized-steel casing with the following features:
1. Water- and air-tight access panels for access and maintenance of internal components.
2. Knockouts for electrical and piping connections.
3. Flanged duct connections.
4. Cabinet Insulation: Glass-fiber liner, 1 inch thick, complying with UL 181.
7. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Indoor Fan: Forward curved centrifugal, with [direct-drive, multispeed motor resiliently mounted in fan inlet] [or] [belt-drive, single-speed motor with adjustable motor sheave installed on an adjustable fan base resiliently mounted in cabinet].
1. General requirements for motors are specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
2. Direct-Drive Fan Motor: Multispeed, permanently lubricated motor.

E. Water Circuit:
1. Refrigerant-to-Water Heat Exchanger:
   a. [Coaxial] [Coil-in-shell] [Shell-and-tube] heat exchanger with copper water tube with enhanced heat-transfer surfaces inside a steel shell; both shell and tube leak tested to 450 psig on refrigerant side and 400 psig on water side. Factory mount heat exchanger in unit on resilient rubber vibration isolators.
2. Motorized Water Valve: Stop water flow through the unit when compressor is off.

F. Refrigerant-to-Air Coils: Copper tubes with aluminum fins, leak tested to 450 psig.

G. Refrigerant Circuit Components:
1. Sealed Refrigerant Circuit: Minimum of 2 circuits required for units 10 tons and larger. Intertwine circuits in refrigerant to air coil.
   a. Charge with R-407C or R-410A refrigerant.
2. Charging Connections: Service fittings on suction and liquid for charging and testing on each circuit.
3. Reversing Valve: Pilot-operated sliding-type valve designed to be fail-safe in heating position with replaceable magnetic coil.
4. Compressor: [Hermetic-reciprocating] [Hermetic scroll] [Semihermetic reciprocating] compressor installed on vibration isolators housed in an acoustically treated enclosure with factory-installed safeties as follows:
   a. Antirecycle timer.
   b. High-pressure cutout.
   c. Low-pressure cutout or loss of charge switch.
d. Internal thermal-overload protection.

e. Freezestat to stop compressor if water-loop temperature in refrigerant-to-water heat exchanger falls below 35 deg F.

f. Condensate overflow switch to stop compressor with high condensate level in condensate drain pan.


8. Refrigerant Metering Device: Thermal expansion valve to allow specified operation with entering-water temperatures from 25 to 125 deg F.


H. Electric Heating Coil: Helix-wound, nickel-chromium wire-heating elements in ceramic insulators mounted on steel supports. Energize on call for heating when entering-water-loop temperature is less than 60 deg F.

I. Hot-Gas Reheat: Reheat valve diverts refrigerant hot gas to reheat coil when remote humidistat calls for dehumidification.

J. Hot-Gas Bypass: Include constant pressure expansion valve, solenoid valve, and controls to maintain continuous refrigeration system operation at 10 percent of full load on lead compressor.

K. Outdoor-Air Damper: Linked damper blades, for minimum 25 percent outdoor air, with [manual slide and] [fully modulating, spring-return damper motor and] hood.

L. Air-Side Economizer: Return-, relief-, and outdoor-air dampers with neoprene seals and with weather-resistant hood.

1. Damper Motors: Fully modulating spring return with adjustable minimum position potentiometer.

2. Temperature Control: Microprocessor-based controller using [outdoor-air, mixed-air and outdoor-air temperature] [outdoor-air, mixed-air temperature and selects between outdoor-air and return-air enthalpy] to adjust mixing dampers with water-loop entering temperature greater than [70 deg F] <Insert temperature>. Delay opening outdoor-air damper to minimum position until room thermostat is satisfied at room set-point temperature.

3. Ventilation Control: Provide carbon dioxide sensor to reset minimum outdoor-air intake rate to minimum 10 percent to maintain maximum 800 ppm concentration of carbon dioxide in return air.

4. Relief Damper: Gravity-actuated damper with bird screen and hood.

M. Filters: Disposable, glass-fiber or pleated type, 1 inch thick, with adhesive, shall have minimum MERV of 5.
N. Roof Curb: Steel, with corrosion-protection coating, gasketing, and factory-installed wood nailer; complying with NRCA standards; minimum height of 14 inches.

O. Horizontal Discharge Roof Curb: Steel, with corrosion-protection coating, gasketing, and factory-installed wood nailer, and configured to convert from downflow to horizontal airflow; complying with NRCA standards; minimum height of 26 inches.

P. Isolation Curb: Rigid upper and lower steel structure with vibration isolation springs having 2-inch static deflection and vertical and horizontal restraints; with elastomeric waterproof membrane.

Q. Controls:
1. Basic Unit Controls:
   a. Low- and high-voltage protection.
   b. Overcurrent protection for compressor and fan motor.
   c. Random time delay, three to ten seconds, start on power-up.
   d. Time delay override for servicing.
   e. Control voltage transformer.
1. Thermostat:
   a. Wall-Mounted Thermostat: Honeywell VIsionPRO 8000

R. Electrical Connection: Single electrical connection with fused disconnect.

2.4 HOSE KITS

A. General: Hose kits shall be designed for minimum 400 psig working pressure, and operating temperatures from 33 to 211 deg F. Tag hose kits to equipment designations.

B. Hose: Minimum diameter, equal to water-source heat-pump connection size.

C. Isolation Valves: Two-piece bronze-body ball valves with stainless-steel ball and stem and galvanized-steel lever handle. Provide valve for supply and return. If balancing device is combination shutoff type with memory stop, the isolation valve may be omitted on the return.

D. Strainer: Y-type with blowdown valve in supply connection.

E. Balancing Device: Mount in return connection. Include meter ports to allow flow measurement with differential pressure gage.
   1. Automatic balancing valve, factory set to operate within 10 percent of design flow rate over a 40:1 differential pressure range of 2 to 80 psig.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Equipment Mounting: Install water-source heat pumps on cast-in-place concrete equipment base(s).
   1. Coordinate sizes and locations of concrete bases with actual equipment provided.
   2. Construct bases to withstand, without damage to equipment, seismic force required by code.
   3. Construct concrete bases 4 inches high and extend base not less than 6 inches in all directions beyond the maximum dimensions of water-source heat pump unless otherwise indicated or unless required for seismic anchor support.
   4. Minimum Compressive Strength: 3000 psi at 28 days.
   5. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
   6. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base, and anchor into structural concrete floor.
   7. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   8. Install anchor bolts to elevations required for proper attachment to supported equipment.

B. Equipment Mounting: Install water-source heat pumps using elastomeric pads or as shown in the drawings.

C. Curb Support: Install roof curb on roof structure, level and secure, according to NRCA's "The NRCA Roofing and Waterproofing Manual, Fifth Edition." Install and secure water-source heat pumps on curbs, and coordinate roof penetrations and flashing with roof construction. Secure units to curb support with anchor bolts as shown in the drawings.

D. Unit Support: Install water-source heat pumps level on structural curbs. Coordinate wall penetrations and flashing with wall construction. Secure units to structural support with anchor bolts or as shown on drawings.

A. Isolation Curb Support: Install water-source heat pumps on isolation curbs, and install flexible duct connectors and vibration isolation and seismic-control devices.
   1. Comply with requirements in Division 23 Section "Air Duct Accessories" for flexible duct connectors.
   2. Comply with requirements in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" for vibration isolation and seismic-control devices.
B. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
   1. Connect supply and return hydronic piping to heat pump as shown in the drawings.
   2. Connect heat-pump condensate drain pan to indirect waste connection with condensate trap of adequate depth to seal against the pressure of fan. Install cleanouts in piping at changes of direction.

C. Duct installation requirements are specified in other Sections.

D. Install piping adjacent to machine to allow service and maintenance.

3.2 QUALITY CONTROL

A. Complete the manufacturer’s installation and startup checklists and resolve all discrepancies.

B. Provide the Commission Agent and SRP PM with the completed checklists/test results.

3.3 TRAINING

A. Engage a factory-authorized service representative to train Owner’s maintenance personnel to adjust, operate, and maintain units.

END OF SECTION
SECTION 238216 - AIR COILS

PART 1 - GENERAL

1.1  SUMMARY
A. This Section includes hot- and chilled-water, refrigerant, and electric air coils that are not part of
air handling units.

1.2  SUBMITTALS
A. Product Data: For each model indicated, provide rated capacities at design conditions,
pressure drop, physical dimensions, required clearances, weights, components, and
accessories.
B. Operation and maintenance data.

1.3  QUALITY ASSURANCE
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA
70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for
intended use.
components, construction, and rating.
Coils."

PART 2 - PRODUCTS

2.1  MANUFACTURERS
A. Manufacturers: Subject to compliance with requirements, provide products by the
manufacturers specified.

2.2  HOT-WATER AND CHILLED-WATER COILS
A. Description: [Continuous circuit coil] [Self-draining coil] [Cleanable coil] fabricated; to ARI 410.
1. Manufacturers:
a. Aerofin Corporation.
b. Carrier Corporation.
c. Dunham-Bush, Inc.
d. Heatcraft Inc.; Heat Transfer Division.
e. Trane Co. (The).
f. USA Coil and Air.
2. Piping Connections: Same end or opposite end connections as indicated on Drawings.
3. Tubes: Copper, complying with ASTM B 75, [0.625 inch] [0.50 inch] outside diameter.
4. Fins: Aluminum, maximum 144 fins per inch.
5. Fin to Tube Joint: Mechanical bond.
6. Headers: Cast iron with drain and air vent tappings or seamless copper tube with brazed joints, prime coated.
7. Frames: Galvanized-steel channel frame, for slip-in or flanged mounting as indicated on Drawings, designed to support weight of water filled coil.
8. Ratings: Design tested and rated according to ASHRAE 33 and ARI 410 for working pressure of 200 psig at 200 degrees F.
9. Source Quality Control: Test to 300 psig, and to 200 psig underwater.

2.3 REFRIGERANT COILS

A. Description: Coil designed for use with R-22 refrigerant, fabricated to ARI 410, connected with brazed fittings.
1. Manufacturers:
   a. Aerofin Corporation.
   b. Carrier Corporation.
   c. Dunham-Bush, Inc.
   d. Heatcraft Inc.; Heat Transfer Division.
   e. Trane Co. (The).
   f. USA Coil and Air.
   g. York International.
2. Capacity Reduction: Circuit for [face control] [row control] [interleaved control].
3. Tubes: Copper, complying with ASTM B 75, [0.625 inch] [0.50 inch] outside diameter.
4. Fins: Aluminum, maximum 144 fins per inch.
5. Fin to Tube Joint: Mechanical bond.
7. Frames: Galvanized-steel channel frame, for slip-in or flanged mounting as indicated on Drawings, designed to support weight of water filled coil.
8. Ratings: Design tested and rated according to ASHRAE 33 and ARI 410 for working pressure of 300 psig.
9. Source Quality Control: Test to 450 psig, and to 300 psig underwater.

2.4 ELECTRICAL HEATING COILS, CONTROLS, AND ACCESSORIES

A. Description: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
1. Manufacturers:
   a. Besco, Inc.
   b. Brasch Manufacturing Co., Inc.
   c. Chromalox Wiegand Industrial Division; Emerson Electric Company.
   d. Dell Corp.
   e. INDEECO.
   f. Markel Products Co.
   g. PM Wright, Ltd.
   h. Tutco Applied Heating Technologies.
   i. Valley Industries.
3. Casing Assembly: Slip-in or flanged type as indicated on Drawings, with galvanized-steel frame.
4. Heating Elements:
   a. Open-Coil: Helix-wound resistance wire of 80 percent nickel and 20 percent chromium, supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame. Watt density shall not exceed 35 watts per square inch of wire surface area.
   b. Finned Tubular: Coiled resistance wire of 80 percent nickel and 20 percent chromium; surrounded by compacted magnesium-oxide powder in tubular-steel sheath; with spiral-wound, copper-plated, steel fins continuously brazed to sheath.
5. Overtemperature Protection: Disk-type, automatically resetting, thermal-cutout, safety device; serviceable through terminal box without removing heater from duct or unit. Provide secondary protection consisting of load-carrying, manually resetting or manually replaceable, thermal cutouts; factory wired in series with each heater stage.
6. Control Panel: Unit mounted with disconnecting means and overcurrent protection. Include the following controls:
   a. Airflow proving switch.
   b. Magnetic contactor.
   c. SCR controller.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install coils level and plumb.
B. Install coils in metal ducts and casings constructed according to SMACNA’s "HVAC Duct Construction Standards, Metal and Flexible."
C. 
D. Install stainless-steel drain pan under each [chilled-water] [DX] coil.
   1. Construct drain pans to comply with ASHRAE 62, to extend beyond coil length and width and to connect to condensate trap and drainage.
   2. Extend drain pan 5 inches upstream from coil face, 10 inches downstream from coil face, and extend under coil headers and exposed supply piping.
   3. 
E. Straighten bent fins on air coils.
F. Clean coils using materials and methods recommended in writing by manufacturer, and clean inside of casing and enclosure to remove dust and debris.

3.2 CONNECTIONS

A. 
B. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
C. Install piping adjacent to coils to allow service and maintenance.

D. 

E. Unless otherwise indicated, connect piping with unions and shutoff valves to allow coils to be disconnected without draining piping. Refer to piping system Sections for specific valve and specialty arrangements.

F. 

G. Ground equipment according to Division 16.

H. Connect wiring according to Division 16.

3.3 FIELD QUALITY CONTROL FOR ELECTRICAL HEATING COILS

A. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove malfunctioning units, replace with new units, and retest.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Shut unit down and reconnect automatic temperature-control operators.

END OF SECTION
SECTION 238219 - FAN-COIL UNITS

PART 1 - GENERAL

1.1 SUMMARY
A. This Section includes fan-coil units and accessories.

1.2 SUBMITTALS
A. Product Data: For each model indicated, provide dimensions, weights, capacities at scheduled conditions, required clearances, electrical requirements, components, and location and size of field connections.
B. Operation and maintenance data.

1.3 QUALITY ASSURANCE
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. York International Corp.
   2. Daikin
   3. Trane Company

2.2 DUCTLESS FAN COIL UNITS
A. Description: An assembly including cabinet, filter, chassis, coil, drain pan(s), fan, and motor. Factory-packaged and tested units rated according to ARI 440, ASHRAE 33, and UL 1995.
B. Coil Section Insulation: 1/2-inch thick, coated glass fiber complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916. Fire-Hazard Classification: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
C. Main and Auxiliary Drain Pans: Plastic or insulated steel as scheduled, formed to slope from all directions to the drain connection as required by ASHRAE 62. Provide extended or auxiliary drain pan for piping connections.
D. Chassis: Galvanized steel where exposed to moisture. Floor-mounting units shall have leveling leg screws.

E. Cabinet: Steel with galvanized or baked enamel finish as scheduled.
   1. Panels: Removable, steel, with discharge grille and channel-formed edges, cam fasteners, and insulation on back of panel.
   2. Steel recessing flanges for recessing fan-coil units into ceiling or wall.

F. Filter Rack: Filter rack with access panel or door. Size filter rack to use two inch thick standard size filters at not more than 500 feet per minute face velocity.

G. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.

H. Provide single-point electrical connection for heater and fan. Unit shall include control transformer and magnetic contactor.

I. Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with fuses in terminal box for over-current protection and limit controls for high-temperature protection. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.

J. Fan and Motor Board: Removable.
   1. Fan: Forward curved, double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.
   3. Wiring Termination: Connect motor to chassis wiring with plug connection.

2.3 DUCTED FAN-COIL UNITS

A. Description:
   1. An assembly including cabinet, filter, chassis, coil, drain pan(s), fan, and motor.
   2. Factory-packaged and -tested units rated according to ARI 440, ASHRAE 33, and UL 1995.

B. Coil Section Insulation: 1-inch thick coated glass fiber complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.
   1. Fire-Hazard Classification: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.

C. Drain Pans: Insulated stainless steel formed to slope from all directions to the drain connection as required by ASHRAE 62. Provide extended drain pan or auxiliary drain pan for piping connections.

D. Chassis: Galvanized steel where exposed to moisture, with baked-enamel finish and removable access panels.

E. Cabinets: Steel with galvanized or baked-enamel finish in manufacturer's standard paint color.
F. Dampers: Galvanized steel with extruded-vinyl blade seals, flexible-metal jamb seals, and interlocking linkage.

G. Filter Rack: Side access filter rack with access panel or door. Size filter rack to accept two inch thick standard size filters at not more than 500 feet per minute face velocity.

H. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain.

I. Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with fuses in terminal box for overcurrent protection and limit controls for high-temperature protection of heaters. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.

J. Provide single-point electrical connection for heater and fan. Unit shall include control transformer and magnetic contactor.

K. Direct-Driven Fans: Double width, forward curved, centrifugal; with permanently lubricated, multispeed motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.

L. Belt-Driven Fans: Double width, forward curved, centrifugal; with permanently lubricated, single-speed motor installed on an adjustable fan base resiliently mounted in the cabinet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.

M. Motors: Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

PART 3 - EXECUTION

3.1 INSTALLATION

A. The fan coil units and associated components shall be installed in accordance with the manufacturer's published installation instructions and their listings.

B. Install fan-coil units to comply with NFPA 90A.

C. Suspend fan-coil units from structure with spring hangers as specified in Section 230548 "Vibration Controls for HVAC Piping and Equipment."

D. Install new filters in each fan-coil unit within two weeks after Substantial Completion.

E. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific requirements are as follows:

1. Install piping adjacent to machine to allow service and maintenance.
2. Connect piping to fan-coil-unit as detailed on the drawings.
3. Connect condensate drain to indirect waste.
4. Install condensate trap of adequate depth to seal against the pressure of fan. Unions shall be provided on both sides of the trap assembly. Install cleanouts in piping at changes of direction.
F. Connect supply and return ducts to fan-coil units with flexible duct connectors specified in Section 233300 "Duct Accessories." Comply with safety requirements in UL 1995 for duct connections.

3.2 FIELD QUALITY CONTROL

A. The fan coil units and associated components shall be installed in accordance with the manufacturer’s installation instructions.

B. Perform the following field tests and inspections and prepare test reports:

1. Complete the pre-start up procedure and checklist included in the manufacturer’s installation instructions.

2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Complete the startup procedure and checklist included in the manufacturer’s installation instructions.

3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

END OF SECTION
SECTION 260519 - CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Building wires and cables rated 600 V and less.
   2. Connectors, splices, and terminations rated 600 V and less.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.
B. Field quality-control test reports.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Copper Conductors: Comply with NEMA WC 70.
B. Conductor Insulation: Types THW, THHN-THWN, XHHW, UF, USE, and SO.
C. Multiconductor Cable: Comply with NEMA WC 70 for armored cable, Type AC metal-clad cable, Type MC mineral-insulated, metal-sheathed cable, Type MI nonmetallic-sheathed cable, Type NM Type SO and Type USE with ground wire.

2.2 CONNECTORS AND SPLICES

A. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
B. Comply with NFPA 70.
PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders, Copper: Install stranded conductors unless otherwise indicated.

B. Branch Circuits, Copper: Install stranded conductors unless otherwise indicated.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THHN-THWN, single conductors in raceway Type XHHW, single conductors in raceway. Type SE or USE multiconductor cable

B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN-THWN, single conductors in raceway. For fished installations only, Armored cable, Type AC Metal-clad cable, Type MC

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway Underground feeder cable, Type UF.

E. Exposed Branch Circuits, Including in Crawlspace: Type THHN-THWN, single conductors in raceway. Armored cable: Type AC, Metal-clad cable: Type MC, where indicated or with approval by AHJ.

F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway. Only when approved in writing by the AHJ: Armored cable, Type AC or Metal-clad cable, Type MC.

G. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway. Underground branch-circuit cable: Type UF.

H. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

I. Class 1 Control Circuits: Type THHN-THWN, in raceway.

J. Class 2 Control Circuits: Type THHN-THWN, in raceway Power-limited cable, concealed in building finishes. Power-limited tray cable, in cable tray.
3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.

B. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
   1. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.5 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."

B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.
3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.7 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

B. FIELD QUALITY CONTROL

C. Tests and Inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors, and conductors feeding the following critical equipment and services for compliance with requirements.
   a. Insert, in separate subparagraphs, critical equipment and services to be tested.


3. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.
   a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.
   b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
   c. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

D. Test Reports: Prepare a written report to record the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

E. Remove and replace malfunctioning units and retest as specified above.
SECTION 260523 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Multimode optical-fiber cabling.
   2. UTP cabling.
   3. RS-485 cabling.
   4. Low-voltage control cabling.
   5. Control-circuit conductors.
   6. Identification products.

1.2 SUBMITTALS

A. Product Data: For each type of product.

B. Source quality-control reports.

C. Field quality-control reports.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 PERFORMANCE REQUIREMENTS

A. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262 by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.
   1. Flame Travel Distance: 60 inches or less.
   2. Peak Optical Smoke Density: 0.5 or less.
   3. Average Optical Smoke Density: 0.15 or less.

B. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.

C. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.
2.3 BACKBOARDS

A. Description: Plywood, [fire-retardant treated] 3/4 by 48 by 96 inches. Comply with requirements for plywood backing panels in Section 061000 "Rough Carpentry."

B. Painting: Paint plywood on all sides and edges with [flat] [eggshell] [black] <Insert color> [latex] [alkyd] paint. Comply with requirements in Section 099123 "Interior Painting."

2.4 OPTICAL-FIBER CABLE

A. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. Belden Inc.
   2. CommScope, Inc.
   3. Corning Incorporated.
   4. Emerson Connectivity Solutions.
   5. General Cable Technologies Corporation.
   6. Mohawk; a division of Belden Inc.
   7. Nexans; Berk-Tek Products.
   8. Siemon Company (The).
   9. Superior Essex Inc.
   10. SYSTIMAX Solutions; a CommScope, Inc. brand.
   11. 3M.
   12. Tyco Electronics/AMP Netconnect; Tyco International Ltd.

C. Description: Multimode, [50/125] [62.5/125]-micrometer,[24]-fiber, nonconductive, tight-buffer, optical-fiber cable.
   1. Comply with ICEA S-83-596 for mechanical properties.
   2. Comply with TIA-568-C.3 for performance specifications.
   4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
      a. Plenum Rated, Nonconductive: [Type OFNP, complying with NFPA 262] [Type OFNP in listed plenum communications raceway] installed according to NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."
      b. Riser Rated, Nonconductive: [Type OFNR or Type OFNP complying with UL 1666] [Type OFNP or Type OFNR in listed riser or plenum communications raceway].
      c. General Purpose, Nonconductive: [Type OFNG or Type OFNP] [Type OFNG, Type OFNP, or Type OFNR in listed communications raceway].
      d. Plenum Rated, Conductive: [Type OFCP complying with NFPA 262] [Type OFCP in listed plenum communications raceway].
e. Riser Rated, Conductive: [Type OFCR or Type OFCP complying with UL 1666][ and ICEA S-103-701] [Type OFCP or Type OFCR in listed riser or plenum communications raceway].

f. General Purpose, Conductive: [Type OFCG or Type OFCP] [Type OFCG or Type OFCP in listed communications raceway].

5. Conductive cable shall be [steel] [aluminum]-armored type.

6. Maximum Attenuation: \[3.5\] \text{dB/km} at 850 nm; \[1.5\] \text{dB/km} at 1300 nm.

7. Minimum Modal Bandwidth: 160 MHz-km at 850 nm; 500 MHz-km at 1300 nm.

D. Jacket:

1. Jacket Color: [Aqua for 50/125] [Orange for 62.5/125]-micrometer cable.

2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-C.

3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

2.5 OPTICAL-FIBER CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. ADC
3. Belden Inc.
5. Dynacom Inc.
7. Molex Premise Networks; a division of Molex, Inc.
8. Panduit Corp.
9. Siemens.

B. Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.

1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares adequate to suit specified expansion criteria.

C. Patch Cords: Factory-made, dual-fiber cables in 36-inch lengths.

D. Cable Connecting Hardware:


2. Quick-connect, simplex and duplex, [Type SC] [Type ST] connectors. Insertion loss of not more than 0.75 dB.

3. Type SFF connectors may be used in termination racks, panels, and equipment packages.
2.6 UTP CABLE

A. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. ADC.
   2. Alpha Wire Company; a division of Belden Inc.
   3. Belden Inc.
   4. CommScope, Inc.
   5. Draka Cableteq USA.
   7. Mohawk; a division of Belden Inc.
   8. Nexans; Berk-Tek Products.
   9. Siemon Company (The).
  10. Superior Essex Inc.
  11. SYSTIMAX Solutions; a CommScope, Inc. brand.
  12. 3M.
  13. Tyco Electronics/AMP Netconnect; Tyco International Ltd.

B. Description: 100-ohm, four-pair UTP[, 24-pair UTP, formed into four-pair binder groups with no overall jacket,][, 25-pair UTP covered with a thermoplastic jacket].
   1. Comply with ICEA S-90-661 for mechanical properties of Category 5e cables.
   2. Comply with ICEA S-102-700 for mechanical properties of Category 6 cables.
   3. Comply with TIA-568-C.1 for performance specifications.
   4. Comply with TIA-568-C.2, [Category 5e] [Category 6] [Category 6A].
   5. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with [NEMA WC 66,] [UL 444] [and] NFPA 70 for the following types:
      a. Communications, Plenum Rated: [Type CMP complying with UL 1685.][Type CM or Type CMX in metallic conduit installed per NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."]
      b. Communications, Riser Rated: [Type CMP, or Type CMR in listed plenum or riser communications raceway.] [Type CMP or Type CMR in metallic conduit installed per NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."]
      c. Communications, General Purpose: [Type CM] [Type CM, Type CMG, Type CMP, Type CMR, or Type CMX in metallic conduit installed per NFPA 70].

2.7 UTP CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

VER:02/11
CONTROL-VOLTAGE ELECTRICAL POWER CABLES
B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. ADC.
   3. Belden Inc.
   4. Dynacom Inc.
   5. Hubbell Incorporated.
   6. Leviton Commercial Networks Division.
   7. Molex Premise Networks; a division of Molex, Inc.
   8. Panduit Corp.
   9. Siemon Company (The).
  10. Tyco Electronics/AMP Netconnect; Tyco International Ltd.

C. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-C.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

D. Connecting Blocks: [110-style IDC for Category 5e] [110-style IDC for Category 6]. Provide blocks for the number of cables terminated on the block, plus [25] <Insert number> percent spare. Integral with connector bodies, including plugs and jacks where indicated.

E. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.

F. Jacks and Jack Assemblies: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with TIA/EIA-568-C.1.

G. Patch Cords: Factory-made, four-pair cables in [36-inch] [48-inch] lengths; terminated with eight-position modular plug at each end.
   1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.
   2. Patch cords shall have color-coded boots for circuit identification.

H. Workstation Outlets: [Two] [Four] -port-connector assemblies mounted in [single] [or] [multigang] faceplate.

I. Faceplates:
   1. Plastic Faceplate: High-impact plastic. Coordinate color with Section 262726 "Wiring Devices."
   2. For use with snap-in jacks accommodating any combination of UTP, optical-fiber, and coaxial work area cords.
      a. Flush-mounted jacks, positioning the cord at a 45-degree angle.

J. Legend:
   1. Factory labeled by silk-screening or engraving.
2.8 TWIN-AXIAL DATA HIGHWAY CABLE

A. Plenum-Rated Cable: NFPA 70, Type CMP.
   1. Paired, \(<\text{insert number}>\) pairs, [No. 20] [No. 22] [No. 24] AWG, stranded \([7x28]\) \([7x30]\) \([7x32]\) tinned-copper conductors.
   2. Plastic insulation.
   3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
   5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned-copper drain wire.

2.9 RS-485 CABLE

A. Plenum-Rated Cable: NFPA 70, Type CMP.
   1. Paired, [one pair] [two pairs], No. 22 AWG, stranded (7x30) tinned-copper conductors.
   2. Fluorinated ethylene propylene insulation.
   3. Unshielded.
   4. Fluorinated ethylene propylene jacket.

2.10 LOW-VOLTAGE CONTROL CABLE

A. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.
   1. [One ][Multi]-pair, twisted, [No. 16 AWG, stranded (19x29)] [No. 18 AWG, stranded (19x30)] tinned-copper conductors.
   2. PVC insulation.
   3. Unshielded.
   4. PVC jacket.
   5. Flame Resistance: Comply with NFPA 262.

2.11 CONTROL-CIRCUIT CONDUCTORS

A. Class 1 Control Circuits: Stranded copper, [Type THHN-2-THWN-2] [Type XHHW-2], in raceway, complying with [UL 44] [UL 83].
B. Class 2 Control Circuits: Stranded copper, [Type THHN-2-THWN-2, in raceway] [Type XHHW-2, in raceway], complying with [UL 44] [UL 83].
C. Class 3 Remote-Control and Signal Circuits: Stranded copper, [Type THHN-2-THWN-2, in raceway] [Type XHHW-2, in raceway] [Type TW or Type TF, in raceway], complying with [UL 44] [UL 83].
D. Class 2 Control Circuits and Class 3 Remote-Control and Signal Circuits That Supply Critical Circuits: Circuit Integrity (CI) cable.
   1. Smoke control signaling and control circuits.

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VER:02/11
CONTROL-VOLTAGE ELECTRICAL POWER CABLES
2. <Insert list of critical circuits that require CI cable>.

2.12 SOURCE QUALITY CONTROL

A. Factory test UTP cables according to TIA-568-C.2.

B. Factory test optical-fiber cables according to TIA-568-C.3.

C. Cable will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Test cables on receipt at Project site.
   1. Test optical-fiber cable to determine the continuity of the strand end to end. Use [optical-fiber flashlight] [optical loss test set] [optical-fiber flashlight or optical loss test set] <Insert test>.
   2. Test each pair of UTP cable for open and short circuits.

3.2 INSTALLATION OF RACEWAYS AND BOXES

A. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or modified in this Section.
   1. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.
   2. Outlet boxes for optical-fiber cables shall be no smaller than 4 inches square by [1-1/2 inches] [2-1/8 inches] deep with extension ring sized to bring edge of ring to within 1/8 inch of the finished wall surface.
   3. Flexible metal conduit shall not be used.

B. Comply with TIA-569-B for pull-box sizing and length of conduit and number of bends between pull points.

C. Install manufactured conduit sweeps and long-radius elbows if possible.

D. Raceway Installation in Equipment Rooms:
   1. Position conduit ends adjacent to a corner on backboard if a single piece of plywood is installed, or in the corner of the room if multiple sheets of plywood are installed around perimeter walls of the room.
   2. Install cable trays to route cables if conduits cannot be located in these positions.
   3. Secure conduits to backboard if entering the room from overhead.
   5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.
E. Backboards: Install backboards with 96-inch dimension vertical. Butt adjacent sheets tightly and form smooth gap-free corners and joints.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1 and NFPA 70.

B. General Requirements for Cabling:
   2. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems" and Ch. 6, "Optical Fiber Structured Cabling Systems."
   3. Terminate all conductors and optical fibers; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and patch panels.
   4. Cables may not be spliced.
   5. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
   6. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems" and Ch. 6, "Optical Fiber Structured Cabling Systems." Install lacing bars and distribution spools.
   7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
   10. Support: Do not allow cables to lie on removable ceiling tiles.
   11. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.

C. UTP Cable Installation:
   2. Install termination hardware as specified in Section 271500 "Communications Horizontal Cabling" unless otherwise indicated.
   3. Do not untwist UTP cables more than 1/2 inch at the point of termination to maintain cable geometry.

D. Optical-Fiber Cable Installation:
   2. Terminate cable on connecting hardware that is rack or cabinet mounted.

E. Open-Cable Installation:
   1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
   2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than [30 inches] <Insert dimension> apart.
3. Cable shall not be run through or on structural members or in contact with pipes, ducts, or other potentially damaging items. Do not run cables between structural members and corrugated panels.

F. Installation of Cable Routed Exposed under Raised Floors:
1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Below each feed point, neatly coil a minimum of 72 inches of cable in a coil.

G. Separation from EMI Sources:
1. Comply with BICSI TDMM and TIA-569-B recommendations for separating unshielded copper voice and data communications cable from potential EMI sources including electrical power lines and equipment.

3.4 REMOVAL OF CONDUCTORS AND CABLES
A. Remove abandoned conductors and cables. Abandoned are those installed that are not terminated at equipment and are not identified for future use with a tag.

3.5 CONTROL-CIRCUIT CONDUCTORS
A. Minimum Conductor Sizes:
   1. Class 1 remote-control and signal circuits; No. 14 AWG.
   2. Class 2 low-energy, remote-control, and signal circuits; No. 16 AWG.
   3. Class 3 low-energy, remote-control, alarm, and signal circuits; No. 12 AWG.

3.6 FIRESTOPPING
A. Comply with requirements in Section 078413 "Penetration Firestopping."
B. Comply with TIA-569-B, Annex A, "Firestopping."
C. Comply with BICSI TDMM, "Firestopping" Chapter.

3.7 GROUNDING
A. For data communication wiring, comply with ANSI-J-STD-607-A and with BICSI TDMM, "Bonding and Grounding (Earthing)" Chapter.
B. For low-voltage control wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.8 IDENTIFICATION
A. Comply with identification requirements in Section 260553 "Identification for Electrical Systems."
B. Identify data and communications system components, wiring, and cabling according to TIA-606-A; label printers shall use label stocks, laminating adhesives, and inks complying with UL 969.

3.9 FIELD QUALITY CONTROL

A. Perform the following tests and inspections [with the assistance of a factory-authorized service representative]:

1. Visually inspect UTP and optical-fiber cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1.

2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

3. Test UTP cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not after cross-connection.
   a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

4. Optical-Fiber Cable Tests:
   a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.0. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
   b. Link End-to-End Attenuation Tests:
      1) Multimode Link Measurements: Test at 850 or 1300 nm in one direction according to TIA/EIA-526-14-A, Method B, One Reference Jumper.
      2) Attenuation test results for links shall be less than 2.0 dB.

B. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

C. End-to-end cabling is considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION
SECTION 260526 - GROUNDING AND BONDING

PART 1 - GENERAL

1.1 SUMMARY
A. This Section includes methods and materials for grounding systems and equipment.

1.2 SUBMITTALS
A. Product Data: For each type of product indicated.
B. Field quality-control test reports.

1.3 QUALITY ASSURANCE
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS
A. Insulated Conductors: Copper or tinned-copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
B. Bare Copper Conductors:
   1. Solid Conductors: ASTM B 3 (Use only when specified)
   4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
   5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
   6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
   7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
2.2 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
   1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding products shall be Erico’s CADWELD system. Connectors shall be provided in kit form and selected per manufacturers written instructions for specific types, sizes, and combination of conductors and connected items.

2.3 GROUNDING ELECTRODE SYSTEM

A. Ground Rods: Copper-clad or Zinc-coated in diameter and length as indicated on the engineering design drawings. (Minimum ¾” X 10’)

B. Grounding Electrode System: For all generator installations, new buildings, and SES replacements for existing buildings.
   1. Minimum two (2) ground rods separated by 23 feet.
   2. Ground rods to be installed in 12” diameter ground well, drilled to a depth of 10’-6” and encased in ground enhancement material. (See Engineering Drawings for Details).
      a. Acceptable Manufacturer
         1) Ground Enhancement Material (GEM): ERICO

C. Ground Wells: Handholds shall be a minimum of 12” deep, open bottomed, with a 9” reinforced concrete lid. Acceptable manufacturers: (See Engineering Drawings for Traffic Rating)
   1. Oldcastle precast
   2. Christy Concrete
   3. Carson
   4. Eritech

D. Concrete Encased Electrode (Ufer): For all generator installations and new buildings connect the slab reinforcing steel to the grounding electrode conductor with a permanent bond.

E. Structural steel: for all new buildings connect the structural steel to the concrete encased electrode conductor as indicated

F. Metal underground water pipe: for all new buildings, connect to the grounding electrode conductor if indicated.

G. Bond (per paragraph 3.1 D) all the above types of grounding electrodes found on the drawings to form a Grounding Electrode System as indicated.
2.4 GROUNDING ELECTRODE CONDUCTORS

A. Install stranded (unless otherwise indicated) copper conductors of the size required by the drawings.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install stranded conductor, unless otherwise indicated.

B. Underground Grounding Conductors: Install bare copper conductor, 2/0 AWG minimum. Trench depth 36 inches below grade, Underground Grounding Conductor at 30 inches minimum with 6 inches of “GEM” below.

C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

D. Conductor Terminations and Connections:
   1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
   2. Underground Connections: Welded connectors, unless otherwise indicated.
   3. Connections to Ground Rods at Test Wells: Welded or Bolted connectors.

3.2 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
   1. Feeders and branch circuits.
   2. Lighting circuits.
   3. Receptacle circuits.
   5. Three-phase motor and appliance branch circuits.
   6. Flexible raceway runs.
   7. Armored and metal-clad cable runs.
   8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.

B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
C. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

D. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

E. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

F. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 6 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

G. Metal and Wood Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.3 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage. (See Paragraph 3.1B)

B. Ground Rods: Install ground rods in 12” diameter ground well, drilled to a depth of 10’-6” and encased in “Ground Enhancement Material”. Install ground well handhold at each grounding electrode location (See Paragraph 2.3C) for inspection and testing of grounding electrode system. Set top of ground well flush with finished grade or floor.

1. Interconnect ground rods with grounding electrode conductor, Minimum 2/0 bare Copper. (See Paragraph 3.1B).
2. For grounding electrode system, install rods spaced at least 23’ from each other (or 2.2 X Rod Length Minimum) and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.
   
a. Acceptable exothermic-welded connector manufacturers:
   
   1) CADWELD

D. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building’s main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.

E. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

3.4 FIELD QUALITY CONTROL

A. Using an independent testing company hired by the Contractor, perform the following tests and inspections and prepare test reports:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.

2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells.

   a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.

   b. Perform tests by fall-of-potential method according to IEEE 81.

B. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 10 ohms.

2. Power and Lighting Equipment or System with Capacity 500 to 1000 kVA: 5 ohms.

3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.

4. Power Distribution Units or Panelboards Serving Electronic Equipment: 1 ohm.

C. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance.

END OF SECTION
SECTION 260529 - HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

1.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of [five] <Insert number> times the applied force.

1.3 SUBMITTALS

A. Product Data: For steel slotted support systems.

B. Shop Drawings:[ Signed and sealed by a qualified professional engineer.] Show fabrication and installation details and include calculations for the following:

1. Trapeze hangers. Include Product Data for components.
2. Steel slotted channel systems. Include Product Data for components.
3. Equipment supports.

C. Welding certificates.

1.4 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Comply with NFPA 70.
PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Cooper B-Line, Inc.; a division of Cooper Industries.
   b. Thomas & Betts Corporation.
   c. Unistrut; Tyco International, Ltd.

2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
5. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: [Steel] [Steel and malleable-iron] hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Hilti Inc.
      2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      3) MKT Fastening, LLC.

2. Mechanical-Expansion Anchors: Insert-wedge-type, [zinc-coated] [stainless] steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Cooper B-Line, Inc.; a division of Cooper Industries.
2) Empire Tool and Manufacturing Co., Inc.
3) Hilti Inc.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Division 5 Section "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as [required by] [scheduled in NECA 1, where its Table 1 lists maximum spacings less than stated in] NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted [or other] support system, sized so capacity can be increased by at least [25] <Insert number> percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with [two-bolt conduit clamps] [single-bolt conduit clamps] [single-bolt conduit clamps using spring friction action for retention in support channel].

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.
3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, [EMT] [IMC] [RMC] [EMT, IMC, and RMC] may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
6. To Steel: [Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts] [Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69] [Spring-tension clamps].
7. To Light Steel: Sheet metal screws.
8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate[ by means that meet seismic-restraint strength and anchorage requirements].

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 5 Section "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.
3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use [3000-psi] <Insert value>, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 3 Section "[Cast-in-Place Concrete] [Cast-in-Place Concrete (Limited Applications)]."

C. Anchor equipment to concrete base.

   1. Place and secure anchorage devices. Use supported equipment manufacturer’s setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   2. Install anchor bolts to elevations required for proper attachment to supported equipment.
   3. Install anchor bolts according to anchor-bolt manufacturer’s written instructions.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

   1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Touchup: Comply with requirements in Division 9 [painting Sections] [Section "High-Performance Coatings"] for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY
A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.2 SUBMITTALS
A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, details, and attachments to other work.

1.3 QUALITY ASSURANCE
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING
A. Rigid Steel Conduit: ANSI C80.1.
B. IMC: ANSI C80.6.
C. EMT: ANSI C80.3.
D. FMC: Zinc-coated steel (Aluminum is not permitted)
E. LFMC: Flexible steel conduit with PVC jacket.
F. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
   2. Fittings for EMT: Steel or die-cast, compression type.
2.2 NONMETALLIC CONDUIT AND TUBING

B. RNC: NEMA TC 2, Type EPC-40-PVC unless otherwise indicated.
C. LFNC: UL 1660.
D. Fittings for ENT and RNC: NEMA TC 3; match to conduit or tubing type and material.
E. Fittings for LFNC: UL 514B.

2.3 METAL WIREWAYS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper B-Line, Inc.
   2. Hoffman.
   3. Square D; Schneider Electric.
B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 123R, unless otherwise indicated.
C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
D. Wireway Covers: Flanged-and-gasketed type, or as indicated.
E. Finish: Manufacturer's standard enamel finish.

2.4 NONMETALLIC WIREWAYS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Hoffman.
   2. Lamson & Sessions; Carlon Electrical Products.
B. Description: PVC plastic, extruded and fabricated to size and shape indicated, with snap-on cover and mechanically coupled connections with plastic fasteners.
C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
2.5 SURFACE RACEWAYS

A. Surface Metal Raceways: Galvanized steel with snap-on covers. Manufacturer's standard enamel finish in color selected by Engineer.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Thomas & Betts Corporation.
   c. Wiremold Company (The); Electrical Sales Division.

B. Surface Nonmetallic Raceways: Two-piece construction, manufactured of rigid PVC with texture and color selected by Engineer from manufacturer's standard colors.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Hubbell Incorporated; Wiring Device-Kellems Division.
   b. Panduit Corp.

2.6 BOXES, ENCLOSURES, AND CABINETS

A. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

B. Cast-Metal Outlet and Device Boxes: NEMA FB 1, ferrous alloy or aluminum, Type FD, with gasketed cover.

C. Nonmetallic Outlet and Device Boxes: NEMA OS 2.

D. Metal Floor Boxes: Cast or sheet metal, fully adjustable, rectangular.

E. Nonmetallic Floor Boxes: Nonadjustable, round.

F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

G. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, cast aluminum or galvanized with gasketed cover.

H. Hinged-Cover Enclosures: NEMA 250, Type 1, or as specified on engineering design drawings, with continuous-hinge cover with flush latch, unless otherwise indicated.

   1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

I. Cabinets:
1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.

2.7 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. General Requirements for Handholds and Boxes:
   1. Boxes and handholds for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
   2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Polymer-Concrete handholds and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.
   1. Standard: Comply with SCTE 77.
   2. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
   3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhold location.
   4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
   5. Cover Legend: Molded lettering, "ELECTRIC".
   6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

C. Fiberglass handholds and Boxes: Molded of fiberglass-reinforced polyester resin, with frame and covers of polymer concrete.
   1. Standard: Comply with SCTE 77.
   2. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
   3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhold location.
   4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
   5. Cover Legend: Molded lettering, "ELECTRIC".

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:
1. Exposed Conduit (Surface Mounted or concealed behind panels designed to allow access): Rigid steel conduit or IMC
2. Concealed Conduit, Aboveground: Rigid steel conduit, IMC, EMT, or RNC Type EPC-40-PVC.
3. Underground Conduit: RNC, Type EPC-40 or 80-PVC, direct buried.(or as specified)
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC or LFNC.
5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R or as specified.

B. Indoors: Comply with the following indoor applications, unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT, ENT or RNC.
2. Exposed, Not Subject to Severe Physical Damage: EMT or RNC identified for such use.
3. Exposed and Subject to Severe Physical Damage: Rigid steel conduit, IMC. Includes raceways in the following locations:
   a. Loading dock.
   b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
   c. Mechanical rooms.
4. Concealed in Ceilings and Interior Walls and Partitions: EMT, ENT, or RNC, Type EPC-40-PVC.
5. **With written permission of the SRP Engineer** FMC may be used in existing walls. FMC must be transitioned to EMT, ENT, or RNC as soon as possible after the FMC exits the wall.
6. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, and use LFMC in damp or wet locations.
7. Damp or Wet Locations: Rigid steel conduit, IMC.
8. Raceways for Optical Fiber or Communications Cable: EMT or ENT
9. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel or nonmetallic in damp or wet locations.

C. **Minimum** Raceway Size: 3/4-inch trade size.

D. Raceway Fittings:

1. Rigid Steel and IMC: Use threaded rigid steel conduit fittings or compression couplings, unless otherwise indicated. Screw couplings are not permitted.

### 3.2 INSTALLATION

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
C. Complete raceway installation before starting conductor installation.

D. Support raceways as specified in Division 26 Section "Hangers and Supports."

E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

F. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.

G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.

H. Raceways Embedded under Slabs:
   1. Run conduit a minimum of 24 inches below finished grade or as specified on engineering drawings.
   2. Change from RNC, Type EPC-40-PVC, to rigid steel conduit, or IMC before rising above the floor.

I. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

J. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.

K. Raceways for Optical Fiber and Communications Cable: Install as follows:
   1. 3/4-Inch Trade Size and Smaller: Install raceways in maximum lengths of 50 feet.
   2. 1-Inch Trade Size and Larger: Install raceways in maximum lengths of 75 feet.
   3. Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

L. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
   1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
   2. Where otherwise required by NFPA 70.

M. Expansion-Joint Fittings for RNC: Install in each run of above ground conduit that is located where environmental temperature change may exceed 30 deg F, and that has straight-run length that exceeds 25 feet.
1. Install expansion-joint fittings for each of the following locations, and provide type and quantity of fittings that accommodate temperature change listed for location:

   a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
   b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
   c. Indoor Spaces: Connected with the Outdoors without Physical Separation: 125 deg F temperature change.
   d. Attics: 135 deg F temperature change.

2. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change.

3. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at the time of installation.

N. Flexible Conduit Connections: Use maximum of 72 inches of flexible conduit for recessed and semi-recessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

   1. Use LFMC in damp or wet locations subject to severe physical damage.
   2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

O. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.

P. Set metal floor boxes level and flush with finished floor surface.

Q. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

   1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 31" Site Work" for pipe less than 6 inches in nominal diameter.
   2. Install backfill as specified in Division 31 "Site Work."
   3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 31 "Site Work."
4. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
   a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
   b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

5. Warning Tape: Bury warning tape approximately 12 inches above direct-buried conduits.

3.4 FIRESTOPPING

   A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 7 Section "Through-Penetration Firestop Systems."

END OF SECTION
SECTION 260536 - CABLE TRAYS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Ladder cable trays.
   3. Trough cable trays.
   4. Fiberglass cable trays.

B. Related Requirements:
   1. Section 270536 "Cable Trays for Communications Systems" for cable trays and accessories serving communications systems.

1.2 SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For each type of cable tray.

C. Delegated-Design Submittal: For seismic restraints.

D. Field quality-control reports.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR CABLE TRAYS

A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.

B. Sizes and Configurations: See the Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.

C. Structural Performance: See articles on individual cable tray types for specific values for uniform load distribution, concentrated load, and load and safety factor parameters.

2.2 LADDER CABLE TRAYS

A. Description:
   1. Configuration: Two I-beam side rails with transverse rungs welded to side rails.
   2. Rung Spacing: minimum 6 inches o.c.
3. Radius-Fitting Rung Spacing: 9 inches at center of tray's width.
5. No portion of the rungs shall protrude below the bottom plane of side rails.
6. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb concentrated load, when tested according to NEMA VE 1.
8. Straight Section Lengths: minimum 10 feet except where shorter lengths are required to facilitate tray assembly.
9. Width: minimum 6 inches and maximum 24 inches unless otherwise indicated on Drawings.
11. Class Designation: Comply with NEMA VE 1, [Class 12B] [Class 12C] [Class 20B] [Class 20C]
12. Splicing Assemblies: Bolted type using serrated flange locknuts.
14. Splice Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

2.3 SINGLE-RAIL CABLE TRAYS

A. Description:
1. Configuration: Center rail with extruded-aluminum rungs arranged symmetrically about the center rail.
2. Construction: Aluminum rungs mechanically connected to aluminum center rail in at least two places, with ends finished to protect installers and cables.
3. Rung Spacing: minimum 6 inches o.c.
4. Radius-Fitting Rung Spacing: 9 inches at center of tray's width.
5. Straight Section Lengths: minimum 10 feet except where shorter lengths are required to facilitate tray assembly.
6. Width: minimum 6 inches and maximum 24 inches unless otherwise indicated on Drawings.
7. Support Point: Splice fittings shall be hanger support point.
8. Support Spacing: Support each section at midpoint. Support wall-mounted sections a maximum of one-sixth of the section length from each end.
9. Loading Depth: minimum 4 inches.
11. Splicing Assemblies: Bolted type using serrated flange locknuts.
12. Splicing Assembly Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.
14. Splices and Connectors: Protect cables from edges of center rail and do not intrude into cable fill area.
2.4 FIBERGLASS CABLE TRAYS

A. Description:
   1. Configuration: Two longitudinal members with rounded edges and smooth surfaces, complying with NEMA FG 1.
   2. Materials: Straight section structural elements; side rails, rungs and splice plates shall be pultruded from glass-fiber-reinforced [polyester] [vinyl ester] resin, complying with NEMA FG 1 and UL 568.
   3. Fasteners: Fiberglass-encapsulated, ASTM F 593 and ASTM F 594 stainless steel, Type 316. Design fasteners so that no metal is visible when fully assembled and tightened. Fastener encapsulation shall not be damaged when torqued to manufacturer's recommended value.
   4. Minimum Usable Load Depth: 3 inches according to NEMA FG 1.
   5. Straight Section Lengths: 10 feet.
   6. Width: minimum 6 inches and maximum 24 inches unless otherwise indicated on Drawings.
   7. Class Designation: Comply with NEMA VE 1, [Class 12B] [Class 12C] [Class 20B] [Class 20C]
   8. Temperature Rating: Reduce the load rating of tray exposed to temperatures above 75 deg F according to Table 4-3, "Working Loads," in NEMA FG 1.
   10. Splicing Assemblies: Minimum four nuts and bolts per plate. Splice plates shall be furnished with straight sections and fittings.
   11. Splicing Assembly Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

2.5 CABLE TRAY ACCESSORIES

A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.

B. Covers: Louvered] [Ventilated-hat] [2-in-3 pitch] type made of same materials and with same finishes as cable tray.

C. Barrier Strips: Same materials and finishes as for cable tray.

D. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.6 WARNING SIGNS

A. Lettering: 1-1/2-inch high, black letters on yellow background with legend "Warning! Not To Be Used as Walkway, Ladder, or Support for Ladders or Personnel."

B. Comply with requirements for fasteners in Section 260553 "Identification for Electrical Systems."
PART 3 - EXECUTION

3.1 CABLE TRAY INSTALLATION

A. Install cable trays according to NEMA VE 2.

B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.

C. Fasten cable tray supports to building structure and install seismic restraints.

D. Design fasteners and supports to carry cable tray, the cables, and a concentrated load of 100 lb. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems".

E. Install center-hung supports for single-rail trays designed for 60 versus 40 percent eccentric loading condition, with a safety factor of 3.

F. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.

G. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA VE 2. Space connectors and set gaps according to applicable standard.

H. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 078413 "Penetration Firestopping."

I. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.

J. Install barriers to separate cables of different systems, such as power, communications, and data processing; or of different insulation levels, such as 600, 5000, and 15 000 V.

K. Install permanent covers, if used, after installing cable. Install cover clamps according to NEMA VE 2.

L. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.2 CABLE TRAY GROUNDING

A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."
B. Cable trays with electrical power conductors shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.

C. Cable trays with single-conductor power conductors shall be bonded together with a grounding conductor run in the tray along with the power conductors and bonded to the tray at 72-inch intervals. The grounding conductor shall be sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors," and Article 392, "Cable Trays."

D. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

3.3 CABLE INSTALLATION

A. Install cables only when each cable tray run has been completed and inspected.

B. Fasten cables on horizontal runs with cable clamps or cable ties according to NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket.

C. Fasten cables on vertical runs to cable trays every 18 inches.

D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches.

E. Tie MI cables down every 36 inches where required to provide a 2-hour fire rating and every 72 inches elsewhere.

F. In existing construction, remove inactive or dead cables from cable trays.

3.4 CONNECTIONS

A. Connect raceways to cable trays according to requirements in NEMA VE 2 and NEMA FG 1.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections[ with the assistance of a factory-authorized service representative]:
   1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
   2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.

4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.

5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.

6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.

7. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.

8. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

B. Prepare test and inspection reports.

END OF SECTION
SECTION 260544 - SLEEVES & SLEEVE SEALS FOR RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.

B. Related Requirements:
1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.2 SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. Sleeves for Rectangular Openings:
2. Minimum Metal Thickness: 0.052 inch.
2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
   a. Advance Products & Systems, Inc.
   b. CALPICO, Inc.
   c. Metraflex Company (The).
   d. Pipeline Seal and Insulator, Inc.
   e. Proco Products, Inc.

2. Sealing Elements: EPDM or MBR rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.


4. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, or stainless steel of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Presealed Systems.
   b. <Insert manufacturer's name>.

2.4 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.


C. Design Mix: 3000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.
B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
   1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
      a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
      b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
   2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
   3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.
   4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
   5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
   1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
   2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve.
Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION
SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Identification for raceways, conduits, enclosures, and boxes.
   2. Identification for conductors, power and control cables.
   3. Circuit identification on switch covers and receptacles covers
   4. Warning labels, signs, and underground warning tape.
   5. Instruction signs.

1.2 SUBMITTALS

A. Product Data for each electrical identification product indicated.

1.3 QUALITY ASSURANCE

A. Comply with ANSI A13.1 and NFPA 70.
C. Comply with ANSI Z535.4 for safety signs and labels

PART 2 - PRODUCTS

2.1 RACEWAYS (<600v), ARMORED OR METAL CLAD CABLES, AND CONTROL CABLES IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.

<table>
<thead>
<tr>
<th>Pipe O.D.</th>
<th>Min Letter Ht.</th>
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<tbody>
<tr>
<td>Inches</td>
<td>Inches</td>
</tr>
<tr>
<td>3/4 to 1 1/4</td>
<td>1/2</td>
</tr>
<tr>
<td>1 1/2 to 2</td>
<td>3/4</td>
</tr>
<tr>
<td>2 1/2 to 6</td>
<td>1.25</td>
</tr>
<tr>
<td>8 to 10 over 10</td>
<td>2.5</td>
</tr>
<tr>
<td></td>
<td>3.5</td>
</tr>
</tbody>
</table>
B. Colors:
1. Black letters on a white field.
2. Legend: Indicate voltage and circuit or service.

C. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

D. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

E. Snap-Around, Color-Coding: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.2 CONDUCTOR IDENTIFICATION MATERIALS

A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification machine printed by thermal transfer or equivalent process.

2.3 FLOOR MARKING TAPE

A. 2-inch wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.4 UNDERGROUND-LINE WARNING TAPE

A. Tape:
1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
2. Printing on tape shall be permanent and shall not be damaged by burial operations.
3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:
1. Comply with ANSI Z535.1 through ANSI Z535.5.
2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.
2.5 WARNING LABELS AND SIGNS


B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

C. Baked-Enamel Warning Signs:
   1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
   2. 1/4-inch grommets in corners for mounting.
   3. Nominal size, 7 by 10 inches.

D. Warning label and sign shall include, but are not limited to, the following legends:
   1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
   2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES"

2.6 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick.
   1. Engraved legend with white letters on black face.
   2. Punched or drilled for mechanical fasteners.
   3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

B. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 1/2 inch.

C. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 1/2 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

2.7 EQUIPMENT IDENTIFICATION LABELS

A. Adhesive Film Label with Clear or White Background: Machine printed, black letters, by thermal transfer or equivalent process. Minimum letter height shall be 1/2 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

B. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a black background. Minimum letter height shall be 1/2 inch.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

B. Apply identification devices to surfaces that require finish after completing finish work.

C. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

D. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

E. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

F. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds 16 inches overall.

G. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

A. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 20A, and 120V to ground: Label each end.

B. Accessible Raceways and Cables within Buildings: On the covers of each junction and pull box of the following systems mark with self-adhesive vinyl labels or permanent black marker. Write the circuit ID, system voltage and wiring system legend. System legends shall be as follows:
   2. UPS.
   3. Power (for normal power mark circuit ID and system voltage only)

C. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
   1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder, and branch-circuit conductors.
a. Color shall be factory applied.
b. Colors for 208/120-V Circuits:
   1) Phase A: Black.
   2) Phase B: Red.
   3) Phase C: Blue.
   4) Neutral: White
   5) Ground: Green

c. Colors for 480/277-V Circuits:
   1) Phase A: Brown.
   2) Phase B: Orange.
   3) Phase C: Yellow.
   4) Neutral: Gray
   5) Ground: Green

d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

D. Install instructional sign including the color code for grounded and ungrounded conductors using adhesive-film-type labels.

E. Conductors to Be Extended in the Future: Attach write-on tags or marker tape to conductors and list source.

F. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
   1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
   2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.

G. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
   1. Install underground-line warning tape for both direct-buried cables and cables in raceway.

H. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

I. Warning Labels for Indoor Cabinets, Boxes, and Enclosures. Self-adhesive warning labels or Acrylic or Melamine warning signs.
   1. Identify system voltage with white letters on a black background
   2. Apply to exterior of door, cover, or other access.
3. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
   a. Power transfer switches.
   b. Controls with external control power connections.

J. Warning Labels for Outdoor Cabinets, Boxes, Enclosures, and Equipment: Acrylic or Melamine only.
   1. Identify system voltage with white letters on a black background
   2. Apply to exterior of door, cover, or other access.
   3. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
      a. Power transfer switches.
      b. Controls with external control power connections.


L. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

M. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 1/2-inch high letters for emergency instructions at equipment used for power transfer, load shedding or other emergency operation.

N. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams and/or schedules. (e.g. CU-1) Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment has its own identification.

   1. Labeling Instructions:
      a. Indoor Equipment: Adhesive film label, Adhesive film label with clear protective overlay, or Self-adhesive, engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch high letters on 1-1/2-inch high label; where two lines of text are required, use labels 2 inches high.
      b. Outdoor Equipment: Engraved, laminated acrylic or melamine label, lettering 1 inches high.
      c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
      d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
SECTION 260913 - ELECTRICAL POWER MONITORING AND CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes PC-based workstation(s) and software for monitoring and control of electrical power system.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.
   1. Attach copies of approved Product Data submittals for products (such as switchboards and switchgear) that describe power monitoring and control features to illustrate coordination among related equipment and power monitoring and control.

B. Shop Drawings: For power monitoring and control equipment. Include plans, elevations, sections, details, and attachments to other work.
   1. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components.
   2. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

C. Software and Firmware Operational Documentation:
   1. Software operating and upgrade manuals.
   2. Software Backup: On a magnetic media or compact disc, complete with Owner-selected options.
   3. Device address list and the set point of each device and operator option, as set in applications software.

D. Software Upgrade Kit: For Owner to use in modifying software to suit future power system revisions or power monitoring and control revisions.

E. Software licenses and upgrades required by and installed for operating and programming digital and analog devices.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For power monitoring and control units, to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
1. Operating and applications software documentation.
2. Software licenses.
3. Hard copies of manufacturer's specification sheets, operating specifications, design guides, user's guides for software and hardware, and PDF files on CD-ROM of the hard-copy submittal.

H. Other Informational Submittals:

1. System installation and setup guides, with data forms to plan and record options and setup decisions.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.4 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning with Substantial Completion, provide software support for two years.

B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include the operating systems. Upgrade shall include new or revised licenses for use of software.

1. Provide 30-day notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide [the product indicated on Drawings] <Insert manufacturer's name; product name or designation> or a comparable product by one of the following:

1. Allen-Bradley; Rockwell Automation.
2. GE Industrial Systems.
3. Schneider Electric.
2.2 FUNCTIONAL DESCRIPTION

A. Instrumentation and Recording Devices: Monitor and record load profiles and chart energy consumption patterns.

1. Calculate and Record the Following:
   a. Load factor.
   b. Peak demand periods.
   c. Consumption correlated with facility activities.

B. Software: Calculate allocation of utility costs.

1. Automatically Import Energy Usage Records to Allocate Energy Costs for the Following:
   b. At least [five] <Insert number> processes.
   c. At least [five] <Insert number> buildings.
   d. <Insert entity.>

2. Verify utility bills[ and analyze alternate energy rates].

C. Power Quality Monitoring: Identify power system anomalies and measure, display, and record trends and alarms of the following power quality parameters:

1. Voltage regulation and unbalance.
2. Continuous three-phase rms voltage.
3. Periodic max./min./avg. samples.
4. Harmonics.
5. Voltage excursions.
6. <Insert parameter.>

2.3 SYSTEM REQUIREMENTS

A. Surge Protection: For external wiring of each conductor entry connection to components to protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads.

1. Minimum Protection for Power Lines 120 V and More: Auxiliary panel suppressors complying with requirements in Division 16 Section "Transient Voltage Suppression."

2.4 OPERATING SYSTEM

A. Software: Configured to run on a portable laptop computer or a single PC with capability for accessing a single meter at a time.
2.5 APPLICATIONS SOFTWARE

A. Basic Requirements:

1. Fully compatible with and based on the approved operating system.
2. Password-protected operator login and access.
5. Capability of creating, deleting, and copying files; and automatically maintaining a directory of all files, including size and location of each sequential and random-ordered record.
6. Automatic and encrypted backups for database and history; automatically stored at [central control PC] [selected workstation] and encrypted with a nine-character alphanumeric password, which must be used to restore or read data contained in backup.
7. Operator audit trail for recording and reporting all changes made to user-defined system options.

B. Data Formats:

1. User-programmable export and import of data to and from commonly used Microsoft Windows spreadsheet, database, billing, and other applications; using dynamic data exchange technology.
2. Option to convert reports and graphics to HTML format.

C. Metered Data: Display metered values in real-time.

D. Remote Control:

1. Display circuit-breaker status and allow breaker control.
2. User defined with load-shedding automatically initiated and executed schemes responding to programmed time schedules, set points of metered demands, utility contracted load shedding, or combinations of these.

E. Waveform Data: Display and record waveforms on demand or automatically on an alarm or programmed event; include the graphic displays of the following, based on user-specified criteria:

1. Phase voltages, phase currents, and residual current.
3. Disturbance and steady-state waveforms up to 512 points per cycle.
4. Calculated waveform on a minimum of four cycles of data of the following:
   a. THD.
   b. rms magnitudes.
   c. Peak values.
   d. Crest factors.
   e. Magnitude of individual harmonics.
F. Data Sharing: Allow export of recorded displays and tabular data to third-party applications software.

G. Activity Billing Software:
   1. Automatically compute and prepare activity demand and energy-use statements based on metering of energy use and peak demand integrated over user-defined interval.
   2. Intervals shall be same as used by electric utilities, including current vendor.
   3. Import metered data from saved records that were generated by metering and monitoring software.
   4. Maintain separate directory for each tenant's historical billing information.
   5. Prepare summary reports in user-defined formats and time intervals.

H. Reporting: User commands initiate the reporting of a list of current alarm, supervisory, and trouble conditions in system or a log of past events.
   1. Print a record of user-defined alarm, supervisory, and trouble events on workstation printer.
   2. Sort and report by device name and by function.
   3. Report type of signal (alarm, supervisory, or trouble), description, date, and time of occurrence.
   4. Differentiate alarm signals from other indications.
   5. When system is reset, report reset event with same information concerning device, location, date, and time.

2.6 COMMUNICATION COMPONENTS AND NETWORKS


2.7 POWER MONITORS

A. Separately mounted, permanently installed instrument for power monitoring and control.

B. Environmental Conditions: System components shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
   1. Indoor installation in [non-air-conditioned] [nontemperature-controlled] spaces that have environmental controls to maintain ambient conditions of [0 to 122 deg F] <Insert temperature range> dry bulb and 20 to 90 percent relative humidity, noncondensing.

C. rms Real-Time Measurements:
1. **Current**: Each phase, neutral, average of three phases, percent unbalance.
2. **Voltage**: Line-to-line each phase, line-to-line average of three phases, line-to-neutral each phase, line-to-neutral average of three phases, line-to-neutral percent unbalance.
3. **Power**: Per phase and three-phase total.
4. **Reactive Power**: Per phase and three-phase total.
5. **Power Factor**: Per phase and three-phase total.
6. **Frequency**.
7. **THD**: Current and voltage.
8. **Accumulated Energy**: Real kWh, reactive kVARh, apparent kVAh (signed/absolute).
9. **Incremental Energy**: Real kWh, reactive kVARh, apparent kVAh (signed/absolute).
10. **Conditional Energy**: Real kWh, reactive kVARh, apparent kVAh (signed/absolute).

**D. Demand Current Calculations, per Phase, Three-Phase Average and Neutral:**

1. Present.
2. Running average.
3. Last completed interval.
4. Peak.

**E. Demand Real Power Calculations, Three-Phase Total:**

1. Present.
2. Running average.
3. Last completed interval.
4. Predicted.
5. Peak.
6. Coincident with peak kVA demand.
7. Coincident with kVAR demand.

**F. Demand Reactive Power Calculations, Three-Phase Total:**

1. Present.
2. Running average.
3. Last completed interval.
4. Predicted.
5. Peak.
6. Coincident with peak kVA demand.
7. Coincident with kVAR demand.

**G. Average Power Factor Calculations, Demand Coincident, Three-Phase Total:**

1. Last completed interval.
2. Coincident with kW peak.
3. Coincident with kVAR peak.
4. Coincident with kVA peak.
H. Power Demand Calculations: According to one of the following calculation methods, selectable by the user:

1. Thermal Demand: Sliding window updated every second for the present demand and at end of the interval for the last interval. Adjustable window that can be set in 1-minute intervals, from 1 to 60 minutes.
2. Block Interval with Optional Subintervals: Adjustable for 1-minute intervals, from 1 to 60 minutes. User-defined parameters for the following block intervals:
   a. Sliding block that calculates demand every second, with intervals less than 15 minutes, and every 15 seconds with an interval between 15 and 60 minutes.
   b. Fixed block that calculates demand at end of the interval.
   c. Rolling block subinterval that calculates demand at end of each subinterval and displays it at end of the interval.
3. Demand Calculation Initiated by a Synchronization Signal:
   a. Signal is a pulse from an external source. Demand period begins with every pulse. Calculation shall be configurable as either a block or rolling block calculation.
   b. Signal is a communication signal. Calculation shall be configurable as either a block or rolling block calculation.

I. Sampling:

1. Current and voltage shall be digitally sampled at a rate high enough to provide accuracy to 63rd harmonic of 60-Hz fundamental.
2. Power monitor shall provide continuous sampling at a rate of \[128\] samples per cycle on all voltage and current channels in the meter.

J. Minimum and Maximum Values: Record monthly minimum and maximum values, including date and time of record. For three-phase measurements, identify phase of recorded value. Record the following parameters:

1. Line-to-line voltage.
2. Line-to-neutral voltage.
3. Current per phase.
4. Line-to-line voltage unbalance.
5. Line-to-neutral voltage unbalance.
6. Power factor.
7. Displacement power factor.
8. Total power.
9. Total reactive power.
10. THD voltage L-L.
11. THD voltage L-N.
12. THD current.
13. Frequency.
K. Harmonic Calculation: Display and record the following:

1. Harmonic magnitudes and angles for each phase voltage and current through 31st \textit{<Insert number>} harmonic. Current and voltage information for all phases shall be obtained simultaneously from same cycle.
2. Harmonic magnitude reported as a percentage of the fundamental or as a percentage of rms values, as selected by user.

L. Current and Voltage Ratings:

1. Designed for use with current inputs from standard instrument current transformers with 5-A secondary and shall have a metering range of 0-10 A.
2. Withstand ratings shall be not less than 15 A, continuous; 50 A, lasting over 10 seconds, no more frequently than once per hour; 500 A, lasting 1 second, no more frequently than once per hour.
3. Designed for use with voltage inputs from standard instrument potential transformers with a 120-V secondary.

M. Accuracy:

1. Comply with ANSI C12.20, Class 0.5; and IEC 60687, Class 0.5 for revenue meters.
2. Accuracy from Light to Full Rating:
   a. Power: Accurate to 0.25 percent of reading, plus 0.025 percent of full scale.
   b. Voltage and Current: Accurate to 0.075 percent of reading, plus 0.025 percent of full scale.
   c. Power Factor: Plus or minus 0.002, from 0.5 leading to 0.5 lagging.
   d. Frequency: Plus or minus 0.01 Hz at 45 to 67 Hz.

N. Waveform Capture:

1. Capture and store steady-state waveforms of voltage and current channels; initiated manually. Each capture shall be for 3 cycles, 128 data points for each cycle, allowing resolution of harmonics to 31st harmonic of basic 60 Hz.
2. Store captured waveforms in internal nonvolatile memory; available for PC display, archiving, and analysis.

O. Input: [One] \textit{<Insert number>} digital input signal(s).

1. Normal mode for on/off signal.
2. Demand interval synchronization pulse, accepting a demand synchronization pulse from a utility demand meter.
3. Conditional energy signal to control conditional energy accumulation.

P. Outputs:

1. Operated either by user command sent via communication link, or set to operate in response to user-defined alarm or event.
2. Closed in either a momentary or latched mode as defined by user.
3. Each output relay used in a momentary contact mode shall have an independent timer that can be set by user.
4. One digital KY pulse to a user-definable increment of energy measurement. Output ratings shall be up to 120-V ac, 300-V dc, 50 mA, and provide 3500-V rms isolation.
5. [One] <Insert number> relay output module(s), providing a load voltage range from 20- to 240-V ac or from 20- to 30-V dc, supporting a load current of 2 A.
6. Output Relay Control:
   a. Relay outputs shall operate either by user command sent via communication link or in response to user-defined alarm or event.
   b. Normally open and normally closed contacts, field configured to operate as follows:
      1) Normal contact closure where contacts change state for as long as signal exists.
      2) Latched mode when contacts change state on receipt of a pickup signal; changed state is held until a dropout signal is received.
      3) Timed mode when contacts change state on receipt of a pickup signal; changed state is held for a preprogrammed duration.
      4) End of power demand interval when relay operates as synchronization pulse for other devices.
      5) Energy Pulse Output: Relay pulses quantities used for absolute kWh, absolute kVARh, kVAr, kWh In, kVARh In, kWh Out, and kVARh Out.
      6) Output controlled by multiple alarms using Boolean-type logic.

Q. Onboard Data Logging:

1. Store logged data, alarms, events, and waveforms in [80] [800] <Insert number> KB of onboard nonvolatile memory.
2. Stored Data:
   a. Billing Log: User configurable; data shall be recorded every 15 minutes, identified by month, day, and 15-minute interval. Accumulate 24 months of monthly data, 32 days of daily data, and between 2 to 52 days of 15-minute interval data, depending on number of quantities selected.
   b. Custom Data Logs: [One] [Three] user-defined log(s) holding up to 96 parameters. Date and time stamp each entry to the second and include the following user definitions:
      1) Schedule interval.
      2) Event definition.
      3) Configured as "fill-and-hold" or "circular, first-in first-out."
   c. Alarm Log: Include time, date, event information, and coincident information for each defined alarm or event.
d. Waveform Log: Store captured waveforms configured as "fill-and-hold" or "circular, first-in first-out."

3. Default values for all logs shall be initially set at factory, with logging to begin on device power up.

R. Alarms.

1. User Options:
   a. Define pickup, dropout, and delay.
   b. Assign one of [four] <Insert number> severity levels to make it easier for user to respond to the most important events first.
   c. Allow for combining up to [four] <Insert value> alarms using Boolean-type logic statements for outputting a single alarm.

2. Alarm Events:
   a. Over/undercurrent.
   b. Over/undervoltage.
   c. Current imbalance.
   d. Phase loss, current.
   e. Phase loss, voltage.
   f. Voltage imbalance.
   g. Over kW demand.
   h. Phase reversal.
   i. Digital input off/on.
   j. End of incremental energy interval.
   k. End of demand interval.

S. Control Power: 90- to 457-V ac or 100- to 300-V dc.

T. Communications:

1. Power monitor shall be permanently connected to communicate via Modbus TCP via a 100 Base-T Ethernet.
2. Local plug-in connections shall be for RS-232 and 100 Base-T Ethernet.

U. Display Monitor:

1. Backlighted LCD to display metered data with [touch-screen] [touch-pad] <Insert interface> selecting device.
2. Touch-screen display shall be a minimum 12-inch diagonal, resolution of 800 by 600 RGB pixels, 256 colors; NEMA 250, Type 1 display enclosure.
3. Display [four] <Insert number> values on one screen at same time.
   
   a. Current, per phase rms, three-phase average[ and neutral].
   b. Voltage, phase to phase, phase to neutral, and three-phase averages of phase to phase and phase to neutral.
   c. Real power, per phase and three-phase total.
d. Reactive power, per phase and three-phase total.
e. Apparent power, per phase and three-phase total.
f. Power factor, per phase and three-phase total.
g. Frequency.
h. Demand current, per phase and three-phase average.
i. Demand real power, three-phase total.
j. Accumulated energy (MWh and MVARh).
k. THD, current and voltage, per phase.

4. Reset: Allow reset of the following parameters at the display:
   a. Peak demand current.
   b. Peak demand power (kW) and peak demand apparent power (kVA).
   c. Energy (MWh) and reactive energy (MVARh).

2.8 LOW-VOLTAGE WIRING

A. Low-Voltage Control Cable: Multiple conductor, color-coded, No. 20 AWG copper, minimum.
   1. Sheath: PVC; except in plenum-type spaces, use sheath listed for plenums.
   2. Ordinary Switching Circuits: Three conductors, unless otherwise indicated.
   3. Switching Circuits with Pilot Lights or Locator Feature: Five conductors, unless otherwise indicated.

PART 3 - EXECUTION

3.1 CABLING

A. Comply with NECA 1.

B. Install cables and wiring according to requirements in Division 16 Section "Voice and Data Communication Cabling."

C. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces.

D. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Use NRTL-listed plenum cable in environmental air spaces, including plenum ceilings. Conceal raceway and cables except in unfinished spaces.

E. Identify components and power and control wiring according to Division 16 Section "Electrical Identification."
F. Label each power monitoring and control module with a unique designation.


3.2 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Electrical Tests: Use caution when testing devices containing solid-state components.
2. Continuity tests of circuits.
3. Operational Tests: Set and operate controls at workstation and at monitored and controlled devices to demonstrate their functions and capabilities. Use a methodical sequence that cues and reproduces actual operating functions as recommended by manufacturer. Submit sequences for approval. Note response to each test command and operation. Note time intervals between initiation of alarm conditions and registration of alarms at central-processing workstation.

   a. Coordinate testing required by this Section with that required by Sections specifying equipment being monitored and controlled.
   b. Test LANs according to requirements in Division 16 Section "Voice and Data Communication Cabling."
   c. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of calculated battery operating time.
   d. Verify accuracy of graphic screens and icons.
   e. Metering Test: Load feeders, measure loads on feeder conductor with an rms reading clamp-on ammeter, and simultaneously read indicated current on the same phase at central-processing workstation. Record and compare values measured at the two locations. Resolve discrepancies greater than 5 percent and record resolution method and results.
   f. Record metered values, control settings, operations, cues, time intervals, and functional observations and submit test reports printed by workstation printer.

C. Correct deficiencies, make necessary adjustments, and retest. Verify that specified requirements are met.

D. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible agency and representative.
E. Reports: Written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.

F. Remove and replace malfunctioning devices and circuits and retest as specified above.

3.3 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain systems. Refer to Division 1 Section "Demonstration and Training."

1. Train Owner's management and maintenance personnel in interpreting and using monitoring displays and in configuring and using software and reports. Include troubleshooting, servicing, adjusting, and maintaining equipment. Provide a minimum of [12] <Insert number> hours' training.

2. Training Aid: Use approved final versions of software and maintenance manuals as training aids.

END OF SECTION
SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following lighting control devices:

1. Time switches.
2. Outdoor photoelectric switches.
3. Indoor occupancy sensors.
4. Outdoor motion sensors.
5. Lighting contactors.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.
B. Field quality-control test reports.
C. Operation and maintenance data.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

PART 2 - PRODUCTS

2.1 TIME SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings:

1. Tyco Electronics ALR brand
2. Intermec, Inc.
3. Invensys Controls
4. Leviton Mfg. Company

C. Electronic Time Switches: Electronic, solid-state programmable units with alphanumeric display; complying with UL 917.
1. Contact Configuration: [SPST] [DPST] [DPDT] <Insert configuration>.
2. Contact Rating: [30-A inductive or resistive, 240-V ac] [20-A ballast load, 120/240-V ac] <Insert rating>.
3. Program: 8 on-off set points on a 24-hour schedule[ and an annual holiday schedule that overrides the weekly operation on holidays].
4. Program: 2 on-off set points on a 24-hour schedule, allowing different set points for each day of the week[ and an annual holiday schedule that overrides the weekly operation on holidays].
5. Programs: <Insert number> channels; each channel shall be individually programmable with 8 on-off set points on a 24-hour schedule.
6. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program[ on selected channels].
7. Astronomic Time: [All] [Selected] channels.
8. Battery Backup: For schedules and time clock.

D. Electromechanical-Dial Time Switches: Type complying with UL 917.

1. Contact Configuration: [SPST] [DPST] [SPDT] [DPDT] <Insert configuration>.
2. Contact Rating: [30-A inductive or resistive, 240-V ac] [20-A ballast load, 120/240-V ac] <Insert rating>.
3. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program.
4. Astronomic time dial.
5. Eight-Day Program: Uniquely programmable for each weekday and holidays.
6. Skip-a-day mode.
7. Wound-spring reserve carryover mechanism to keep time during power failures, minimum of [16] <Insert number> hours.

2.2 OUTDOOR PHOTOELECTRIC SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Industries, Inc.
2. Intermatic, Inc.
3. NSi Industries LLC; TORK Products.
4. Tyco Electronics; ALR Brand.

B. Description: Solid state, with [SPST] [DPST] dry contacts rated for 1800-VA to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.

1. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of photocell to prevent fixed light sources from causing turn-off.
2. Time Delay: 30-second minimum, to prevent false operation.
3. Mounting: Twist lock complying with IEEE C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.
2.3 INDOOR OCCUPANCY SENSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bryant Electric; a Hubbell company.
2. Cooper Industries, Inc.
3. Hubbell Building Automation, Inc.
4. Leviton Mfg. Company Inc
5. Lithonia Lighting; Acuity Lighting Group, Inc.
7. NSi Industries LLC; TORK Products.
8. RAB Lighting.
9. Sensor Switch, Inc.
10. Square D; a brand of Schneider Electric.

B. General Description: Wall- or ceiling-mounting, solid-state units with a separate relay unit.

1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
3. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
4. Mounting:
   a. Sensor: Suitable for mounting in any position on a standard outlet box.
   b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
   c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
6. Bypass Switch: Override the on function in case of sensor failure.
7. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; keep lighting off when selected lighting level is present.

C. PIR Type: Ceiling mounting; detect occupancy by sensing a combination of heat and movement in area of coverage.

1. Detector Sensitivity: Detect occurrences of 6-inch- minimum movement of any portion of a human body that presents a target of not less than 36 sq. in..
2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. when mounted on a 96-inch- high ceiling.
3. Detection Coverage (Corridor): Detect occupancy within 90 feet when mounted on a 10-foot- high ceiling.
2.4 OUTDOOR MOTION SENSORS (PIR)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bryant Electric; a Hubbell company.
2. Cooper Industries, Inc.
3. Hubbell Building Automation, Inc.
5. Lithonia Lighting; Acuity Lighting Group, Inc.
6. NSi Industries LLC; TORK Products.
7. RAB Lighting.
8. Sensor Switch, Inc.

B. Performance Requirements: Suitable for operation in ambient temperatures ranging from minus 40 to plus 130 deg F, rated as raintight according to UL 773A.

1. Operation: Turn lights on when sensing infrared energy changes between background and moving body in area of coverage; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
2. Mounting:
   a. Sensor: Suitable for mounting in any position on a standard outdoor junction box.
   c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
3. Bypass Switch: Override the on function in case of sensor failure.
4. Automatic Light-Level Sensor: Adjustable from 1 to 20 fc; keep lighting off during daylight hours.

C. Detector Sensitivity: Detect occurrences of 6-inch- minimum movement of any portion of a human body that presents a target of not less than 36 sq. in..

D. Detection Coverage: [Up to 35 feet, with a field of view of 90 degrees] [Up to 100 feet, with a field of view of 60 degrees] [Up to 35 feet, with a field of view of 180 degrees] [Up to 52.5 feet, with a field of view of 270 degrees] <Insert coverage area>.

E. Lighting Fixture Mounted Sensor: Suitable for switching 300 W of tungsten load at 120- or 277-V ac.

F. Individually Mounted Sensor: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.

1. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
2. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
2.5 LIGHTING CONTACTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2. ASCO Power Technologies, LP; a division of Emerson Electric Co.
4. General Electric Company; GE Consumer & Industrial - Electrical Distribution; Total Lighting Control.
5. Square D; a brand of Schneider Electric.

B. Description: Electrically operated and [mechanically] [electrically] held, combination type with [fusible switch] [nonfused disconnect], complying with NEMA ICS 2 and UL 508.

1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
3. Enclosure: Comply with NEMA 250.
4. Provide with control and pilot devices as [indicated on Drawings] [scheduled], matching the NEMA type specified for the enclosure.

2.6 EMERGENCY SHUNT RELAY

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide [the product indicated on Drawings] <Insert manufacturer's name; product name or designation> or a comparable product by one of the following:

1. Lighting Control and Design, Inc.

C. Description: Normally closed, electrically held relay, arranged for wiring in parallel with manual [or automatic ]switching contacts; complying with UL 924.

1. Coil Rating: [120] [277] V.

2.7 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 16 Section "Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. [18] [22] [24] AWG. Comply with requirements in Division 16 Section "Conductors and Cables."
C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 [16] [18] AWG. Comply with requirements in Division 16 Section "Conductors and Cables."

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

A. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

B. When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to [two] <Insert number> visits to Project during other than normal occupancy hours for this purpose.

3.2 CONTACTOR INSTALLATION

A. Mount electrically held lighting contactors with elastomeric isolator pads, to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.3 WIRING INSTALLATION

A. Wiring Method: Comply with Division 16 Section "Conductors and Cables." Minimum conduit size shall be 1/2 inch.

B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.4 IDENTIFICATION

A. Identify components and power and control wiring according to Division 16 Section "Electrical Identification."

1. Identify controlled circuits in lighting contactors.
2. Identify circuits or luminaries controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.
3.5 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
2. Operational Test: Verify operation of each lighting control device, and adjust time delays.

B. Lighting control devices that fail tests and inspections are defective work.

END OF SECTION
SECTION 262200 - LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:
   1. Distribution transformers.
   2. Buck-boost transformers.

1.2 SUBMITTALS

A. Product Data: For each product indicated.
B. Shop Drawings: Indicate dimensions and weights.
C. Field quality-control test reports.
D. Operation and maintenance data.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
B. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   2. Siemens Energy & Automation, Inc.
   3. Square D; Schneider Electric.
2.2 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Cores: Grain-oriented, non-aging silicon steel.

C. Coils: Continuous windings without splices except for taps.
   1. Internal Coil Connections: Brazed or pressure type.
   2. Coil Material: [Aluminum] [Copper].

2.3 DISTRIBUTION TRANSFORMERS

A. Comply with NEMA ST 20, and list and label as complying with UL 1561.

B. Provide transformers that are constructed to withstand seismic forces specified in Division 16 Section "Electrical Supports and Seismic Restraints."

C. Cores: One leg per phase.

D. Enclosure: Ventilated, NEMA 250, Type 2.
   1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

E. Enclosure: Ventilated, NEMA 250, [Type 3R] [Type 4X, stainless steel].
   1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

F. Transformer Enclosure Finish: Comply with NEMA 250.
   1. Finish Color: Gray.

G. Taps for Transformers Smaller Than 3 kVA: None.

H. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.

I. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.

J. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.

K. Energy Efficiency for Transformers Rated 15 kVA and Larger:
   1. Complying with NEMA TP 1, Class 1 efficiency levels.
   2. Tested according to NEMA TP 2.

L. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.
1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.

2. Indicate value of K-factor on transformer nameplate.

M. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.

N. Wall Brackets: Manufacturer's standard brackets.

2.4 BUCK-BOOST TRANSFORMERS

A. Description: Self-cooled, two-winding dry type, rated for continuous duty and with wiring terminals suitable for connection as autotransformer. Transformers shall comply with NEMA ST 1 and shall be listed and labeled as complying with UL 506 or UL 1561.

B. Enclosure: Ventilated, NEMA 250, Type 2.

1. Finish Color: Gray.

2.5 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate. Nameplates are specified in Division 16 Section "Electrical Identification."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.

B. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions.

3.2 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

2. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.

   a. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
b. Perform 2 follow-up infrared scans of transformers, one at 4 months and the other at 11 months after Substantial Completion.
c. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

3.3 ADJUSTING

A. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Connect buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent, at secondary terminals.


END OF SECTION
SECTION 262413 - SWITCHBOARDS

PART 1 - GENERAL

1.1 SUMMARY
   A. This Section includes:
      1. Service and distribution switchboards rated 600 V and less.
      2. Transient voltage suppression devices.
      3. Disconnecting and overcurrent protective devices.
      4. Instrumentation.
      5. Control power.
      6. Accessory components and features.
      7. Identification.

1.2 SUBMITTALS
   A. Product Data: For each type of switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

   B. Shop Drawings: For each switchboard and related equipment.
      1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
      2. Wiring Diagrams: Power, signal, and control wiring.

   C. Field quality-control test reports.

   D. Operation and maintenance data.

1.3 QUALITY ASSURANCE
   A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

   B. Comply with NEMA PB 2, "Deadfront Distribution Switchboards."

   C. Comply with NFPA 70.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 MANUFACTURED UNITS

A. Manufacturers:

2. Siemens Energy & Automation, Inc.
3. Square D.

B. Front-Connected, Front-Accessible Switchboard: [Panel-mounted] [Fixed, individually mounted] main device, panel-mounted branches, and sections rear aligned.

C. Nominal System Voltage: [480Y/277 V] [208Y/120 V] <Insert system voltage>.

D. Main-Bus Continuous: [4000] [3000] [2500] [2000] [1600] [1200] <Insert ampere rating> A.

E. Enclosure: Steel, NEMA 250, Type [1] [3R] [3R, with interior-lighted walk-in aisle].

F. Enclosure Finish: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

G. Barriers: Between adjacent switchboard sections.

H. Utility Metering Compartment: Fabricated compartment and section complying with utility company's requirements. If separate vertical section is required for utility metering, match and align with basic switchboard.

I. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

J. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

K. Pull Box on Top of Switchboard:

1. Adequate ventilation to maintain temperature in pull box within same limits as switchboard.
2. Set back from front to clear circuit-breaker removal mechanism.
3. Removable covers shall form top, front, and sides. Top covers at rear shall be easily removable for drilling and cutting.
4. Bottom shall be insulating, fire-resistive material with separate holes for cable drops into switchboard.
5. Cable supports shall be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.

L. Buses and Connections: Three phase, four wire, unless otherwise indicated. Hard-drawn copper of 98 percent conductivity with feeder circuit-breaker line connections.

1. Ground Bus: 1/4-by-2-inch- minimum-size, hard-drawn copper of 98 percent conductivity, equipped with pressure connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
2. Contact Surfaces of Buses: Silver plated.
3. Main Phase Buses, Neutral Buses, and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
5. Neutral Buses: 50 percent of the ampacity of phase buses, unless otherwise indicated, equipped with pressure connectors for outgoing circuit neutral cables. Bus extensions for busway feeder neutral bus are braced.

M. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

2.3 TRANSIENT VOLTAGE SUPPRESSION DEVICES

A. IEEE C62.41, integrally mounted, plug-in-style, solid-state, parallel-connected, sine-wave tracking suppression and filtering modules.

B. Minimum single-impulse current rating shall be as follows:

1. Line to Neutral: [100,000] <Insert value> A.
2. Line to Ground: [100,000] <Insert value> A.
3. Neutral to Ground: [50,000] <Insert value> A.

C. Protection modes shall be as follows:

1. Line to neutral.
2. Line to ground.
3. Neutral to ground.

D. EMI/RFI Noise Attenuation Using 50-ohm Insertion Loss Test: 55 dB at 100 kHz.

E. Maximum Category C combination wave clamping voltage shall not exceed [600 V, line to neutral and line to ground on 120/208 V] [1000 V, line to neutral and line to ground on 277/480 V] systems.
F. Maximum UL 1449 clamping levels shall not exceed \([400 \text{ V, line to neutral and line to ground on 120/208 V}, 800 \text{ V, line to neutral and line to ground on 277/480 V}]\) systems.

G. Withstand Capabilities: 3000 Category C surges with less than 5 percent change in clamping voltage.

H. Accessories:
   1. Form-C contacts, one normally open and one normally closed, for remote monitoring of system operation. Contacts to reverse position on failure of any surge diversion module.
   2. Audible alarm activated on failure of any surge diversion module.
   3. Six-digit transient-counter set to total transient surges that deviate from the sine-wave envelope by more than 125 V.

2.4 OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker: NEMA AB 3, with interrupting capacity to meet available fault currents.

   3. Electronic trip-unit circuit breakers shall have RMS sensing, field-replaceable rating plug, and the following field-adjustable settings:
      a. Instantaneous trip.
      b. Long- and short-time pickup levels.
      c. Long- and short-time time adjustments.
      d. Ground-fault pickup level, time delay, and \(I^2t\) response.

   4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
   5. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.
   6. GFCI Circuit Breakers: Single- and two-pole configurations with \([5] \ [30]-\text{mA trip sensitivity.}\)

B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.

   1. Lugs: [Mechanical] [Compression] style, suitable for number, size, trip ratings, and conductor material.
2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.


4. Communication Capability: [Circuit-breaker-mounted] [Universal-mounted] [Integral] [Din-rail-mounted] communication module with functions and features compatible with power monitoring and control system, specified in Division 16 Section "Electrical Power Monitoring and Control."

5. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at [55] [75] percent of rated voltage.

6. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage [without intentional] [with field-adjustable 0.1- to 0.6-second] time delay.

7. Auxiliary Contacts: [One SPDT switch] [Two SPDT switches] with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.

8. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.


C. Insulated-Case Circuit Breaker: Fully rated, encased-power circuit breaker with interrupting capacity rating to meet available fault current.

1. [Fixed] [Drawout] circuit-breaker mounting.

2. Two-step, stored-energy closing.

3. Microprocessor-based trip units with interchangeable rating plug, LED trip indicators, and the following field-adjustable settings:
   a. Instantaneous trip.
   b. Long- and short-time pickup levels.
   c. Long- and short-time time adjustments with I²t response.
   d. Ground-fault pickup level, time delay, and I²t response.

4. Remote trip indication and control.

5. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system specified in Division 16 Section "Electrical Power Monitoring and Control."

6. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

7. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.

8. Control Voltage: [40] [125] [250]-V, [dc] [ac].

D. Bolted-Pressure Contact Switch: Operating mechanism uses rotary-mechanical-bolting action to produce and maintain high clamping pressure on the switch blade after it engages the stationary contacts.
1. Manufacturers:
   a. Eaton Corporation.
   b. Siemens Energy & Automation, Inc.
   c. Square D.

E. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

F. Fuses are specified in Division 16 Section "Fuses."

2.5 INSTRUMENTATION

A. Instrument Transformers: NEMA EI 21.1, IEEE C57.13, and the following:
   1. Potential Transformers: Secondary voltage rating of 120 V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.
   2. Current Transformers: Ratios shall be as indicated with accuracy class and burden suitable for connected relays, meters, and instruments.
   3. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kV.
   4. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondaries to ground overcurrent relays to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker ground-fault protection.

B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
   1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
      a. Phase Currents, Each Phase: Plus or minus 1 percent.
      b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
      c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
      d. Megawatts: Plus or minus 2 percent.
      e. Megavars: Plus or minus 2 percent.
      f. Power Factor: Plus or minus 2 percent.
      g. Frequency: Plus or minus 0.5 percent.
      h. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from 5 to 60 minutes.
      i. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent. Accumulated values unaffected by power outages up to 72 hours.
   2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.
C. Watt-Hour Meters: Flush or semiflush type, rated 5 A, 120 V, 3 phase, 3 wire, with 3 elements, 15-minute-indicating-demand register, and provision for testing and adding pulse initiation.

D. Recording Demand Meter: Usable as totalizing relay or as indicating and recording maximum-demand meter with 15-minute interval. Meter shall count and control a succession of pulses entering two channels. House in drawout, back-connected case arranged for semiflush mounting.

2.6 CONTROL POWER

A. Control Circuits: 120 V, supplied through secondary disconnecting devices from control-power transformer.

B. Electrically Interlocked Main and Tie Circuit Breakers: Two control-power transformers in separate compartments, with interlocking relays, connected to the primary side of each control-power transformer at the line side of the associated main circuit breaker. 120-V secondaries connected through automatic transfer relays to ensure a fail-safe automatic transfer scheme.

C. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.

D. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.7 ACCESSORY COMPONENTS AND FEATURES

A. Furnish accessory set including tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Furnish portable test set to test functions of solid-state trip devices without removal from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

C. Furnish one portable, floor-supported, roller-based, elevating carriage arranged for movement of circuit breakers in and out of compartments for present and future circuit breakers.

D. Furnish overhead circuit-breaker lifting device, mounted at top front of switchboard, with hoist and lifting yokes matching each drawout circuit breaker.

E. Spare-Fuse Cabinet: Suitably identified, wall-mounted, lockable, compartmented steel box or cabinet. Arrange for wall mounting.
2.8 IDENTIFICATION

A. Mimic Bus: Continuously integrated mimic bus factory applied to front of switchboard. Arrange in single-line diagram format, using symbols and letter designations consistent with final mimic-bus diagram. Coordinate mimic-bus segments with devices in switchboard sections to which they are applied. Produce a concise visual presentation of principal switchboard components and connections.

B. Presentation Media: Painted graphics in color contrasting with background color to represent bus and components, complete with lettered designations.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install switchboards and accessories according to NEMA PB 2.1 and NECA 40.

B. Install and anchor switchboards level on concrete bases, 4-inch nominal thickness. Concrete base is specified in Division 16 Section "Basic Electrical Materials and Methods Electrical Supports and Seismic Restraints," and concrete materials and installation requirements are specified in Division 3.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

D. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.

E. Install overcurrent protective devices, transient voltage suppression devices, and instrumentation.

1. Set field-adjustable switches and circuit-breaker trip ranges.

F. Install spare-fuse cabinet.

3.2 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Section 260553- Identification for Electrical Systems.

B. Switchboard Nameplates: Label each switchboard compartment with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.
3.3 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Perform the following field tests and inspections and prepare test reports:

1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Sections 7.1, 7.5, 7.6, 7.9, 7.10, 7.11, and 7.14 as appropriate. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

END OF SECTION
SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes all panelboards.

1.2 SUBMITTALS

A. Product Data: For each type of panelboard, overcurrent protective device, accessory, and component indicated. Include dimensions and manufacturers’ technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.
   1. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:
      a. Enclosure types and details for types other than NEMA 250, Type 1.
      b. Bus configuration, current, and voltage ratings.
      c. Short-circuit current rating of panelboards and overcurrent protective devices.
      d. L listing for series rating of installed devices.
      e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

   2. Wiring Diagrams: Power, signal, and control wiring.
   3. Field quality-control test reports.
   4. Operation and maintenance data.

C. Panelboard Schedules (directory) showing installed circuit uses.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a qualified testing agency, and marked for intended use.

B. Comply with NEMA PB 1.

C. Comply with NFPA 70.
1.4 WARRANTY

A. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Enclosures: Flush- and surface-mounted cabinets.

1. Rated for environmental conditions at installed location.
   a. Outdoor Locations: NEMA 250, Type 3R.
   c. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
   d. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.

2. Front: Secured to box with concealed side hinges. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.

3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
   a. Square D products, require “door in door” panel option.


B. Incoming Mains Location: Top and bottom.

C. Phase and Ground Buses: Hard-drawn copper, 98 percent conductivity.

D. Conductor Connectors: Suitable for use with conductor material.

   1. Ground Lugs and Bus Configured Terminators: Compression type.
   3. Main and Neutral Lugs: Compression type.
   4. Ground Lugs and Bus Configured Terminators: Compression type.
   5. Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
   6. Subfeed (Double) Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.

E. Service Equipment Label: UL labeled for use as service equipment for panelboards with main service disconnect switches.

F. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.

G. Panelboard Short-Circuit Rating:
1. UL label indicating series-connected rating with integral or remote upstream overcurrent protective devices. Include size and type of upstream device allowable, branch devices allowable, and UL series-connected short-circuit rating.

2. Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 DISTRIBUTION, LIGHTING, AND APPLIANCE PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Square D; a brand of Schneider Electric.

B. Doors: Secured with vault-type latch with tumbler lock; using manufacturer’s standard key. Omit for fused-switch panelboards.

C. Main Overcurrent Protective Devices: Circuit breaker, unless otherwise indicated.

D. Branch Overcurrent Protective Devices:

1. For Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
2. For Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers.
3. Fused switches.

2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Square D; a brand of Schneider Electric.

B. Molded-Case Circuit Breaker: UL 489, with series-connected rating or interrupting capacity as shown on the design to meet available fault currents.

3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
   a. Instantaneous trip.
   b. Long- and short-time pickup levels.
   c. Long- and short-time time adjustments.
4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.

5. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).


8. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
   a. Standard frame sizes, trip ratings, and number of poles.
   b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
   c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
   d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
   e. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system specified in Division 26 Section “Electrical Power Monitoring and Control.”
   f. Shunt Trip: 120 or 240-V trip coil energized from separate circuit, set to trip at 55 or 75 percent of rated voltage.
   g. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in off position.
   h. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
   1. Fuses are specified in Division 26 Section "Fuses."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.

B. Mount top of trim 90 inches above finished floor, unless otherwise indicated.

C. Mount plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.

D. Install overcurrent protective devices and controllers.
   1. Set field-adjustable switches and circuit-breaker trip ranges.
E. Install filler plates in unused spaces.

F. Identify field-installed conductors and components. Bundle and wrap with tie wires, mark with identification as specified in Section 260553 Identification for Electrical Systems

G. Panelboard Nameplates: Label as specified in Division 260553 Identification for Electrical Systems

H. Create a printed panel schedule (directory) to indicate installed circuit loads and spares. Obtain approval before installing. Handwritten schedules are not acceptable.

I. Ground equipment according to Division 260526 Section "Grounding and Bonding."

J. Connect wiring according to Division 260519 Section "Low-Voltage Conductors and Cables."

3.2 QUALITY CONTROL

A. Perform acceptance tests as follows:
   1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit
      a. Perform insulation-resistance tests on each bus section, phase-to-phase, and phase-to-ground for one minute. Applied potential shall be 500V for 300V equipment and 1000V for 600V equipment.
   2. Perform Phase Rotation test of each three-phase circuit.
   3. Perform Voltage Checks of all circuits.

B. Prepare test reports:

C. Panelboards will be considered defective if they do not pass tests and inspections.

END OF SECTION
SECTION 262419 - MOTOR-CONTROL CENTERS

PART 1 - GENERAL

1.1 SUMMARY
   A. This Section includes motor-control centers for use on ac circuits rated 600 V and less.

1.2 SUBMITTALS
   A. Product Data: For each type of controller and each type of motor-control center.
   B. Shop Drawings: For each motor-control center.
      1. Include wiring diagrams.
   C. Qualification Data: For [manufacturer] [testing agency] [manufacturer and testing agency].
   D. Field quality-control test reports.
   E. Operation and maintenance data.
   F. Load-current and overload-relay heater list.
   G. Load-current and list of settings of adjustable overload relays.

1.3 QUALITY ASSURANCE
   A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100.
   B. Comply with NFPA 70.
   C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for motor-control centers, including clearances between motor-control centers, and for adjacent surfaces and other items. Comply with indicated maximum dimensions and clearances.

1.4 COORDINATION
   A. Coordinate features of motor-control centers, installed units, and accessory devices with pilot devices and control circuits to which they connect.
   B. Coordinate features, accessories, and functions of each motor-control center, each controller, and each installed unit with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2. Siemens/Furnas Controls.
3. Square D.

2.2 MOTOR-CONTROL CENTERS

A. Wiring: NEMA ICS 3, Class [I, Type A] [I, Type B] [I, Type C] [II, Type B] [II, Type C].

B. Enclosures: Flush- or surface-mounting cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated to comply with environmental conditions at installed location.

1. Outdoor Locations: NEMA 250, Type 3R.
2. Compartments: Modular; individual doors with concealed hinges and quick-captive screw fasteners. Interlocks on combination controller units requiring disconnecting means in off position before door can be opened or closed, except by operating a permissive release device.
3. Interchangeability: Compartments constructed to allow for removal of units without opening adjacent doors, disconnecting adjacent compartments, or disturbing operation of other units in motor-control center; same size compartments to permit interchangeability and ready rearrangement of units, such as replacing three single units with a unit requiring three spaces, without cutting or welding.
4. Wiring Spaces: Wiring channel in each vertical section for vertical and horizontal wiring to each unit compartment; supports to hold wiring in place.

C. Short-Circuit Current Rating for Each Section: Equal to or greater than indicated available fault current in symmetrical amperes at motor-control center location.

2.3 BUSES

A. Material: Plated hard-drawn copper, 98 percent conductivity.

B. Ampacity Ratings: As indicated for horizontal and vertical main buses.

C. Neutral Buses: Full size.

D. Equipment Ground Bus: Noninsulated, horizontal configuration; adequate for equipment ground conductors; bonded to enclosure.

E. Horizontal Bus Arrangement: Main phase, neutral and ground buses extended with same capacity the entire length of motor-control center, with provision for future extension at both ends by bolt holes and captive bus splice sections or equivalent.

F. Short-Circuit Withstand Rating: Same as short-circuit current rating of section.
2.4 FUNCTIONAL FEATURES

A. Description: Modular arrangement of controllers, control devices, overcurrent protective devices, transformers, panelboards, instruments, indicating panels, blank panels, and other items mounted in compartments of motor-control center.

B. Controller Units: Combination controller units of types and with features, ratings, and circuit assignments indicated.

1. Install units up to and including Size 3 on drawout mountings with connectors that automatically line up and connect with vertical-section buses while being racked into their normal, energized positions.
2. Provide units with short-circuit current ratings equal to or greater than short-circuit current rating of motor-control center section.
3. Equip units in Type B and Type C motor-control centers with pull-apart terminal strips or drawout terminal boards for external control connections.

   a. Fusible Disconnecting Means: NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by an NRTL.

C. Overcurrent Protective Devices: Individual feeder-tap units through 225-A rating shall have drawout mountings with connectors that automatically line up and connect with vertical-section buses while being racked into their normal, energized positions.

D. Spaces and Blank Compartments: Fully bused and equipped, ready for insertion of drawout units.

E. Spare Units: Type, sizes, and ratings indicated; installed in compartments indicated “spare.”

2.5 ACROSS-THE-LINE CONTROLLERS


B. Magnetic Controller: NEMA ICS 2, Class A, full voltage, nonreversing, across the line, unless otherwise indicated.

1. Control Circuit: 120 V; obtained from [integral control power transformer] <Insert source of control power> with a control power [transformer] [source] of sufficient capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.
2. Overload Relay: Ambient-compensated type with inverse-time-current characteristic and NEMA ICS 2, Class [10] [20] [30] tripping characteristic. Provide with heaters or sensors in each phase matched to nameplate full-load current of specific motor to which they connect and with appropriate adjustment for duty cycle.
3. Adjustable Overload Relay: Dip switch selectable for motor running overload protection with NEMA ICS 2, Class [10] [20] [30] tripping characteristic, and selected to protect motor against voltage and current unbalance and single phasing. Provide relay with Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.

2.6 MULTISPEED CONTROLLERS

A. Multispeed Controller: Match controller to motor type, application, and number of speeds; include the following accessories:

1. Compelling relay to ensure that motor will start only at low speed.
2. Accelerating relay to ensure properly timed acceleration through speeds lower than that selected.
3. Decelerating relay to ensure automatically timed deceleration through each speed.

2.7 FEEDER OVERCURRENT PROTECTION


1. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
2. Electronic Trip Unit Circuit Breakers: RMS sensing; field-replaceable rating plug; with the following field-adjustable settings:
   a. Instantaneous trip.
   b. Long- and short-time pickup levels.
   c. Long- and short-time time adjustments.
   d. Ground-fault pickup level, time delay, and $I^2t$ response.

3. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
4. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.
6. Molded-Case Switch: Molded-case circuit breaker without trip units.

B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.

1. Lugs: Mechanical style, suitable for number, size, trip ratings, and material of conductors.
2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
4. Communication Capability:  [Circuit-breaker-mounted] [Universal-mounted] [Integral] communication module with functions and features compatible with power monitoring and control system.

5. Shunt Trip:  120-V trip coil energized from separate circuit, set to trip at [55] [75] percent of rated voltage.

6. Undervoltage Trip:  Set to operate at 35 to 75 percent of rated voltage [without intentional] [with field-adjustable 0.1- to 0.6-second] time delay.

7. Auxiliary Switch:  [One SPDT switch] [Two SPDT switches] with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts; "b" contacts operate in reverse of circuit-breaker contacts.

8. Key Interlock Kit:  Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.


C. Fusible Switch:  NEMA KS 1, Type HD, clips to accommodate fuses with lockable handle.

2.8 ACCESSORIES

A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.


C. Stop and Lockout Push-Button Station:  Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

D. Control Relays:  Auxiliary and adjustable time-delay relays.

E. Meters:

   1. Ammeter:  Output current, with current sensors rated to suit application.
   2. Voltmeter:  Output voltage.
   3. Frequency Meter:  Output frequency.


G. Spare-Fuse Cabinet:  Identified and compartmented steel box.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Select features of each controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, controller, and load; and configuration of pilot device and control circuit affecting controller functions.
3.2 INSTALLATION

A. Anchor each motor-control center assembly to steel-channel sills arranged and sized according to manufacturer's written instructions. Attach by bolting. Level and grout sills flush with motor-control center mounting surface.

B. Install motor-control centers on concrete bases.

C. Controller Fuses: Install fuses in each fusible switch. Comply with Section 262813 - Fuses.

3.3 IDENTIFICATION

A. Identify motor-control center, motor-control center components, and control wiring according to Division 16 Section "Electrical Identification."

B. Operating Instructions: Frame printed operating instructions for motor-control centers, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of motor-control centers.

3.4 CONTROL WIRING INSTALLATION

A. Install wiring between motor-control devices according to Division 26 Section "Conductors and Cables." Bundle, train, and support wiring in enclosures.

B. Connect hand-off-automatic switch and other automatic-control devices where applicable.

1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
2. Connect selector switches with motor-control circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.5 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each motor-control center element, bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Perform the following field tests and inspections and prepare test reports:

1. Perform each electrical test and visual and mechanical inspection, except for optional tests, stated in NETA ATS "Motor Control Centers." Certify compliance with test parameters.
2. Correct malfunctioning units and retest to demonstrate compliance; otherwise, replace with new units and retest.

END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Weather-resistant receptacles.
3. Snap switches and wall-box dimmers.
4. Solid-state fan speed controls.
5. Wall-switch occupancy sensors.
6. Communications outlets.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.
B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
C. Samples: One for each type of device and wall plate specified, in each color specified.
D. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
4. Leviton Mfg. Company Inc. (Leviton)
2.2 STRAIGHT BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Cooper; 5351 (single), CR5362 (duplex).
   b. Hubbell; HBL5351 (single), HBL5352 (duplex).
   c. Pass & Seymour; 5361 (single), 5362 (duplex).
   d. Leviton; 5891 (single), 5352 (duplex)

2.3 GFCI RECEPTACLES

A. General Description: Straight blade, [feed] [non-feed]-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Cooper; VGF20.
   b. Pass & Seymour; 2095.
   c. Hubbell; GFR5352L
   d. Leviton; 7590

2.4 TOGGLE (SNAP) SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Cooper;
   b. Hubbell;
   c. Pass & Seymour;
   d. Leviton

C. Pilot Light Switches, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Cooper;
   b. Hubbell;
   c. Pass & Seymour;
   d. Leviton

2. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON."
D. Key-Operated Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Cooper;
   b. Hubbell;
   c. Pass & Seymour;
   d. Leviton;

2. Description: Single pole, with factory-supplied key in lieu of switch handle.

E. Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Cooper.
   b. Hubbell.
   c. Pass & Seymour;
   d. Leviton;

F. Key-Operated, 120/277 V, 20 A; single pole, with factory-supplied key in lieu of switch handle.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Cooper;
   b. Hubbell;
   c. Pass & Seymour;
   d. Leviton;

2.5 WALL-BOX DIMMERS

A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.

B. Control: Continuously adjustable [slider] [toggle switch] [rotary knob]; with single-pole or three-way switching. Comply with UL 1472.

C. Incandescent Lamp Dimmers: 120 V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module.

1. 600 W; dimmers shall require no derating when ganged with other devices. [Illuminated when "OFF."]

2. <Insert other wattage ratings and descriptions.>

D. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.
2.6  FAN SPEED CONTROLS
A. Modular, 120-V, full-wave, solid-state units with integral, quiet on-off switches and audible frequency and EMI/RFI filters. Comply with UL 1917.
1. Continuously adjustable [slider] [toggle switch] [rotary knob], [5 A] [1.5 A].
2. Three-speed adjustable [slider] [rotary knob], 1.5 A.

2.7  OCCUPANCY SENSORS
A. Wall-Switch Sensors:
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Leviton; 091-ODS15-IDI
2. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 180-degree field of view, with a minimum coverage area of 900 sq. ft..

2.8  WALL PLATES
A. Single and combination types to match corresponding wiring devices.
1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: [Smooth, high-impact thermoplastic] [0.035-inch- thick, satin-finished stainless steel]
4. Material for Damp Locations: Thermoplastic with spring-loaded lift cover, and listed and labeled for use in "wet locations."
B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant [die-cast aluminum], [thermoplastic] with lockable cover.

2.9  FLOOR SERVICE FITTINGS
A. Type: Modular, [flush-type] [flap-type] [above-floor], dual-service units suitable for wiring method used.
B. Compartments: Barrier separates power from voice and data communication cabling.
C. Service Plate: [Rectangular] [Round], [die-cast aluminum] [solid brass] with satin finish.
D. Power Receptacle: NEMA WD 6 configuration 5-20R, gray finish, unless otherwise indicated.
E. Voice and Data Communication Outlet: [Blank cover with bushed cable opening] [Two modular, keyed, color-coded, RJ-45 Category 5e jacks for UTP cable].
2.10 FINISHES

A. Color: Wiring device catalog numbers in Section Text do not designate device color.

1. Wiring Devices Connected to Normal Power System: Ivory or as selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.
3. TVSS Devices: Blue.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

B. Coordination with Other Trades:

1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:
   a. Cut back and pigtail, or replace all damaged conductors.
   b. Straighten conductors that remain and remove corrosion and foreign matter.
   c. Pigtailing existing conductors is permitted provided the outlet box is large enough.

D. Device Installation:

1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.

6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.

7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtail for device connections.

8. Tighten unused terminal screws on the device.

9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

**E. Receptacle Orientation:**

1. Install ground pin of vertically mounted receptacles [up] [down], and on horizontally mounted receptacles to the [right] [left].

**F. Device Plates:** Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

**G. Dimmers:**

1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

**H. Arrangement of Devices:** Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

### 3.2 IDENTIFICATION

**A. Comply with Division 16 Section "Electrical Identification."

1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with [black] [white] [red]-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

### 3.3 FIELD QUALITY CONTROL

**A. Perform tests and inspections and prepare test reports.

1. Test Instruments: Use instruments that comply with UL 1436.
2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

**B. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new, and retest as specified above.

END OF SECTION
SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 SUMMARY
   A. This Section includes the following:
      1. Cartridge fuses rated 600 V and less for use in [switches] [panelboards] [switchboards] [controllers] [and] [motor-control centers].

1.2 SUBMITTALS
   A. Product Data: For each fuse type indicated.
   B. Operation and maintenance data.

1.3 QUALITY ASSURANCE
   A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
   B. Comply with NEMA FU 1.
   C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1. Cooper Bussman, Inc.
      2. Littelfuse, Inc.
      3. Edison Fuse, Inc.
      4. Ferraz Shawmut, Inc.

2.2 CARTRIDGE FUSES
   A. Characteristics: NEMA FU 1, nonrenewable cartridge fuse; class and current rating indicated; voltage rating consistent with circuit voltage.
PART 3 - EXECUTION

3.1 FUSE APPLICATIONS

A. Service Entrance: Class [L, fast acting] [L, time delay] [RK1, fast acting] [RK1, time delay] [J, fast acting] [J, time delay] [T, fast acting].

B. Feeders: Class [L, fast acting] [L, time delay] [RK1, fast acting] [RK1, time delay] [J, fast acting] [J, time delay] [RK5, time delay].

C. Motor Branch Circuits: Class [RK1] [RK5], time delay.

D. Other Branch Circuits: Class [RK1, time delay] [RK5, time delay] [J, fast acting] [J, time delay].

3.2 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.3 IDENTIFICATION

A. Install labels indicating fuse replacement information on inside door of each fused switch.

END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following individually mounted, enclosed switches and circuit breakers:

1. Fusible switches.
2. Nonfusible switches.
4. Enclosures.

1.2 SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and maintenance data.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
2.2 FUSIBLE AND NONFUSIBLE SWITCHES

A. Manufacturers:
   2. Siemens Energy & Automation, Inc.
   3. Square D/Group Schneider.

B. Fusible Switch, [600] [1200] A and Smaller: NEMA KS 1, Type [GD] [HD], with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

C. Nonfusible Switch, [600] [1200] A and Smaller: NEMA KS 1, Type [GD] [HD], lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

D. Accessories:
   1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
   2. Neutral Kit: Internally mounted; insulated, capable of being grounded, and bonded; and labeled for copper and aluminum neutral conductors.
   3. Auxiliary Contact Kit: Auxiliary set of contacts arranged to open before switch blades open.

2.3 MOLDED-CASE CIRCUIT BREAKERS AND SWITCHES

A. Manufacturers:
   2. Siemens Energy & Automation, Inc.
   3. Square D/Group Schneider.

B. Molded-Case Circuit Breaker: NEMA AB 1, with interrupting capacity to meet available fault currents.

   3. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller and let-through ratings less than NEMA FU 1, RK-5.

C. Molded-Case Circuit-Breaker Features and Accessories:

   1. Standard frame sizes, trip ratings, and number of poles.
   2. Lugs: Mechanical style with compression lug kits suitable for number, size, trip ratings, and conductor material.
   3. Application Listing: Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.

5. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at [55] [75] percent of rated voltage.

2.4 ENCLOSURES

A. NEMA AB 1 and NEMA KS 1 to meet environmental conditions of installed location.

1. Outdoor Locations: NEMA 250, Type 3R.
3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.

B. Comply with applicable portions of NECA 1, NEMA PB 1.1, and NEMA PB 2.1 for installation of enclosed switches and circuit breakers.

C. Mount individual wall-mounting switches and circuit breakers with tops at uniform height, unless otherwise indicated. Anchor floor-mounting switches to concrete base.

D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

E. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 16 Section "[Basic Electrical Materials and Methods] [Electrical Identification]."

3.2 FIELD QUALITY CONTROL

A. Prepare for acceptance testing as follows:

1. Inspect mechanical and electrical connections.
2. Verify switch and relay type and labeling verification.
3. Verify rating of installed fuses.

B. Perform the following field tests and inspections and prepare test reports:

1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
SECTION 262913 - ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY
A. This Section includes ac, enclosed controllers rated 600 V and less, of the following types:
   1. Across-the-line, manual and magnetic controllers.
   2. Multispeed controllers.

1.2 SUBMITTALS
A. Product Data: For each type of enclosed controller.
B. Shop Drawings: For each enclosed controller.
   1. Include wiring diagrams.
C. Field quality-control test reports.
D. Operation and maintenance data.
E. Load-current and overload-relay heater list.
F. Load-current and list of settings of adjustable overload relays.

1.3 QUALITY ASSURANCE
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100.
B. Comply with NFPA 70.
C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed controllers, minimum clearances between enclosed controllers, and for adjacent surfaces and other items. Comply with indicated maximum dimensions and clearances.

1.4 COORDINATION
A. Coordinate features of enclosed controllers and accessory devices with pilot devices and control circuits to which they connect.
B. Coordinate features, accessories, and functions of each enclosed controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2. Rockwell Automation; Allen-Bradley Co.; Industrial Control Group.
3. Siemens/Furnas Controls.

2.2 ACROSS-THE-LINE ENCLOSED CONTROLLERS

A. Manual Controller: NEMA ICS 2, general purpose, Class A, with "quick-make, quick-break" toggle or pushbutton action, and marked to show whether unit is "OFF," "ON," or "TRIPPED."

1. Overload Relay: Ambient-compensated type with inverse-time-current characteristics and NEMA ICS 2, Class 10 tripping characteristics. Relays shall have heaters and sensors in each phase, matched to nameplate, full-load current of specific motor to which they connect and shall have appropriate adjustment for duty cycle.

B. Magnetic Controller: NEMA ICS 2, Class A, full voltage, nonreversing, across the line, unless otherwise indicated.

1. Control Circuit: 120 V; obtained from [integral control power transformer] <Insert source of control power> with a control power [transformer] [source] of sufficient capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.
2. Overload Relay: Ambient-compensated type with inverse-time-current characteristic and NEMA ICS 2, Class [10] [20] [30] tripping characteristic. Provide with heaters or sensors in each phase matched to nameplate full-load current of specific motor to which they connect and with appropriate adjustment for duty cycle.
3. Adjustable Overload Relay: Dip switch selectable for motor running overload protection with NEMA ICS 2, Class [10] [20] [30] tripping characteristic, and selected to protect motor against voltage and current unbalance and single phasing. Provide relay with Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.

C. Combination Magnetic Controller: Factory-assembled combination controller and disconnect switch.

1. Fusible Disconnecting Means: NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by an NRTL.
2.3 MULTISPEED ENCLOSED CONTROLLERS

A. Multispeed Enclosed Controller: Match controller to motor type, application, and number of speeds; include the following accessories:

1. Compelling relay to ensure that motor will start only at low speed.
2. Accelerating relay to ensure properly timed acceleration through speeds lower than that selected.
3. Decelerating relay to ensure automatically timed deceleration through each speed.

2.4 ENCLOSURES

A. Description: Flush- or surface-mounting cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated.

1. Outdoor Locations: NEMA 250, Type 3R.

2.5 ACCESSORIES

A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.


C. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock control circuit open.

D. Control Relays: Auxiliary and adjustable time-delay relays.

E. Phase-Failure and Undervoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connection. Provide adjustable undervoltage setting.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Select features of each enclosed controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, controller, and load; and configuration of pilot device and control circuit affecting controller functions.

3.2 INSTALLATION

A. For control equipment at walls, bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks.

B. Install freestanding equipment on concrete bases.

C. Comply with mounting and anchoring requirements specified in Division 16 Section "Electrical Supports and Seismic Restraints."
D. Enclosed Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 16 Section "Fuses."

3.3 IDENTIFICATION

A. Identify enclosed controller, components, and control wiring according to Division 16 Section "Electrical Identification."

3.4 CONTROL WIRING INSTALLATION

A. Install wiring between enclosed controllers according to Division 16 Section "Conductors and Cables." Bundle, train, and support wiring in enclosures.

B. Connect hand-off-automatic switch and other automatic-control devices where applicable.
   1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
   2. Connect selector switches with enclosed controller circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.5 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:
   1. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

B. Perform the following field tests and inspections and prepare test reports:

   1. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in NETA ATS, "Motor Control - Motor Starters." Certify compliance with test parameters.
   2. Correct malfunctioning units and retest to demonstrate compliance; otherwise, replace with new units and retest.

END OF SECTION
SECTION 263231 - ENGINE GENERATORS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes packaged engine-generator sets for standby power supply with the following features:

1. Diesel engine.
2. Unit-mounted cooling system.
3. Unit-mounted control and monitoring.
4. Outdoor enclosure.

1.2 SUBMITTALS

A. Product Data: For each type of packaged engine generator and accessory indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

C. Source quality-control test reports.

D. Field quality-control test reports.

E. Operation and maintenance data.

F. Warranty: Special warranty specified in this Section.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer’s authorized representative who is trained and approved for installation of units required for this Project.

B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 200 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with ASME B15.1.

E. Comply with NFPA 37.

F. Comply with NFPA 70.
G. Comply with NFPA 99.

H. Comply with NFPA 110 requirements for Level 2 emergency power supply system.

I. Comply with UL 2200.

J. Engine Exhaust Emissions: Comply with applicable state and local government requirements.

1.4 PROJECT CONDITIONS

A. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: 5 to 40 deg C.
2. Relative Humidity: 0 to 95 percent.
3. Altitude: 1300 feet (for installations in Phoenix MSA).

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Caterpillar; Engine Div.
2. Generac Power Systems

2.2 ENGINE-GENERATOR SET

A. Factory-assembled and -tested, engine-generator set.

B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.

C. Capacities and Characteristics:

1. Power Output Ratings: Nominal ratings as indicated.
2. Output Connections: Three-phase, four wire.
3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

D. Generator-Set Performance:

1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.
2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
7. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
8. Start Time: Comply with NFPA 110, Type 10, system requirements.

2.3 ENGINE


B. Rated Engine Speed: 1800 rpm.

C. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm.

D. Lubrication System: The following items are mounted on engine or skid:

1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

E. Engine Fuel System:

2. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.
F. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.

G. Governor: Adjustable isochronous, with speed sensing.

H. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.
   1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
   2. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.

I. Muffler/Silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
   1. Minimum sound attenuation of 25 dB at 500 Hz.
   2. Sound level measured at a distance of 10 feet from exhaust discharge after installation is complete shall be 87 dBA or less.

J. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

K. Starting System: 24-V electric, with negative ground.
   1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
   2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
   3. Cranking Cycle: As required by NFPA 110 for Level 2.
   4. Battery: Adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" Article to provide specified cranking cycle at least twice without recharging.
      a. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236.

2.4 FUEL OIL STORAGE

A. Comply with NFPA 30.

B. Base-Mounted Fuel Oil Tank: Factory installed and piped, complying with UL 142 fuel oil tank. Features include the following:
   1. Tank level indicator.
   2. Capacity: Fuel for 24 hours' continuous operation at 100 percent rated power output.
   3. Vandal-resistant fill cap.
2.5 CONTROL AND MONITORING

A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms.

B. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts generator set. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms.

C. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration.

D. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 2 system, and the following:

1. AC voltmeter.
2. AC ammeter.
3. AC frequency meter.
4. DC voltmeter (alternator battery charging).
5. Engine-coolant temperature gage.
6. Engine lubricating-oil pressure gage.
7. Running-time meter.
9. Generator-voltage adjusting rheostat.
10. Fuel tank derangement alarm.
11. Fuel tank high-level shutdown of fuel supply alarm.
12. Generator overload.

E. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

F. Common Remote Audible Alarm: Comply with NFPA 110 requirements for Level 2 systems. Include necessary contacts and terminals in control and monitoring panel.

1. Overcrank shutdown.
2. Coolant low-temperature alarm.
3. Control switch not in auto position.
4. Battery-charger malfunction alarm.
5. Battery low-voltage alarm.

G. Remote Alarm Annunciator: Comply with NFPA 99. An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.
2.6 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Generator Circuit Breaker: Molded-case, thermal-magnetic type; 100 percent rated; complying with NEMA AB 1 and UL 489.

1. Tripping Characteristic: Designed specifically for generator protection.
2. Trip Rating: Matched to generator rating.
3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
4. Mounting: Adjacent to or integrated with control and monitoring panel.


2.7 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: Class H or Class F.

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.

E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

F. Enclosure: Dripproof.

G. Instrument Transformers: Mounted within generator enclosure.

H. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.

1. Adjusting rheostat on control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.

I. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

J. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

K. Subtransient Reactance: \[ 12 \] \% maximum.

2.8 OUTDOOR GENERATOR-SET ENCLOSURE

A. Description: Vandal-resistant, weatherproof steel housing, wind resistant up to 100 mph. Multiple panels shall be lockable and provide adequate access to components requiring
maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.

B. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.

1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.
2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.

C. Interior Lights with Switch: Factory-wired, vaporproof-type fixtures within housing; arranged to illuminate controls and accessible interior. Arrange for external electrical connection.

1. AC lighting system and connection point for operation when remote source is available.
2. DC lighting system for operation when remote source and generator are both unavailable.

D. Convenience Outlets: Factory wired, GFCI. Arrange for external electrical connection.

2.9 VIBRATION ISOLATION DEVICES

A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.

2. Durometer Rating: \([30] [40] [45] [50] [60] [65] [70] <Insert number>\).
3. Number of Layers: \([One] [Two] [Three] [Four] <Insert number>\).

B. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch-thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
2. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.10 FINISHES

A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.
2.11 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

2. Report factory test results within 10 days of completion of test.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with packaged engine-generator manufacturers’ written installation and alignment instructions and with NFPA 110.

B. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

C. Install packaged engine generator with elastomeric isolator pads on 4-inch- high concrete base. Secure sets to anchor bolts installed in concrete bases. Concrete base construction is specified in Division 16 Section "Electrical Supports and Seismic Restraints."

D. Install Schedule 40, black steel piping with welded joints and connect to engine muffler. Install thimble at wall. Piping shall be same diameter as muffler outlet. Flexible connectors and steel piping materials and installation requirements are specified in Division 23 Section "Hydronic Piping."

1. Install condensate drain piping to muffler drain outlet full size of drain connection with a shutoff valve, stainless-steel flexible connector, and Schedule 40, black steel pipe with welded joints. Flexible connectors and piping materials and installation requirements are specified in Division 15 Section "Hydronic Piping."

E. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

F. Piping installation requirements are specified in Division 22 Sections. Drawings indicate general arrangement of piping and specialties.

G. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.

H. Connect engine exhaust pipe to engine with flexible connector.

I. Ground equipment according to Division 26 Section "Grounding and Bonding."

J. Connect wiring according to Division 26 Section "Conductors and Cables."

K. Identify system components according to Division 23 Section "Mechanical Identification" and Division 26 Section "Electrical Identification."
3.2 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Manufacturer’s Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing. Provide manufacturer’s Installation checklist and Startup checklist completed and signed by the service representative, prior to beginning the (Functional Performance Test) Commissioning.

2. Conduct Commissioning of the generator set in accordance with Section 263235 Standby Generator Testing and Commissioning.

B. Tests and Inspections:

1. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.

2. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.

3. Noise Level Tests: Measure level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, as required in Paragraph 2.3, I and insure the noise complies with required values.

C. Remove and replace malfunctioning units and retest as specified above.

D. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

3.3 TRAINING

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators. Refer to Division 1 Section "Demonstration and Training."

END OF SECTION
SECTION 263235 – STANDBY GENERATOR – TESTING AND COMMISSIONING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Standby generators.
2. Automatic Transfer Switches (ATS).
3. System start-up services.
4. Battery charging system testing.
5. Load bank testing.
6. Integral system testing.
7. System demonstration.

B. Refer to Division 26 Section “Static Uninterruptible Power System Testing and Commissioning”.

C. All equipment, including load banks, measuring instruments, cables, connectors, etc. required for the site testing of the complete generator installation shall be provided by the generator manufacturer’s factory authorized firm. The electrical contractor shall assist and coordinate with the generator manufacturer’s factory authorized firm in the administration and performance of the site testing.

1.2 SUBMITTALS

A. Factory test reports.

B. Field test reports and other documentation including a description of the test procedures and inspections with results listed for each test performed in a type-written format. Include results of tests, inspections and retests.

C. Battery and battery charging test results and inspections required in this specification.

D. Infrared scanning reports with pictures printed in a final report with any deficiencies and actions taken to rectify.

1.3 QUALITY ASSURANCE
A. Provide a list of testing equipment with make and model numbers. Test Equipment shall have current calibration validation.

PART 2 – PRODUCTS (Not Applicable)

PART 3 – EXECUTION

3.1 SYSTEM START-UP

A. Perform tests and inspections and prepare test reports.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
   2. Perform generator testing, ATS testing and integral system testing including both generators and ATS.

B. Visual and Mechanical Inspections:
   1. Compare equipment nameplate data with drawings and specifications.
   2. Inspect physical and mechanical condition.
   3. Inspect anchorage, alignment and grounding.
   4. Verify unit is clean.
   5. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding parts (ATS).
   6. Verify ATS warnings are attached and visible.
   7. Verify tightness of all control connections.

C. Generator Electrical and Mechanical Tests:
      a. Machines larger than 200 horsepower (150kW): Test duration shall be ten minutes minimum. Calculate the polarization index.
      b. Machines 200 horsepower (150kW) or less: Test duration shall be one minute minimum. Calculate the dielectric-absorption ratio.
   2. Test protective relays and main circuit breakers.
   3. System Integrity Tests: Methodically verify proper installation, anchorage, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
   4. Test phase rotation, phasing and synchronized operation as required by the application.
   5. Functionally test engine shutdown for low oil pressure, over-temperature overspeed, and other protective features as applicable.
   6. Perform vibration test for each main bearing cap.
   7. Verify correct functioning of the governor and regulator.
8. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.

9. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
   a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
   b. Test for contact integrity of all connectors. Perform a battery system integrity load test and a capacity load test.
   c. Verify acceptance of charge for each element of the battery after discharge.
   d. Verify that measurements are within manufacturer's specifications.

10. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.

11. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg. Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer’s written allowable limits for the engine.

12. Exhaust Emissions Test: Comply with applicable government test criteria.

13. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.

14. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.

15. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at [four] <Insert number> locations [on the property line] <Insert location for measurement>, and compare measured levels with required values.

D. ATS Electrical and Mechanical Tests:

1. Inspect bolted electrical connections for high resistance using one of the following methods:
   a. Use of low-resistance ohmmeter.
   b. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer’s published data.
   c. Perform thermographic survey.

2. Perform manual transfer operation.

3. Verify positive mechanical interlocking between normal and alternate sources.

4. Perform insulation-resistance tests on all control wiring with respect to ground. Applied potential shall be 500 volts dc for 300-volt rated cable and 1000 volts dc for 600-volt rated cable. Test duration shall be one minute. For units with solid-state components or for control devices that cannot tolerate the applied voltage, follow manufacturer’s recommendation.

5. Perform a contact/pole-resistance test.
6. Verify settings and operation of control devices.
7. Calibrate and set all relays and timers.
8. Verify phase rotation, phasing, and synchronized operation as required by the application.
9. Perform automatic transfer test:
   a. Simulate loss of normal power.
   b. Return to normal power.
   c. Simulate loss of emergency power.
   d. Simulate all forms of single-phase conditions.
10. Verify correct operation and timing of the following functions:
    a. Normal source voltage-sensing relays.
    b. Engine start sequence.
    c. Time delay upon transfer.
    d. Alternate source voltage-sensing relays.
    e. Automatic transfer operation.
    f. Interlocks and limit switch function.
    g. Time delay and retransfer upon normal power restoration.
    h. Engine cool down and shutdown feature.

E. ATS Test Values:
1. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
2. Bolt torque levels shall be in accordance with manufacturer’s published data.
3. Microhm or dc millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer’s published data. If manufacturer’s published data is not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
4. Control devices shall operate in accordance with manufacturer’s published data.
5. Phase rotation, phasing, and synchronization shall be in accordance with system design specifications.
6. Automatic transfers shall operate in accordance with manufacturer’s design.
7. Operation and timing shall be in accordance with manufacturer’s and system design requirements.

F. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

G. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

H. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

I. Report results of tests and inspections in writing. Record adjustable relay and breaker settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.
3.2 LOAD BANK TESTING

A. Perform load bank testing as recommended by the manufacturer or as a minimum:

1. Four hour burn-in test at 100%.
   a. At end of four hour burn-in test perform infrared scanning of electrical connections.

2. Perform block loading tests of generator system including:
   a. 25% for 30 min
   b. 50% for 30 min
   c. 75% for 60 min
   d. 100% for 10 min
   e. 75% for 110 min

B. Report results of load bank tests in writing. Attach a label or tag to equipment indicating satisfactory completion of load bank tests.

3.3 INTEGRAL POWER SYSTEM TEST

A. An integral power system test shall be performed for projects including the installation of an uninterruptible power system (UPS).

B. The integral power system test shall be dictated and performed by the UPS system provider.

C. The generator provider shall provide assistance as required where compatibility issues between the UPS systems and the generator arise including:

1. Compatibility between the UPS system and the generators, i.e. harmonics shall not influence voltage regulation and the UPS input filter shall not affect the generator.

2. Ability of the UPS system to synchronize the generator output.

3. Ability of the UPS system to transfer the load from UPS system to maintenance bypass and back while on generator power.

4. Ability of the UPS to limit battery recharge current while on generator power.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators. Refer to Division 1 Section "Demonstration and Training."

END OF SECTION
SECTION 263353 - STATIC UNINTERRUPTIBLE POWER SUPPLY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Three-phase, on-line, double-conversion, static-type, UPS units with the following features:
   a. Surge suppression.
   b. Rectifier-charger.
   c. Inverter.
   d. Static bypass transfer switch.
   e. Battery and battery disconnect device.
   f. Battery monitoring.

1.2 SUBMITTALS

A. Product Data: For each UPS component indicated.

B. Shop Drawings: Detail assemblies of equipment indicating dimensions, weights, components, and location and identification of each field connection. Show access, workspace, and clearance requirements; details of control panels; and battery arrangement.

1. Include wiring diagrams.

C. Factory test reports.

D. Field quality-control test reports.

E. Operation and maintenance data.

F. Warranties.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use and for compliance with the following:

1. UL 1778.
2. Suitable for installation in computer rooms according to NFPA 75.
1.4 WARRANTY

A. Special Battery Warranties: Specified form in which manufacturer and Installer agree to repair or replace UPS system storage batteries that fail in materials or workmanship within specified warranty period.

1. Warranted Cycle Life for Valve-Regulated, Lead-Acid Batteries: Equal to or greater than that represented in manufacturer's published table, including figures corresponding to the following, based on annual average battery temperature of 77 deg F (25 deg C):

<table>
<thead>
<tr>
<th>Discharge Rate</th>
<th>Discharge Duration</th>
<th>Discharge End Voltage</th>
<th>Cycle Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 hours</td>
<td>8 hours</td>
<td>1.67</td>
<td>6 cycles</td>
</tr>
<tr>
<td>30 minutes</td>
<td>30 minutes</td>
<td>1.67</td>
<td>20 cycles</td>
</tr>
<tr>
<td>15 minutes</td>
<td>45 seconds</td>
<td>1.67</td>
<td>120 cycles</td>
</tr>
</tbody>
</table>

2. Warranted Cycle Life for Premium Valve-Regulated, Lead-Acid Batteries: Equal to or greater than that represented in manufacturer's published table, including figures corresponding to the following, based on annual average battery temperature of 77 deg F (25 deg C):

<table>
<thead>
<tr>
<th>Discharge Rate</th>
<th>Discharge Duration</th>
<th>Discharge End Voltage</th>
<th>Cycle Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 hours</td>
<td>8 hours</td>
<td>1.67</td>
<td>40 cycles</td>
</tr>
<tr>
<td>30 minutes</td>
<td>30 minutes</td>
<td>1.67</td>
<td>125 cycles</td>
</tr>
<tr>
<td>15 minutes</td>
<td>1.5 minutes</td>
<td>1.67</td>
<td>750 cycles</td>
</tr>
</tbody>
</table>

B. Special UPS Warranties: Specified form in which manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within special warranty period.

1. Special Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 OPERATIONAL REQUIREMENTS

A. Automatic operation includes the following:

1. Normal Conditions: Supply the load with ac power flowing from the normal ac power input terminals, through the rectifier-charger and inverter, with the battery connected in parallel with the rectifier-charger output.

2. Abnormal Supply Conditions: If normal ac supply deviates from specified and adjustable voltage, voltage waveform, or frequency limits, the battery supplies
energy to maintain constant, regulated inverter ac power output to the load without switching or disturbance.

3. If normal power fails, energy supplied by the battery through the inverter continues supply-regulated ac power to the load without switching or disturbance.

4. When power is restored at the normal supply terminals of the system, controls automatically synchronize the inverter with the external source before transferring the load. The rectifier-charger then supplies power to the load through the inverter and simultaneously recharges the battery.

5. If the battery becomes discharged and normal supply is available, the rectifier-charger charges the battery. On reaching full charge, the rectifier-charger automatically shifts to float-charge mode.

6. If any element of the UPS system fails and power is available at the normal supply terminals of the system, the static bypass transfer switch switches the load to the normal ac supply circuit without disturbance or interruption.

7. If a fault occurs in the system supplied by the UPS, and current flows in excess of the overload rating of the UPS system, the static bypass transfer switch operates to bypass the fault current to the normal ac supply circuit for fault clearing.

8. When the fault has cleared, the static bypass transfer switch returns the load to the UPS system.

9. If the battery is disconnected, the UPS continues to supply power to the load with no degradation of its regulation of voltage and frequency of the output bus.

B. Manual operation includes the following:

1. Turning the inverter off causes the static bypass transfer switch to transfer the load directly to the normal ac supply circuit without disturbance or interruption.

2. Turning the inverter on causes the static bypass transfer switch to transfer the load to the inverter.

C. Maintenance Bypass/Isolation Switch Operation: Switch is interlocked so it cannot be operated unless the static bypass transfer switch is in the bypass mode. Device provides manual selection among the three conditions in subparagraphs below without interrupting supply to the load during switching:

1. Full Isolation: Load is supplied, bypassing the UPS. Normal UPS ac input circuit, static bypass transfer switch, and UPS load terminals are completely disconnected from external circuits.

2. Maintenance Bypass: Load is supplied, bypassing the UPS. UPS ac supply terminals are energized to permit operational checking, but system load terminals are isolated from the load.

3. Normal: Normal UPS ac supply terminals are energized and the load is supplied through either the static bypass transfer switch and the UPS rectifier-charger and inverter, or the battery and the inverter.

D. Environmental Conditions: The UPS shall be capable of operating continuously in the following environmental conditions without mechanical or electrical damage or degradation of operating capability, except battery performance.
1. Ambient Temperature for Electronic Components: 32 to 104 deg F (0 to 40 deg C).
2. Ambient Temperature for Battery: 41 to 95 deg F (5 to 35 deg C).
3. Relative Humidity: 0 to 95 percent, noncondensing.

2.2 PERFORMANCE REQUIREMENTS

A. The UPS shall perform as specified in this Article while supplying rated full-load current, composed of any combination of linear and nonlinear load, up to 100 percent nonlinear load with a load crest factor of 3.0, under the following conditions or combinations of the following conditions:

1. Inverter is switched to battery source.
2. Steady-state ac input voltage deviates up to plus or minus 10 percent from nominal voltage.
3. Steady-state input frequency deviates up to plus or minus 5 percent from nominal frequency.
4. THD of input voltage is 15 percent or more with a minimum crest factor of 3.0, and the largest single harmonic component is a minimum of 5 percent of the fundamental value.
5. Load is [30] [50] [100] percent unbalanced continuously.

B. Minimum Duration of Supply: If battery is sole energy source supplying rated full UPS load current at 80 percent power factor, duration of supply is [5] [10] [15] <Insert duration> minutes.


D. Overall UPS Efficiency: Equal to or greater than <Insert number> percent at 100 percent load, <Insert number> percent at 75 percent load, and <Insert number> percent at 50 percent load.

E. Maximum Acoustical Noise: <Insert value>, "A" weighting, emanating from any UPS component under any condition of normal operation, measured 39 inches (990 mm) <Insert distance> from nearest surface of component enclosure.

F. Maximum Energizing Inrush Current: [Six] [Eight] times the full-load current.

G. Maximum AC Output-Voltage Regulation for Loads up to 50 Percent Unbalanced: Plus or minus 2 percent over the full range of battery voltage.

H. Output Frequency: 60 Hz, plus or minus 0.5 percent over the full range of input voltage, load, and battery voltage.

I. Limitation of harmonic distortion of input current to the UPS shall be as follows:
1. **Description:** Either a tuned harmonic filter or an arrangement of rectifier-charger circuits shall limit THD to [5] [10] percent, maximum, at rated full UPS load current, for power sources with X/R ratio between 2 and 30.

J. **Maximum Harmonic Content of Output-Voltage Waveform:** 5 percent RMS total and 3 percent RMS for any single harmonic, for rated full load with THD up to 50 percent, with a load crest factor of 3.0.

K. **Minimum Overload Capacity of UPS at Rated Voltage:** 125 percent of rated full load for 10 minutes, and 150 percent for 30 seconds in all operating modes.

L. **Maximum Output-Voltage Transient Excursions from Rated Value:** For the following instantaneous load changes, stated as percentages of rated full UPS load, voltage shall remain within stated percentages of rated value and recover to, and remain within, plus or minus 2 percent of that value within 100 ms:

   1. 50 Percent: Plus or minus 5 percent.
   2. 100 Percent: Plus or minus 5 percent.
   3. Loss of AC Input Power: Plus or minus 1 percent.
   4. Restoration of AC Input Power: Plus or minus 1 percent.

M. **Input Power Factor:** A minimum of [0.70] [0.85] lagging when supply voltage and current are at nominal rated values and the UPS is supplying rated full-load current.

N. **EMI Emissions:** Comply with FCC Rules and Regulations, and with 47 CFR 15 for Class A equipment.

### 2.3 UPS SYSTEMS

A. **Manufacturers:**

   1. Liebert Corporation; a division of Emerson.
   2. APC.
   3. Powerware Division of Eaton Corp.

B. **Electronic Equipment:** Solid-state devices using hermetically sealed, semiconductor elements. Devices include rectifier-charger, inverter, static bypass transfer switch, and system controls.

C. **Enclosures:** Comply with NEMA 250, Type 1, unless otherwise indicated.

D. **Control Assemblies:** Mount on modular plug-ins, readily accessible for maintenance.

E. **Surge Suppression:** Protect internal UPS components from surges that enter at each ac power input connection including main disconnect switch and static bypass transfer switch. Protect rectifier-charger, inverter, controls, and output components.

   1. Use factory-installed surge suppressors tested according to IEEE C62.41, Category [B] [C].
F. Output Circuit Neutral Bus, Conductor, and Terminal Ampacity: Rated phase current times a multiple of 1.73, minimum.

2.4 RECTIFIER-CHARGER

A. Capacity: Adequate to supply the inverter during rated full output load conditions and simultaneously recharge the battery from fully discharged condition to 95 percent of full charge within 10 times the rated discharge time for duration of supply under battery power at full load.

B. Output Ripple: Limited by output filtration to less than 0.5 percent of rated current, peak to peak.

C. Rectifier-Charger Control Circuits: Immune to frequency variations within rated frequency ranges of normal and emergency power sources.

   1. Response Time: Field adjustable for maximum compatibility with local generator-set power source.

D. Battery Float-Charging Conditions: Comply with battery manufacturer's written instructions for battery terminal voltage and charging current required for maximum battery life.

2.5 INVERTER

A. Description: Pulse-width modulated, with sinusoidal output.

2.6 STATIC BYPASS TRANSFER SWITCH

A. Description: Solid-state switching device providing uninterrupted transfer. A contactor or electrically operated circuit breaker automatically provides electrical isolation for the switch.

B. Switch Rating: Continuous duty at the rated full UPS load current, minimum.

2.7 BATTERY

A. Description: Valve-regulated, premium, heavy-duty, recombinant, lead-calcium units, factory assembled in an isolated compartment or in a separate matching cabinet, complete with battery disconnect switch.

   1. Manufacturers:

      a. EnerSys, Inc.
      b. Powerware Division of Eaton Corporation.
      c. C&D Technologies, Inc.; standby Power Division
2.8 CONTROLS AND INDICATIONS

A. Description: Group displays, indications, and basic system controls on a common control panel on front of UPS enclosure.

B. Minimum displays, indicating devices, and controls include those in lists below. Provide sensors, transducers, terminals, relays, and wiring required to support listed items. Alarms include audible signals and visual displays.

C. Indications: [Labeled LED] [Plain-language messages on a digital LCD or LED].

1. Quantitative indications shall include the following:
   a. Input voltage, each phase, line to line.
   b. Input current, each phase, line to line.
   c. Bypass input voltage, each phase, line to line.
   d. Bypass input frequency.
   e. System output voltage, each phase, line to line.
   f. System output current, each phase.
   g. System output frequency.
   h. DC bus voltage.
   i. Battery current and direction (charge/discharge).
   j. Elapsed time discharging battery.

2. Basic status condition indications shall include the following:
   a. Normal operation.
   b. Load-on bypass.
   c. Load-on battery.
   d. Inverter off.
   e. Alarm condition.

3. Alarm indications shall include the following:
   a. Bypass ac input overvoltage or undervoltage.
   b. Bypass ac input overfrequency or underfrequency.
   c. Bypass ac input and inverter out of synchronization.
   d. Bypass ac input wrong-phase rotation.
   e. Bypass ac input single-phase condition.
   f. Bypass ac input filter fuse blown.
   g. Internal frequency standard in use.
   h. Battery system alarm.
   i. Control power failure.
   j. Fan failure.
   k. UPS overload.
   l. Battery-charging control faulty.
   m. Input overvoltage or undervoltage.
n. Input transformer overtemperature.
o. Input circuit breaker tripped.
p. Input wrong-phase rotation.
q. Input single-phase condition.
r. Approaching end of battery operation.
s. Battery undervoltage shutdown.
t. Maximum battery voltage.
u. Inverter fuse blown.
v. Inverter transformer overtemperature.
w. Inverter overtemperature.
x. Static bypass transfer switch overtemperature.
y. Inverter power supply fault.
z. Inverter transistors out of saturation.
aa. Identification of faulty inverter section/leg.
bb. Inverter output overvoltage or undervoltage.
c. UPS overload shutdown.
dd. Inverter current sensor fault.
e. Inverter output contactor open.
ff. Inverter current limit.

4. Controls shall include the following:

a. Inverter on-off.
b. UPS start.
c. Battery test.
d. Alarm silence/reset.
e. Output-voltage adjustment.

D. Emergency Power Off Switch: Capable of local operation and operation by means of activation by external dry contacts.

E. Manufacturers:

1. BTECH Inc.
2. Albercorp
3. Powerware Division of Eaton Corporation.

F. Battery Ground-Fault Detector: Initiates alarm when resistance to ground of positive or negative bus of battery is less than 5000 ohms.

G. Annunciation of Alarms: At UPS control panel.

2.9 BATTERY-CYCLE WARRANTY MONITORING

A. Description: Electronic device, acceptable to battery manufacturer as a basis for warranty action, for monitoring of charge-discharge cycle history of batteries covered by cycle-life warranties.
B. Performance: Automatically measures and records each discharge event, classifies it according to duration category, and totals discharges according to warranty criteria, displaying remaining warranted battery life on front panel display.

2.10 SOURCE QUALITY CONTROL

A. Factory test complete UPS system before shipment. Use simulated battery testing. Include the following:

1. Test and demonstration of all functions, controls, indicators, sensors, and protective devices.
2. Full-load test.
4. Overload test.
5. Power failure test.

B. Report test results.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install system components on 4-inch- (100-mm-) high concrete bases. Concrete base construction requirements are specified in Division 16 Section "Electrical Supports and Seismic Restraints."

B. Maintain minimum 36" clearance on all (4) four sides and the top to allow for disassembly and servicing.

C. Connections: Interconnect system components. Make connections to supply and load circuits according to manufacturer's wiring diagrams, unless otherwise indicated.

D. Separately Derived Systems: If not part of a listed power supply for a data-processing room, comply with NFPA 70 requirements for connecting to grounding electrodes and for bonding to metallic piping near isolation transformer.

E. Identify components and wiring according to Division 26 Section "Electrical Identification."

F. Equalize charging of battery cells according to manufacturer's written instructions. Record individual-cell voltages.
3.2 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust equipment installation including connections[, and to assist in field testing. Report results in writing.

B. Electrical Tests and Inspections: Perform tests and inspections according to manufacturer's written instructions and as listed below to demonstrate condition and performance of each UPS component:

1. Inspect interiors of enclosures, including the following:
   a. Integrity of mechanical and electrical connections.
   b. Component type and labeling verification.
   c. Ratings of installed components.

2. Test manual and automatic operational features and system protective and alarm functions.

C. Retest: Correct deficiencies and retest until specified requirements are met.

D. Record of Tests and Inspections: Maintain and submit documentation of tests and inspections, including references to manufacturers' written instructions and other test and inspection criteria. Include results of tests, inspections, and retests.

3.3 TRAINING

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the UPS. Refer to Division 1 Section "Closeout Procedures."

END OF SECTION
SECTION 263354 – STATIC UPS – TESTING AND COMMISSIONING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes
   1. System start-up services.
   2. Battery charging.
   3. Load bank testing.
   4. Battery load testing.
   5. Integral system testing.

B. All equipment, including load banks, measuring instruments, cables, connectors, etc. required for the site testing of the complete UPS system installation shall be provided by the UPS manufacturer's factory authorized firm. The electrical contractor shall assist and coordinate with the UPS manufacturer's factory authorized firm in the administration and performance of the site testing.

1.2 SUBMITTALS

A. Factory test reports.

B. Field test reports and other documentation including a description of the test procedures and inspections with results listed for each test performed in a type-written format. Include results of tests, inspections and retests.

C. Battery test results including resistance measurements, voltage and temperature readings, specific gravity readings, load values and discharge times and other tests and inspections required in this specification.

D. Infrared scanning reports with pictures printed in a final report with any deficiencies and actions taken to rectify.

1.3 QUALITY ASSURANCE

A. Provide a list of testing equipment with make and model numbers. Test Equipment shall have current calibration validation.

B.

PART 2 – PRODUCTS (Not Applicable)

PART 3 – EXECUTION
3.1 SITE TESTING

A. System Start-Up:
   1. After completion of the UPS system installation and battery system certification; the following inspections and test procedures, as a minimum, shall be performed by the UPS manufacturer’s Field Engineers.
         1) Compare equipment nameplate data with drawings and specifications.
         2) Inspect equipment for signs of damage incurred during delivery.
         3) Inspect anchorage, alignment, grounding and required clearances.
         4) Verify installation per drawings, including proper termination of all cables.
         5) Inspect cabinets for foreign objects and remove any if present.
         6) Verify phase, neutral and ground conductors are properly sized and configured.
         7) Verify date code on batteries to insure batteries have been manufactured within the past 12 months. Return batteries to manufacturer with a date code indicating batteries are older than 12 months.
         8) Verify battery racks and cabinets are seismically rated for the geographical location and installed as specified.
         9) Verify battery support rack and cabinet grounding and clearances.
        10) Verify battery systems are clean.
        11) Verify and inspect battery spill containment installation.
        12) Verify application of oxide inhibitor on battery terminal connections.
      b. Mechanical Inspection.
         1) Check all control wiring connections for tightness.
         2) Check all power wiring connections for tightness.
         3) Check all terminal screws, nuts, and/or spade lugs for tightness.
         4) Verify filters are in place and vents are clear.
         5) Verify battery area ventilation is operable.
         6) Verify existence of eyewash equipment as required by drawings.
      c. Electrical Inspection.
         1) Check all fuses for continuity.
         2) Confirm input and bypass voltage and phase rotation is correct.
         3) Verify control transformer connections are correct for voltages being used.
         4) Assure connection and voltage of the battery string(s).
         5) Verify battery electrolyte levels and measure electrolyte specific gravity and temperature where applicable.
         6) Verify all alarm indicating lamps and audible devices are operating properly. Record all trip points either by simulation or actual fault condition. Indicate on documented procedure, which faults, were conducted by which means.
      d. Start-Up Test Procedures.
         1) Energize control power.
         2) Perform control/logic checks and adjust to meet specification.
3) Verify DC float and equalized voltage levels.
4) Verify DC voltage clamp and overvoltage shutdown levels.
5) Verify battery discharge, low battery warning and low battery shutdown levels.
6) Verify fuse monitor alarms and system shutdown.
7) Verify inverter voltages and regulation circuits.
8) Verify inverter/bypass sync circuits and set overlap time.
9) Perform manual transfer and returns.
10) Simulate utility outage and verify transfer operation to battery source.
11) Verify proper recharge of batteries.
e. Provide recording multichannel oscillograph and conduct the following tests to demonstrate operation in conformance with the operating characteristics specified herein:
1) Verify sync to bypass source when within limits including operation from the on-site standby generator system.
2) Verify sync between UPS modules with input source removed alternately from each UPS module, and from both UPS modules, with each UPS module alternately selected as “master” at the ups bus controller panel.
3) Simulate all alarms and failure modes. Verify alarm indication, alarm logging, and system response to failure mode with protection of the load.
4) Verify voltage regulation and output waveform while applying and removing step loads of 25%, 50%, 75% and 100% with operation from a normal source and with operation from standby generator source.
5) Verify voltage regulation and output waveform while applying and removing step loads of 25%, 50%, 75% and 100% with operation from the battery source.
6) Verify charger current limit operation.
7) Verify voltage regulation and output waveform while transferring full load to and from the bypass source both manually and automatically.
f. Verify proper operation of battery cycle monitor.
2. All pertinent data, including parts replaced and corrective actions taken as a result of the system start-up services, shall be recorded and submitted to the Architect/Engineer, in writing.

B. Battery Charging
1. Prior to battery discharge, battery systems shall be tested including internal-cell resistance tests for all battery cells, inter-cell connection tests and inter-tier connection tests.
2. Upon completion of the UPS system start-up services, the battery systems shall be given an equalizing charge, if required, as determined by the battery system certification. The battery manufacturer’s authorized firm shall include in his base bid the manpower required for qualified personnel to continuously monitor and record all pertinent data for the battery systems during the equalize charge period per the selected battery manufacturer’s requirements and/or recommendations.
3. After the battery equalizing charge period, the battery systems shall be placed on a float charge per the selected battery manufacturer’s recommendations and requirements to stabilize the battery system voltage prior to load bank testing.

C. Load Bank Testing
1. A 4 hour burn-in, 100% load bank test of the entire UPS system, including UPS modules and battery systems, shall be conducted at the site by the UPS system supplier and the UPS manufacturer’s authorized firm. The load bank shall be connected to the UPS system output at the maintenance bypass cabinet. The purpose of the load bank test is to ensure that all circuitry is functional, that no shipping damage has occurred, and to verify the integrity of the installation.
2. After 4 hour burn-in test, transfer the UPS to static/internal bypass for 15 minutes and perform infrared scanning. Then transfer to maintenance bypass for 15 minutes and repeat infrared scanning. All transfers to occur while on full load.
3. Since the accuracy of the UPS system’s panel instrumentation was proven during the factory testing, they shall be used for all readings where practical. Load banks, cables, connectors and any additional recording instruments required shall be furnished and installed by the UPS system supplier and the UPS manufacturer’s authorized firm.
4. Completion of the load bank and battery load tests and cognizant Owner Representative signature evidencing approval shall constitute final acceptance of the UPS system and the commencement of the warranty period. The load bank testing will not be limited to, but shall include as a minimum, the following:
   a. Apply power in the proper sequence.
   b. Verify input and output AC and DC voltage and current reading on all three phases of system output. Record data with power quality meters set up to record input and output voltage, current, frequency and transients of the output.
   c. After 1/2 hours, verify that the battery system will support the full load for the specified time by interrupting the power inputs to the modules.
   d. Perform block loading of the system including 0%-50%-0%; 25%-75%-25%; 0%-100%-0% while recording data with the power quality meters.
   e. For the final fifteen (15) minute period, verify automatic and manual transfer functions of the UPS system to bypass, and back to UPS, by simulating all conditions which would cause transfer (including UPS module emergency shutdown-EPO).
   f. Verify proper activation of all UPS system alarms and indicators including remote types during the test procedure.

D. Battery Rundown Test:
1. The test shall be conducted with each UPS module at full load.
   a. Remove the AC input and record the time and measure and record voltage drop across each battery connection under full load.
   b. At thirty second intervals, record the DC voltage and current.
   c. Record the time in which the battery discharge related alarm occurs
   d. Conduct an infrared scan of the battery installation during discharge test.
   e. Using the wave form recorder set at the highest resolution, record the critical load voltage and one phase input current prior to and during the entire input fail.
f. Continue to record without interruption for a minimum of five minutes to demonstrate the input walk-in current and the input current limit. These manual readings are required as well as automated data recording.

2. Upon successful completion of the battery tests and after the batteries have a chance to reach their normal charge and temperature, take a full set of cell voltage readings, specific gravity and cell temperature readings.

3. After completion of installation and acceptance of battery system by the Owner, UPS supplier shall certify that installation is complete and in accordance with all of UPS suppliers requirements and the UPS supplier warrantee is in effect.

E. Any damage, discrepancies and/or parts replaced as a result of the load bank test shall be noted and the Owner/Engineer informed of such, in writing. All battery system data recorded during the continuous monitoring period and the load test shall be submitted to the Owner/Engineer for analysis.

F. If the system does not function properly, further tests shall be performed on any item of equipment to determine whether it meets the pertinent specifications. Any measurements deemed necessary by the Architect/Engineer shall be made. Modify or adjust any item of equipment to meet the specifications for the particular item of equipment and the functional requirements of the complete system.

G. Record all system test results and corrective actions undertaken for submittal to the Owner at the time of system acceptance.

H. An integral power system test designed to demonstrate the operation of the UPS system in conjunction with the emergency generators shall also be conducted by the Contractor with the assistance of the UPS supplier. The test shall extend for at least four (4) hours and shall prove the following:
   1. Compatibility between the UPS system and the generators, i.e. harmonics shall not influence voltage regulation and the UPS input filter shall not affect the generators.
   2. Ability of the UPS system to synchronize the generator output.
   3. Ability of the UPS system to transfer the load from UPS system to maintenance bypass and back while on generator power.
   4. Ability of the UPS to limit battery recharge current while on generator power.

3.2 DEMONSTRATION

A. The UPS supplier shall provide qualified field service personnel as required to supervise the site tests. The UPS supplier's field service technicians shall provide all special instrumentations, including line disturbance analyzers, oscilloscopes and event recorders, required to perform the tests.

B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate and maintain the UPS System.
SECTION 263355 – STATIC UPS (LARGE SYSTEM) – TESTING AND COMMISSIONING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes
   1. System start-up and commissioning services.
   2. Battery charging.
   3. Load bank testing.
   4. Battery load testing.
   5. Integral system testing.

B. All equipment, including load banks, measuring instruments, cables, connectors, etc. required for the site testing of the complete UPS system installation shall be provided by the UPS manufacturer’s factory authorized firm. The electrical contractor shall assist and coordinate with the UPS manufacturer’s factory authorized firm in the administration and performance of the site testing.

1.2 SUBMITTALS

A. Factory test reports.

B. Field test reports and other documentation including a description of the test procedures and inspections with results listed for each test performed in a type-written format. Include results of tests, inspections and retests.

C. Battery test results including resistance measurements, voltage and temperature readings, specific gravity readings, load values and discharge times and other tests and inspections required in this specification.

D. Infrared scanning reports with pictures printed in a final report with any deficiencies and actions taken to rectify.

1.3 QUALITY ASSURANCE

A. Provide a list of testing equipment with make and model numbers. Test Equipment shall have current calibration validation.

1.4 REFERENCES

A. Section 019100 Commissioning Requirements
3.1 START-UP, COMMISSIONING AND INTEGRATED SYSTEM TESTING

A. Commissioning and testing of the UPS system shall be provided by the Owner’s Commissioning Agent. After installation, the UPS supplier shall provide one or more qualified, experienced representatives to assist and supervise start-up commissioning. The Owner shall advise the UPS supplier at least 5 days in advance of the date when such supervisors will be required. Such supervisors shall meet with the Owner and the Owner’s Commissioning Agent prior to system start-up to establish a mutually agreeable schedule for start-up and testing activities. The supervisors shall be assigned to work continuously until successful start-up completion. The Electrical Contractor shall assist and coordinate with the Owner’s Commissioning Agent and the UPS system supplier’s on-site support personnel in the administration and performance of the site testing and commissioning.

B. Commissioning: The UPS supplier shall provide on-site support for the duration of equipment commissioning. A minimum of [fifteen (15)] <number of days> man days for each system shall be included in the Bid. Support shall be dedicated to this project and assigned to work continuously until successful commissioning completion. A man day shall be no more than but up to 12 hours each day, Monday through Friday.

C. Integrated System Testing: The UPS supplier shall provide on-site support for the duration of equipment integrated system testing. A minimum of [fifteen (15)] <number of days> man days for each system shall be included in the Bid. Support shall be dedicated to this project and assigned to work continuously until successful completion of integrated system testing. A man day shall be no more than but up to 12 hours each day, Monday through Friday.

D. System Start-Up:
   1. After completion of the UPS system installation and battery system certification, the following inspections and test procedures, as a minimum, shall be performed by the UPS manufacturer’s Field Engineers.
         1) Compare equipment nameplate data with drawings and specifications.
         2) Inspect equipment for signs of damage incurred during delivery.
         3) Inspect anchorage, alignment, grounding and required clearances.
         4) Verify installation per drawings, including proper termination of all cables.
         5) Inspect cabinets for foreign objects and remove any if present.
         6) Verify phase, neutral and ground conductors are properly sized and configured.
7) Verify date code on batteries to insure batteries have been manufactured within the past 12 months. Return batteries to manufacturer with a date code indicating batteries are older than 12 months.

8) Verify battery racks and cabinets are seismically rated for the geographical location and installed as specified. Verify mounting, anchorage and alignment of battery racks and cabinets.

9) Verify battery support rack and cabinet grounding and clearances.

10) Verify battery systems are clean.

11) Verify and inspect battery spill containment installation.

12) Verify application of oxide inhibitor on battery terminal connections.

b. Mechanical Inspection.
   1) Check all control wiring connections for tightness.
   2) Check all power wiring connections for tightness.
   3) Check all terminal screws, nuts, and/or spade lugs for tightness.
   4) Verify filters are in place and vents are clear.
   5) Verify battery area ventilation is operable.
   6) Verify existence of eyewash equipment as required by drawings.

c. Electrical Inspection.
   1) Check all fuses for continuity.
   2) Confirm input and bypass voltage and phase rotation is correct.
   3) Verify control transformer connections are correct for voltages being used.
   4) Assure connection and voltage of the battery string(s).
   5) Verify battery electrolyte levels and measure electrolyte specific gravity and temperature where applicable.
   6) Verify all alarm indicating lamps and audible devices are operating properly. Record all trip points either by simulation or actual fault condition. Indicate on documented procedure, which faults, were conducted by which means.

3.2 SITE TESTING

A. In general, the UPS system supplier shall be responsible for the performance of all site tests on the UPS system, including batteries, switchgears and disconnecting devices, as required to certify the proper operation of the system as a whole. A recommended site test procedure shall be provided by the UPS system supplier and approved by the Owner or Commissioning Agent. The UPS supplier shall inspect the installation location of the UPS system for the purpose of choosing locations for portable load bank installation. This testing shall be coordinated with the Owner and may occur during normal working hours, overtime or premium time hours.

B. As a minimum, the following site tests are required:
   1. Verify that all operating controls, alarms, meters and mimic lights are functioning properly.
2. Verify that all alarms function properly. Record all trip points either by simulation or actual fault condition. Indicate on documented procedure, which faults, were conducted by which means.

3. Verify all switchgear functions including all transfer capabilities.

4. Conduct tests on air power circuit breakers in accordance with applicable ANSI/IEEE Standards, including but not limited to the following:
   a. Insulation resistance tests pole-to-pole, pole-to-ground, across open poles and all major insulation components.
   b. Insulation resistance test on control wiring. For units with solid-state components or control devices, that cannot tolerate the applied voltages, follow the manufacturer's recommendations.
   c. Primary current injection tests for breakers outside the UPS equipment. Verify components located in the UPS equipment have been factory tested and provide field testing of breakers as recommended by the manufacturer.
   d. Contact resistance test using a Digital Low Resistance Ohmmeter.
   e. Alignment test with master call to verify interfaces and interchangeability.
   f. Mechanical and electrical operational tests.
   g. Coil check test.

5. Voltage regulation. Record L-L voltage for each module for the system.
   a. Record each module and system output voltage at no load.
   b. Record each module and system output voltage at half rated load.
   c. Record each module and system output voltage at full rated load.
   d. Calculate the voltage regulation as follows:
      e. \( \frac{(NL-L)}{NL} \times 100 = \% \text{ Voltage regulation} \)
      f. NL = No load volts
      g. L = 1/2 of full rated load volts
      h. Verify multi-module systems are sharing the load evenly across all modules per manufacturer's specifications.

6. Transient Tests
   a. A disturbance analyzer capable of capturing subcycle impulses shall be utilized with sufficient channels to monitor three-phase voltage output, single-phase current output, single-phase current input and single-phase voltage input.
   b. Record all system level voltages, current, kW and PF for both, input and output of steady state load steps prior to conducting test.
   c. Example: Step load from 25% to 75%. Record the 25% load setting and the 75% load setting before performing the transient test.
   d. Each transient test listed below shall be recorded and shall meet the following criteria, except when noted otherwise:
      1) Plus 8% or minus 8% with a recovery of 16 milliseconds to within plus or minus one percent of the initial steady state value. These criteria shall be met by each individual transient, measured line-to-line.
      2) The method of measuring a transient is as follows. The steady state voltage envelope prior to the transient measure in millimeters is subtracted from the peak-to-peak transient measure in millimeters. This absolute difference is divided by the steady state voltage envelope and multiplied by 100 to arrive at the percent transient.
e. Module Level Transient Response Tests: (Record operation times)
   1) 0% to 50% to 0% of the full module load.
   2) 25% to 75% to 25% of the full module load.
   3) 50% to 100% to 50% of the full module load.
   4) 75% to 110% to 75% of the full module load.
   5) 0% to 100% to 0% of the full module load.

f. System Level Transient Response Tests: (Record operation times)
   1) 0% to 50% to 0% of the redundant load.
   2) 25% to 75% to 25% of the redundant load.
   3) 50% to 100% to 50% of the redundant load.
   4) 75% to 110% to 75% of the redundant load.
   5) 0% to 100% to 0% of the redundant load.

g. Repeat for the system operating in non-redundant mode.

h. UPS to Bypass Transfer Transients
   1) With the entire system operating at full load, transfer the load from
      the UPS to the bypass and back to the UPS. Mark operation time.
   2) Repeat the test with the system operating in non-redundant mode.

i. Isolation Transients: With the entire system operating at full redundant
   load, simulate a blown fuse in one module. Observe the module removing
   itself from the output bus without affecting the load or the other UPS
   modules. Verify with disturbance analyzers there was no loss of load.
   Verify remaining modules share the load. Record transfer times. Simulate
   a blown fuse in the second module; verify that the system transfers to
   bypass.

j. Input Fail Transient: This test is to be conducted with a fully charged
   battery, with all modules on-line and at full rate load. The system output
   voltage shall be monitored by the light beam recorder.

k. Note that the transients do not exceed the Specification or that the output
   modulation of each module does not exceed 1% as defined by the formula
   below:

   \[ \text{VM}\% = \frac{(E_{\text{p MAX}} - E_{\text{p MIN}})}{E_{\text{p MAX}}} \times 100 \]

   \( E_{\text{p MAX}} = \) Maximum phase voltage (peak-to-peak)

   \( E_{\text{p MIN}} = \) Minimum phase voltage (peak-to-peak)

l. Remove the input power for one minute and then re-energize.

m. Repeat this test a total of three times to demonstrate consistency in
   performance.

n. Loss of Bypass: Remove the bypass line from the system input for 3
   minutes. Reconnect the bypass and record the time until the UPS system
   synchronizes to the bypass.

7. Heat Run:
   a. Operate the entire system continuously for 8 hours at full reactive load.
      Load banks and cabling shall be provided by the installing Contractor. For
      the first four hours operate with all modules on line. Immediately
thereafter, operate the system with each module off sequentially for three hours. Complete the heat run with all modules on line again. Perform step load transfers after heat run.

b. Record the system output voltage, current and frequency on each phase at one-hour time intervals to verify stability of the UPS output. Also monitor and record the room temperature throughout the heat run. Perform an infrared scan of each mechanical connection in the critical path 15 minutes after full load has been reached and every 30 minutes during the testing period. Record pictures of the initial scan and put into a report for future reference.

8. System Battery Tests: The objective of this test is to verify the compatibility of the batteries with the associated UPS system and to verify the full load operation of each module for the reserve time and cut off voltage specified.

a. Prior to the start of the test, the battery shall be floated at the required voltage for the time specified by the battery UPS supplier. Measure and record the resistance of all inter-cell and inter-tier connections using a Digital Low Resistance Ohmmeter. Measure and record the internal-cell resistance of all cells.

b. Each module shall be tested with a [675kW] <specify load> load that shall be maintained for a minimum of 15 minutes and to a DCUV (DC Under Voltage) trip at the cut off voltage of 1.67 volts/cell. Test shall be monitored with a battery monitoring system at the cell level. The module output voltage shall be recorded to verify compliance with the steady-state voltage regulation specified.

c. After all modules have been successfully load tested, recharge batteries of system for minimum of 3 hours (to 100% capacity), after which time perform system tests as specified.

d. The test shall be conducted with each UPS module at the specified load. Remove the AC input and record the time and measure and record voltage drop across each battery connection under full load. At thirty second intervals, record the DC voltage and current. Record the time in which the battery discharge related alarm occurs and conduct an infrared scan of the battery installation. Using the waveform recorder running at highest resolution, record the critical load voltage and one phase input current prior to and during the entire input fail. Continue to record without interruption for a minimum of five minutes to demonstrate the input walk-in current and the input current limit. These manual readings are required as well as automated data recording.

e. After successful completion of individual module testing, perform the following system tests at full load using a disturbance analyzer connected across system output.

1) Open utility input breaker, record output voltage and current during input failure when inverter input transfers from rectifier to battery.

2) Close utility input breaker, record output voltage and current during time when inverter input transfer from battery to rectifier.

3) Fail UPS system, critical load transfers to UPS static by-pass utility input, record voltage and current during time, load transfers between inverter output and utility.
4) Re-establish UPS system output, critical load transfers from UPS static bypass to UPS output, record voltage and current during time, load transfers between static switch and inverter output.

f. In order to test the Redundant/Non-redundant system feature, perform following tests with systems of [5 x 750KVA/675 kW operating module systems] <specify system configuration and edit below>, using a disturbance analyzer connected across system output, record output voltage and current:

1) With a load of [2700 kW], disable one module and [four (4)] remaining modules should power load without going to static bypass.
2) With a load of more than [2700 kW], disable one module, [four (4)] remaining modules cannot support load and load shall transfer to static bypass.
3) With a load of [1350 kW, disable three (3) modules, remaining two (2)] modules should power load without going to static bypass.
4) With a load of [2700 kW], system operates in ‘redundant’ fashion.

g. The batteries shall be recharged to 95% of full charge within 12 times the discharge time. Record every thirty (30) minutes the input and output voltage, current, kW, pf, frequency and the DC voltage and current until the recharge requirement is met.

h. Upon successful completion of the battery tests and after the batteries have a chance to reach their normal charge and temperature, take a full set of cell voltage readings, specific gravity and cell temperature readings.

i. After completion of discharge testing, re-torque connections varying by more than ±10% of average voltage.

j. After completion of installation and acceptance of system by the Owner, UPS supplier shall certify that installation is complete and in accordance with all of UPS suppliers requirements and the UPS supplier warrantee is in effect.

9. Synchronizing Circuit: The operation of the synchronizing circuits shall be demonstrated during the site acceptance-testing test.

10. Switchgear: UPS parallel output switchgear including all circuit breakers shall be tested as described herein prior to being connected to the UPS System:

a. Inspect for physical damage.

b. Compare equipment nameplate information with latest single line diagram and report discrepancies.

c. Inspect for proper alignment, anchorage and grounding.

d. Check tightness of accessible bolted bus joints by calibrated torque wrench method. Refer to manufacturer’s instructions for proper foot-pound levels.

e. Interlock systems shall be physically tested to ensure proper functions.

1) Closure attempt shall be made on locked open devices. Opening attempt shall be made on locked closed devices.

2) Key exchange shall be made with devices operated in off-normal positions.

f. All doors, panels and sections shall be inspected for paint, dents, scratches and fit.

g. Insulation Resistance Test:
1) Measure insulation resistance of each bus section phase-to-phase and phase-to-ground for one (1) minute.

h. Test Valves:
   1) Insulation resistance test to be performed in accordance with the following:

<table>
<thead>
<tr>
<th>Voltage Rating</th>
<th>Test Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>150-600V</td>
<td>1000V</td>
</tr>
<tr>
<td>601-5000V</td>
<td>2500V</td>
</tr>
<tr>
<td>5001 and above</td>
<td>5000V</td>
</tr>
</tbody>
</table>

2) Values of insulation resistance less than manufacturer’s minimum or 100 megohms should be investigated. Overpotential tests should not proceed until insulation resistance levels are raised to said minimum.

i. Circuit breaker draw-out mechanisms shall be inspected and adjusted as required for proper reliable operation. Each circuit breaker shall be racked in and out at least 5 times. All auxiliary switches shall be tested for proper and reliable operation. Circuit breakers shall be exchanged between cubicle without readjustment to assure a uniform standard of fit and adjustment.

j. Installed circuit breaker options shall be verified against those required by the shop drawings with a report given to the Owner of any deviations.

k. All circuit breakers shall be tested and calibrated by means of primary injection and secondary injection.

l. Circuit breakers shall be exercised at least 10 times to assure consistent mechanical and electrical operation of all functions.

m. Conduct visual and mechanical inspections and electrical testing of switchgear assemblies in accordance with current NET ATS specifications.

C. An integral power system test designed to demonstrate the operation of the UPS system in conjunction with the emergency generators shall also be conducted by the Contractor with the assistance of the UPS supplier. The test shall extend for at least four (4) hours and shall prove the following:

1. Compatibility between the UPS system and the generators, i.e. harmonics shall not influence voltage regulation and the UPS input filter shall not affect the generators.

2. Ability of the UPS system to synchronize the generator output.

3. Ability of the UPS system to transfer the load from UPS system to maintenance bypass and back while on generator power.

4. Ability of the UPS to limit battery recharge current while on generator power.

5. Infrared scanning of critical path mechanical connections shall be performed during integral power systems test.

3.3 DEMONSTRATION

A. The UPS supplier shall provide qualified field service personnel as required to supervise the site tests. The UPS supplier’s field service technicians shall provide all special instrumentations, including line disturbance analyzers, oscilloscopes and event recorders, required to perform the tests.
B. Engage a factory-authorized service representative to train Owner’s maintenance personnel to adjust, operate and maintain the UPS System

END OF SECTION
SECTION 263600 - TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SUMMARY
   A. This Section includes automatic transfer switches rated 600 V and less.

1.2 SUBMITTALS
   A. Product Data: Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.
   B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.
   C. Field quality-control test reports.
   D. Operation and maintenance data.

1.3 QUALITY ASSURANCE
   A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
   B. Comply with NEMA ICS 1.
   C. Comply with NFPA 70.
   D. Comply with NFPA 99.
   E. Comply with NFPA 110.
   F. Comply with UL 1008 unless requirements of these Specifications are stricter.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Contactor Transfer Switches:
   a. Emerson; ASCO Power Technologies, LP.
   b. GE Zenith Controls.
   c. Russelectric, Inc.

2. Transfer Switches Using Molded-Case Switches or Circuit Breakers:
   b. GE Zenith Controls.
   c. Hubbell Industrial Controls, Inc.

2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.

B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.

C. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

D. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

E. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.

F. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.
2. Switch Action: Double throw; mechanically held in both directions.
3. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.
G. Neutral Switching. Where four-pole switches are indicated, provide [neutral pole switched simultaneously with phase poles] [overlapping neutral contacts].

H. Neutral Terminal: Solid and fully rated, unless otherwise indicated.

I. Oversize Neutral: Ampacity and switch rating of neutral path through units indicated for oversize neutral shall be double the nominal rating of circuit in which switch is installed.

J. Battery Charger: For generator starting batteries.
   2. Ammeter to display charging current.
   3. Fused ac inputs and dc outputs.

K. Enclosures: General-purpose NEMA 250, Type [1] [3R] [12], complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.3 AUTOMATIC TRANSFER SWITCHES

A. Comply with Level 1 equipment according to NFPA 110.

B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.

C. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.

D. Transfer Switches Based on Molded-Case-Switch Components: Comply with NEMA AB 1, UL 489, and UL 869A.

E. In-Phase Monitor: Factory-wired, internal relay controls transfer so it occurs only when the two sources are synchronized in phase.

F. Motor Disconnect and Timing Relay: Controls designate starters so they disconnect motors before transfer and reconnect them selectively at an adjustable time interval after transfer. Time delay for reconnecting individual motor loads is adjustable between 1 and 60 seconds, and settings are as indicated.

G. Programmed Neutral Switch Position: Switch operator has a programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer.

H. Automatic Transfer-Switch Features:
   1. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to
100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.

2. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.

3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.

4. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.

5. Test Switch: Simulate normal-source failure.

6. Switch-Position Pilot Lights: Indicate source to which load is connected.

   a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."

8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.

9. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.

10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.

11. Engine Shutdown Contacts: Instantaneous; shall initiate shutdown sequence at remote engine-generator controls after retransfer of load to normal source.

12. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.

13. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
   a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
   b. Push-button programming control with digital display of settings.
   c. Integral battery operation of time switch when normal control power is not available.
2.4 SOURCE QUALITY CONTROL

A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Floor-Mounting Switch: Anchor to floor by bolting.

1. Concrete Bases: 4 inches high, reinforced, with chamfered edges. Extend base no more than 4 inches in all directions beyond the maximum dimensions of switch, unless otherwise indicated or unless required for seismic support. Construct concrete bases according to Division 16 Section "Electrical Supports and Seismic Restraints."

B. Identify components according to Division 16 Section "Electrical Identification."

C. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

3.2 CONNECTIONS

A. Ground equipment according to Division 16 Section "Grounding and Bonding."

B. Connect wiring according to Division 16 Section "Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installation, including connections, and to assist in testing.

2. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.

   a. Check for electrical continuity of circuits and for short circuits.
   b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
   c. Verify that manual transfer warnings are properly placed.
   d. Perform manual transfer operation.

5. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
   a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
   b. Simulate loss of phase-to-ground voltage for each phase of normal source.
   c. Verify time-delay settings.
   d. Verify pickup and dropout voltages by data readout or inspection of control settings.
   e. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.
   f. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

   a. Verify grounding connections and locations and ratings of sensors.

C. Coordinate tests with tests of generator and run them concurrently.

D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

E. Remove and replace malfunctioning units and retest as specified above.

F. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.
   1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.
   2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Division 1 Section "Demonstration and Training."

B. Coordinate this training with that for generator equipment.

END OF SECTION
SECTION 264313 - TRANSIENT VOLTAGE SUPPRESSION

PART 1 - GENERAL

1.1 SUMMARY
A. This Section includes TVSSs for low-voltage power equipment.

1.2 SUBMITTALS
A. Product Data: For each type of product indicated. Include rated capacities, operating weights, operating characteristics, furnished specialties, and accessories.
B. Field quality-control test reports.
C. Operation and Maintenance Data.

1.3 QUALITY ASSURANCE
A. Source Limitations: Obtain suppression devices and accessories through one source from a single manufacturer.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
D. Comply with NEMA LS 1, "Low Voltage Surge Protection Devices."
E. Comply with UL 1283, "Electromagnetic Interference Filters," and UL 1449, "Transient Voltage Surge Suppressors."

1.4 PROJECT CONDITIONS
A. Service Conditions: Rate surge protection devices for continuous operation under the following conditions, unless otherwise indicated:
   1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.
   2. Operating Temperature: 30 to 120 deg F.
   3. Humidity: 0 to 85 percent, noncondensing.
   4. Altitude: Less than 20,000 feet above sea level.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Advanced Protection Technologies, Inc.
2. Current Technology, Inc.
3. Square D; Schneider Electric.

2.2 SERVICE ENTRANCE SUPPRESSORS

A. Surge Protection Device Description: Non-modular, sine-wave-tracking type with the following features and accessories:

1. LED indicator lights for power and protection status.
2. Audible alarm, with silencing switch, to indicate when protection has failed.
3. Fuses, rated at 200-kA interrupting capacity.
4. Integral disconnect switch.
5. Redundant suppression circuits.
6. Surge-event operations counter.

B. Peak Single-Impulse Surge Current Rating: [320] [240] [160] kA per phase.

C. Connection Means: Permanently wired.

D. Protection modes and UL 1449 suppressed voltage rating for grounded wye circuits with voltages of [480Y/277] [208Y/120], 3-phase, 4-wire circuits shall be as follows:

1. Line to Neutral: [800 V for 480Y/277] [400 V for 208Y/120].
2. Line to Ground: [800 V for 480Y/277] [400 V for 208Y/120].
3. Neutral to Ground: [800 V for 480Y/277] [400 V for 208Y/120].

E. Protection modes and UL 1449 suppressed voltage rating for 240/120-V, single-phase, 3-wire circuits shall be as follows:

1. Line to Neutral: 400 V.
2. Line to Ground: 400 V.
3. Neutral to Ground: 400 V.

F. Protection modes and UL 1449 suppressed voltage rating for 240/120-V, 3-phase, 4-wire circuits with high leg shall be as follows:

1. Line to Neutral: 400 V, 800 V from high leg.
2. Line to Ground: 400 V.
3. Neutral to Ground: 400 V.

G. Protection modes and UL 1449 suppressed voltage rating for voltages of 240 or 480, 3-phase, 3-wire, delta circuits shall be as follows:
1. Line to Line: [2000 V for 480 V] [1000 V for 240 V].
2. Line to Ground: [2000 V for 480 V] [1000 V for 240 V].

2.3 PANELBOARD SUPPRESSORS

A. Surge Protection Device Description: Non-modular, sine-wave-tracking type with the following features and accessories:
   1. LED indicator lights for power and protection status.
   2. Audible alarm, with silencing switch, to indicate when protection has failed.
   3. Fuses, rated at 200-kA interrupting capacity.
   4. Integral disconnect switch.
   5. Redundant suppression circuits.
   6. Surge-event operations counter.

B. Peak Single-Impulse Surge Current Rating: [160] [120] [80] kA per phase.

C. Protection modes and UL 1449 suppressed voltage rating for grounded wye circuits with voltages of [480Y/277] [208Y/120], 3-phase, 4-wire circuits shall be as follows:
   1. Line to Neutral: [800 V for 480Y/277] [400 V for 208Y/120].
   2. Line to Ground: [800 V for 480Y/277] [400 V for 208Y/120].
   3. Neutral to Ground: [800 V for 480Y/277] [400 V for 208Y/120].

D. Protection modes and UL 1449 suppressed voltage rating for 240/120-V, single-phase, 3-wire circuits shall be as follows:
   1. Line to Neutral: 400 V.
   2. Line to Ground: 400 V.
   3. Neutral to Ground: 400 V.

E. Protection modes and UL 1449 suppressed voltage rating for 240/120-V, 3-phase, 4-wire circuits with high leg shall be as follows:
   1. Line to Neutral: 400 V, 800 V from high leg.
   2. Line to Ground: 400 V.
   3. Neutral to Ground: 400 V.

F. Protection modes and UL 1449 suppressed voltage rating for voltages of 240 or 480, 3-phase, 3-wire, delta circuits shall be as follows:
   1. Line to Line: [2000 V for 480 V] [1000 V for 240 V].
   2. Line to Ground: [1500 V for 480 V] [800 V for 240 V].

2.4 SUPPRESSORS FOR ELECTRONIC-GRADE PANELBOARDS

A. Surge Protection Device Description: Sine-wave-tracking type, panel-mounted design with the following features and accessories:
   1. LED indicator lights for power and protection status.
   2. Audible alarm, with silencing switch, to indicate when protection has failed.
3. Arrangement with wire connections to phase buses, neutral bus, and ground bus.

B. Peak Single-Impulse Surge Current Rating: \([160][120][80]\) kA per phase.

C. Protection modes and UL 1449 suppressed voltage rating for grounded wye circuits with voltages of \([480\text{Y/277}][208\text{Y/120}]\), 3-phase, 4-wire circuits shall be as follows:

1. Line to Neutral: \([800\text{ V for } 480\text{Y/277}][400\text{ V for } 208\text{Y/120}]\).
2. Line to Ground: \([800\text{ V for } 480\text{Y/277}][400\text{ V for } 208\text{Y/120}]\).
3. Neutral to Ground: \([800\text{ V for } 480\text{Y/277}][400\text{ V for } 208\text{Y/120}]\).

D. Protection modes and UL 1449 suppressed voltage rating for 240/120-V, single-phase, 3-wire circuits shall be as follows:

1. Line to Neutral: 400 V.
2. Line to Ground: 400 V.
3. Neutral to Ground: 400 V.

E. Protection modes and UL 1449 suppressed voltage rating for 240/120-V, 3-phase, 4-wire circuits with high leg shall be as follows:

1. Line to Neutral: 400 V, 800 V from high leg.
2. Line to Ground: 400 V.
3. Neutral to Ground: 400 V.

F. Protection modes and UL 1449 suppressed voltage rating for voltages of 240, 480, or 600, 3-phase, 3-wire, delta circuits shall be as follows:

1. Line to Line: \([2000\text{ V for } 480\text{V}][1000\text{ V for } 240\text{V}]\).
2. Line to Ground: \([1500\text{ V for } 480\text{V}][800\text{ V for } 240\text{V}]\).

2.5 ENCLOSURES

A. NEMA 250, with type matching the enclosure of panel or device being protected.

PART 3 - EXECUTION

3.1 INSTALLATION OF SURGE PROTECTION DEVICES

A. Install devices at service entrance on load side, with ground lead bonded to service entrance ground.

B. Install devices for panelboard and auxiliary panels with conductors or buses between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

1. Provide multipole, \([30][60][100]\)-A circuit breaker as a dedicated disconnect for suppressor, unless otherwise indicated.
3.2 PLACING SYSTEM INTO SERVICE
   A. Do not energize or connect [service entrance equipment] [panelboards] [control terminals] [data terminals] to their sources until surge protection devices are installed and connected.

3.3 FIELD QUALITY CONTROL
   A. Testing: [Owner will engage] [Engage] a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports:

   B. Testing: Perform the following field tests and inspections and prepare test reports:
      1. Complete startup checks according to manufacturer's written instructions.
      2. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, "Surge Arresters, Low-Voltage Surge Protection Devices" Section. Certify compliance with test parameters.

   END OF SECTION
SECTION 265100 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Interior lighting fixtures, lamps, and ballasts.
2. Emergency lighting units.
3. Exit signs.
4. Lighting fixture supports.
5. Retrofit kits for fluorescent lighting fixtures.

1.2 SUBMITTALS

A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, and finishes.

B. Shop Drawings: Show details of nonstandard or custom lighting fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, from manufacturer.

C. Field quality-control reports.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide product indicated on Drawings.

2.2 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
B. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.

C. HID Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5B.

D. Metal Parts: Free of burrs and sharp corners and edges.

E. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.

F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

G. Diffusers and Globes:
1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
2. Glass: Annealed crystal glass unless otherwise indicated.

H. Air-Handling Fluorescent Fixtures: For use with plenum ceiling for air return and heat extraction and for attaching an air-diffuser-boot assembly specified in Section 233713 "Diffusers, Registers, and Grilles."

2.3 BALLASTS FOR LINEAR FLUORESCENT LAMPS

A. General Requirements for Electronic Ballasts:
1. Comply with UL 935 and with ANSI C82.11.
2. Designed for type and quantity of lamps served.
3. Ballasts shall be designed for full light output unless another BF, dimmer, or bi-level control is indicated.
4. Sound Rating: Class A
5. Total Harmonic Distortion Rating: Less than 20 percent.
6. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
7. Operating Frequency: 42 kHz or higher.
8. Lamp Current Crest Factor: 1.7 or less.
9. BF: 0.88 or higher.
10. Power Factor: [0.95] [0.98] or higher.

B. Luminaires controlled by occupancy sensors shall have programmed-start ballasts.

C. Electromagnetic Ballasts: Comply with ANSI C82.1; energy saving, high-power factor, Class P, and having automatic-reset thermal protection.

D. Single Ballasts for Multiple Lighting Fixtures: Factory wired with ballast arrangements and bundled extension wiring to suit final installation conditions without modification or rewiring in the field.
E. Ballasts for Dimmer-Controlled Lighting Fixtures: Electronic type.
   1. Dimming Range: 100 to 5 percent of rated lamp lumens.
   2. Ballast Input Watts: Can be reduced to 20 percent of normal.
   3. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated.
   4. Control: Coordinate wiring from ballast to control device to ensure that the ballast, controller, and connecting wiring are compatible.

F. Ballasts for Bi-Level Controlled Lighting Fixtures: Electronic type.
   1. Operating Modes: Ballast circuit and leads provide for remote control of the light output of the associated lamp between high- and low-level and off.
      a. High-Level Operation: 100 percent of rated lamp lumens.
      b. Low-Level Operation: 30 percent of rated lamp lumens.
   2. Ballast shall provide equal current to each lamp in each operating mode.
   3. Compatibility: Certified by manufacturer for use with specific bi-level control system and lamp type indicated.

2.4 BALLASTS FOR COMPACT FLUORESCENT LAMPS

A. Description: Electronic-programmed rapid-start type, complying with UL 935 and with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated:
   1. Lamp end-of-life detection and shutdown circuit.
   2. Automatic lamp starting after lamp replacement.
   3. Sound Rating: Class A.
   4. Total Harmonic Distortion Rating: Less than 20 percent.
   5. Transient Voltage Protection: IEEE C62.41.1 and .2, Category A or better.
   6. Operating Frequency: 20 kHz or higher.
   7. Lamp Current Crest Factor: 1.7 or less.
   8. BF: 0.95 or higher unless otherwise indicated.
   9. Power Factor: 0.95 or higher.
   10. Interference: Comply with 47 CFR 18, Ch. 1, Subpart C.

2.5 EMERGENCY FLUORESCENT POWER UNIT

A. Internal Type: Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture body and compatible with ballast. Comply with UL 924.
   1. Emergency Connection: Operate one fluorescent lamp continuously at an output of 1100 lumens each. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
   2. Nightlight Connection: Operate one fluorescent lamp continuously.
   3. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.
      a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
      b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
5. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
6. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.6 BALLASTS FOR HID LAMPS

A. Electromagnetic Ballast for Metal-Halide Lamps: Comply with ANSI C82.4 and UL 1029. Include the following features unless otherwise indicated:
   1. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.
   2. Rated Ambient Operating Temperature: 104 deg F.
   3. Open-circuit operation that will not reduce average life.
   4. Low-Noise Ballasts: Manufacturers’ standard epoxy-encapsulated models designed to minimize audible fixture noise.

B. High-Pressure Sodium Ballasts: Electromagnetic type, with solid-state igniter/starter. Igniter/starter shall have an average life in pulsing mode of 10,000 hours at an igniter/starter-case temperature of 90 deg C.
   1. Instant-Restrike Device: Integral with ballast, or solid-state potted module, factory installed within fixture and compatible with lamps, ballasts, and mogul sockets up to 150 W.
   2. Minimum Starting Temperature: Minus 40 deg F.

2.7 EXIT SIGNS

A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:
   1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.
   2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
      a. Battery: Sealed, maintenance-free, nickel-cadmium type.
      b. Charger: Fully automatic, solid-state type with sealed transfer relay.
      c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
      d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
      e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
2.8 EMERGENCY LIGHTING UNITS

A. General Requirements for Emergency Lighting Units: Self-contained units complying with UL 924.
   1. Battery: Sealed, maintenance-free, lead-acid type.
   2. Charger: Fully automatic, solid-state type with sealed transfer relay.
   3. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
   4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
   5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

2.9 FLUORESCENT LAMPS

A. T8 rapid-start lamps, rated 32 W maximum, nominal length of 48 inches, 2800 initial lumens (minimum), CRI 85 (minimum), color temperature 3500 K, and average rated life 20,000 hours unless otherwise indicated.

B. T5 rapid-start lamps, rated 28 W maximum, nominal length of 45.8 inches, 2900 initial lumens (minimum), CRI 85 (minimum), color temperature 3500 K, and average rated life 20,000 hours unless otherwise indicated.

C. T5HO rapid-start lamps, rated 54 W maximum, length of 45.8 inches, 5000 initial lumens (minimum), CRI 85 (minimum), color temperature 3500, and average rated life of 20,000 hours unless otherwise indicated.

D. Compact Fluorescent Lamps: 4-Pin, CRI 80 (minimum), color temperature 3500 K, average rated life of 10,000 hours at three hours operation per start, [and suitable for use with dimming ballasts] unless otherwise indicated.
   1. 13 W: T4, double or triple tube, rated 900 initial lumens (minimum).
   2. 18 W: T4, double or triple tube, rated 1200 initial lumens (minimum).
   3. 26 W: T4, double or triple tube, rated 1800 initial lumens (minimum).
   4. 32 W: T4, triple tube, rated 2400 initial lumens (minimum).
   5. 42 W: T4, triple tube, rated 3200 initial lumens (minimum).
   6. 57 W: T4, triple tube, rated 4300 initial lumens (minimum).
   7. 70 W: T4, triple tube, rated 5200 initial lumens (minimum).

2.10 HID LAMPS

A. Pulse-Start, Metal-Halide Lamps: Minimum CRI 65, and color temperature 4000 K.

B. Ceramic, Pulse-Start, Metal-Halide Lamps: Minimum CRI 80, and color temperature 4000 K.

C. Low-Pressure Sodium Lamps: ANSI 78.41, CRI 0, and color temperature 1800 K.
2.11 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with Section 260529 "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.


E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage.

F. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

2.12 RETROFIT KITS FOR FLUORESCENT LIGHTING FIXTURES

A. Ballast and Lamp Change Kit: UL 1598, Type II. Suitable for changing existing ballast, lamps, and sockets.

PART 3 - EXECUTION

3.1 OFFICE ENVIRONMENTS

A. Provide direct/indirect fixtures or indirect fixtures to reduce glare.

B. T5HO lamps maybe used in indirect or direct/indirect pendant fixtures.

3.2 WAREHOUSE, MANUFACTURING, AND OTHER “HIGH-BAY” APPLICATIONS

A. Use T5HO lamps in locations where heights will be 15-40 feet above surfaces to be illuminated.

B. Choose fixtures and lamps such that glare is not an issue.

3.3 INSTALLATION

A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.

B. Comply with NFPA 70 for minimum fixture supports.
C. Suspended Lighting Fixture Support:
   1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
   3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.

D. Air-Handling Lighting Fixtures: Install with dampers closed and ready for adjustment.

E. Adjust aimable lighting fixtures to provide required light intensities.

F. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION
SECTION 265600 - EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Exterior luminaires with lamps and ballasts.
   2. Luminaire-mounted photoelectric relays.
   3. Poles and accessories.

B. See Division 16 Section "Interior Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings.

1.2 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

A. Dead Load: Weight of luminaire and its horizontal and vertical supports and supporting structure, applied as stated in AASHTO LTS-4.

B. Ice Load: Load of 3 lb/sq. ft., applied as stated in AASHTO LTS-4.

C. Wind Load: Pressure of wind on pole and luminaire, calculated and applied as stated in AASHTO LTS-4.
   1. Wind speed for calculating wind load for poles exceeding 50 feet in height is 90 mph.
   2. Wind speed for calculating wind load for poles 50 feet or less in height is 90 mph.

1.3 SUBMITTALS

A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, and finishes.

B. Shop Drawings: Include anchor-bolt templates keyed to specific poles and certified by manufacturer.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In Exterior Lighting Device Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:

1. Basis of Design Product: The design of each item of exterior luminaire and its support is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified.

2.2 LUMINAIRES, GENERAL REQUIREMENTS

A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.

B. Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.

C. Metal Parts: Free of burrs and sharp corners and edges.

D. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.

E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.

G. Exposed Hardware Material: Stainless steel.

H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.

J. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.

K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

L. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.


N. Factory-Applied Finish for Aluminum Luminaires: Color shall be [light bronze] [medium bronze] [dark bronze] [black]. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

2.3 LUMINAIRE-MOUNTED PHOTOELECTRIC RELAYS

A. Comply with UL 773 or UL 773A.

B. Contact Relays: Factory mounted, single throw, designed to fail in the on position, and factory set to turn light unit on at 1.5 to 3 fc and off at 4.5 to 10 fc with 15-second minimum time delay.[ Relay shall have directional lens in front of photocell to prevent artificial light sources from causing false turnoff.]

1. Relay with locking-type receptacle shall comply with NEMA C136.10.
2. Adjustable window slide for adjusting on-off set points.

2.4 FLUORESCENT BALLASTS AND LAMPS

A. Low-Temperature Ballast Capability: Rated by its manufacturer for reliable starting and operation of indicated lamp(s) at temperatures 0 deg F and higher.

B. Ballast Characteristics:

1. Power Factor: 90 percent, minimum.
2. Sound Rating: A.
3. Total Harmonic Distortion Rating: Less than 20 percent.
6. Transient-Voltage Protection: Comply with IEEE C62.41 Category A or better.
C. Low-Temperature Lamp Capability: Rated for reliable starting and operation with ballast provided at temperatures 0 deg F and higher.

D. Fluorescent Lamps: Low-mercury type. Comply with the EPA’s toxicity characteristic leaching procedure test; shall yield less than 0.2 mg of mercury per liter when tested according to NEMA LL 1.

2.5 BALLASTS FOR HID LAMPS

A. Comply with ANSI C82.4 and UL 1029 and capable of open-circuit operation without reduction average life. Include the following features, unless otherwise indicated:

1. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.
2. Normal Ambient Operating Temperature: 104 deg F.
3. Ballast Fuses: One in each ungrounded power supply conductor. Voltage and current ratings as recommended by ballast manufacturer.

B. High-Pressure Sodium Ballasts: Electromagnetic type with solid-state igniter/starter and capable of open-circuit operation without reduction of average lamp life. Igniter/starter shall have an average life in pulsing mode of 10,000 hours at an igniter/starter-case temperature of 90 deg C.

1. Instant-Restrike Device: Integral with ballast, or solid-state potted module, factory installed within fixture and compatible with lamps, ballasts, and mogul sockets up to 150 W.
   a. Restrike Range: 105- to 130-V ac.
   b. Maximum Voltage: 250-V peak or 150-V ac RMS.

2.6 HID LAMPS

A. High-Pressure Sodium Lamps: ANSI C78.42, CRI 21 (minimum), color temperature [1900] <Insert value> K, and average rated life of 24,000 hours, minimum.

B. Metal-Halide Lamps: ANSI C78.1372, with a minimum CRI 65, and color temperature 4000 K.

C. Pulse-Start, Metal-Halide Lamps: Minimum CRI 65, and color temperature 4000 K.

D. Ceramic, Pulse-Start, Metal-Halide Lamps: Minimum CRI 80, and color temperature 4000 K.

2.7 POLES AND SUPPORT COMPONENTS, GENERAL REQUIREMENTS

A. Structural Characteristics: Comply with AASHTO LTS-4.
1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in Part 1 "Structural Analysis Criteria for Pole Selection" Article, with a gust factor of 1.3.

2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts, unless otherwise indicated.

C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.

1. Materials: Shall not cause galvanic action at contact points.
2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication, unless stainless-steel items are indicated.
3. Anchor-Bolt Template: Plywood or steel.

D. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 3 Section "Cast-in-Place Concrete."

E. Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123M; and with top-plate and mounting bolts to match pole base flange and strength required to support pole, luminaire, and accessories.

F. Breakaway Supports: Frangible breakaway supports, tested by an independent testing agency acceptable to authorities having jurisdiction, according to AASHTO LTS-4.

2.8 STEEL POLES

A. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig; 1-piece construction up to 40 feet in height with access handhole in pole wall.

1. Shape: [Round, tapered] [Round, straight] [Square, tapered] [Square, straight].
2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

B. Steel Mast Arms: [Single-arm] [Truss] [Davit] type, continuously welded to pole attachment plate. Material and finish same as pole.

C. Brackets for Luminaires: Detachable, cantilever, without underbrace.
1. Adapter fitting welded to pole and bracket, then bolted together with [stainless] [galvanized]-steel bolts.

2. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire. 

3. Match pole material and finish.

D. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

E. Steps: Fixed steel, with nonslip treads, positioned for 15-inch vertical spacing, alternating on opposite sides of pole; first step at elevation 10 feet above finished grade.

F. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Division 16 Section "Grounding and Bonding," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

G. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported cable times a 5.0 safety factor.

H. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.

I. Galvanized Finish: After fabrication, hot-dip galvanize complying with ASTM A 123/A 123M.

J. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Color shall be as selected by Architect.

2.9 ALUMINUM POLES

A. Poles: Seamless, extruded structural tube complying with ASTM B 429, Alloy 6063-T6 with access handhole in pole wall.

B. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

C. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Division 16 Section "Grounding and Bonding," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

D. Brackets for Luminaires: Detachable, with pole and adapter fittings of cast aluminum. Adapter fitting welded to pole and bracket, then bolted together with stainless-steel bolts.
1. Tapered oval cross section, with straight tubular end section to accommodate luminaire.
2. Finish: Same as luminaire.

E. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.

F. Aluminum Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Color shall be as selected by Architect from manufacturer's full range.

2.10 POLE ACCESSORIES

A. Duplex Receptacle: 120 V, 20 A in a weatherproof assembly complying with Division 16 Section "Wiring Devices" for ground-fault circuit-interrupter type.

1. [Surface mounted] [Recessed], [12 inches] <Insert other mounting height> above finished grade.
2. Nonmetallic polycarbonate plastic or reinforced fiberglass cover, <Insert color to match pole>, that when mounted results in NEMA 250, Type [3R] [4X] enclosure.
3. With cord opening.
4. With lockable hasp and latch that complies with OSHA lockout and tag-out requirements.

B. Minimum 1800-W transformer, protected by replaceable fuses, mounted behind access cover.

C. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.

D. Transformer Type Base: Same material and color as pole. Coordinate dimensions to suit pole's base flange and accept [ballast(s)] [indicated accessories].

PART 3 - EXECUTION

3.1 LUMINAIRE INSTALLATION

A. Install lamps in each luminaire.

B. Fasten luminaire to indicated structural supports.

C. Adjust luminaires that require field adjustment or aiming.[Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources.]
3.2 POLE INSTALLATION

A. Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.

B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features, unless otherwise indicated on Drawings:

1. Fire Hydrants and Storm Drainage Piping: [60 inches] <Insert dimension>.
3. Trees: [15 feet] <Insert dimension>.
4. <Insert features and clearance dimensions.>

C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 3 Section "Cast-in-Place Concrete."

D. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.

1. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
2. Install base covers, unless otherwise indicated.
3. Use a short piece of 1/2-inch- diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

E. Embedded Poles with Tamped Earth Backfill: Set poles to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.

1. Dig holes large enough to permit use of tampers in the full depth of hole.
2. Backfill in 6-inch layers and thoroughly tamp each layer so compaction of backfill is equal to or greater than that of undisturbed earth.

F. Embedded Poles with Concrete Backfill: Set poles in augered holes to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.

1. Make holes 6 inches in diameter larger than pole diameter.
2. Fill augered hole around pole with air-entrained concrete having a minimum compressive strength of 3000 psi at 28 days, and finish in a dome above finished grade.
3. Use a short piece of 1/2-inch- diameter pipe to make a drain hole through concrete dome. Arrange to drain condensation from interior of pole.
4. Cure concrete a minimum of 72 hours before performing work on pole.

G. Raise and set poles using web fabric slings (not chain or cable).
3.3 BOLLARD LUMINAIRE INSTALLATION

A. Align units for optimum directional alignment of light distribution.

B. Install on concrete base with top [4 inches] <Insert height> above finished grade or surface at bollard location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 3 Section "Cast-in-Place Concrete."

3.4 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRAES

A. Install on concrete base with top [4 inches] <Insert height> above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 3 Section "Cast-in-Place Concrete."

3.5 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Division 16 Section "Raceways and Boxes." In concrete foundations, wrap conduit with 0.010-inch-thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.6 GROUNDING

A. Ground metal poles and support structures according to Division 16 Section "Grounding and Bonding."

1. Install grounding electrode for each pole, unless otherwise indicated.
2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

B. Ground nonmetallic poles and support structures according to Division 16 Section "Grounding and Bonding."

1. Install grounding electrode for each pole.
2. Install grounding conductor and conductor protector.
3. Ground metallic components of pole accessories and foundations.

END OF SECTION
1.1 SUMMARY

A. Types of data/communication cable systems specified in this section include the following:
   1. Fiber-optic cable systems.
   2. Voice communication cable system.
   3. Data communication cable system.
   4. CATV communication cable system.
   5. Associated conduit raceway distribution and equipment rack/cabinet system.

B. The Contractor shall furnish, install and test cable and conduit support system, fiber-optic, voice, data and CATV cables, associated connectors, patch panels, equipment racks, grounding system, patch cords, etc., as indicated on the drawings and in these specifications.

C. The Contractor shall include all work shown on the drawings and in the specifications. The drawings and specifications are intended to agree with each other. Any discrepancies shall be brought to the attention of the Engineer for correction. No omission from any drawing shall release the Contractor from furnishing equipment, materials or services required by these documents.

D. The Contractor, the cable manufacturer, the connectivity manufacturer and the distributor shall collaborate and work in partnership with one another so as to provide the Owner with UL or ETL independently verified cabling installation that is guaranteed to perform at levels above and beyond the EIA/TIA 568B.1 Standards, as per the minimum acceptable full channel performance specification contained herein. The partnership shall make available optional UL or ETL independent testing and verification of the completed installation. The partnership shall provide full written certification of the installation to the Owner upon completion.

E. Any deviation, alteration or substitution from the drawings and specifications shall be fully documented by the Contractor and submitted as a voluntary alternate to the base bid. Approval of requests for substitution of products, processes or procedures other than those specified shall be contingent upon submission of fully acceptable documentation to the Engineer.

F. The Contractor shall also be responsible for protecting any and all equipment and materials from damage during his installation process. Any equipment, material and/or facilities damaged by the Contractor during, due to, or in the performance of his contract, shall be replaced or repaired at the expense of the Contractor, as directed by the Engineer.

1.2 QUALITY CONTROL

A. Manufacturer Qualifications: Firms regularly engaged in manufacture of communication cabling system equipment whose products have been in satisfactory use in similar service for not less than five years.

B. Installer Qualifications:
1. Installers shall be fully capable and experienced in communication cabling system specified. This Contractor and all subcontractors engaged in this communication cabling installation shall have experience in this business for not less than five years and shall have successfully completed a minimum of five projects of similar size.

2. The Contractor shall specify, in his bid, all subcontractors who shall be utilized in this project. Subcontractors’ company name, contact and responsibilities shall be listed.

3. The Contractor shall employ a Registered Communication Distribution Designer (RCDD) who shall be responsible to the Engineer, Architect and Owner for all work performed by the Contractor and his subcontractors. The RCDD shall have the authority of the Contractor to make immediate decisions regarding implementation of changes to the project as directed by the Engineer or Architect.

4. If, in the opinion of the Engineer, Architect or Owner, the RCDD does not possess or demonstrate adequate qualifications to support the project, the Owner reserves the right to require the Contractor to assign an RCDD who, in the Owner’s opinion, possesses the skill necessary to complete the project.

1.3 ON-SITE SUPERVISOR

A. The Supervisor shall provide reports to the RCDD, Engineer, Architect and Owner for quality of installation and compliance with these documents.

B. The Supervisor shall be a manufacturer certified and a BICSI registered cabling installation technician, NJATC installer technician, BICSI RCDD or Engineer-approved equal and have a minimum of two years experience.

C. The Supervisor shall maintain all documentation in accordance with these specifications.

D. Journeymen and Apprentices performing work under this specification shall be enrolled in or have completed the BICSI, registered cabling installation technician, NJATC installer technician, or Engineer-approved equal course.

1.4 ALTERNATE MATERIALS AND EQUIPMENT

A. Refer to Division 1 for description of alternate material and equipment.

B. Refer to Division 1 for substitution request requirements.

1.5 SHOP DRAWINGS

A. Submit all shop drawings and data in accordance with Division 1. The complete communication shop drawings shall all be bound in one hardcover, 3-ring binder indexed to this Division.

B. Manufacturers' data and dimension sheets shall be submitted, giving all pertinent physical and engineering data including weights, cross-sections and maintenance instructions. Standard items of equipment such as receptacles, switches, plates, etc., which are cataloged items, shall be listed by manufacturer.

C. Index all submittals and reference to these specifications.
1.6 EQUIPMENT PURCHASES

A. All materials and equipment shall be ordered in ample quantities for delivery at the proper time. If items are not on the project in time to expedite completion, the Owner may purchase said equipment and materials and deduct the cost from the Contract Sum.

B. Provide all materials of similar class or service by one manufacturer.

1.7 WORK AND MATERIALS

A. All electrical materials and equipment shall be new and of the type and quality specified, and shall be listed by UL and bear their label where standards have been established, in compliance with the applicable standards of NEC (NFPA 70), NFPA, ANSI, IEEE, IPCEA and NEMA. Replace or repair any nonconforming, damaged, or defective items at no extra cost to the Owner.

B. Perform all labor in a thorough and workman like manner, to the satisfaction of the Architect. The Contractor shall staff the project with sufficient skilled workmen, including a fully qualified superintendent Project Manager, to complete the work in the time allotted. The Project Manager shall be qualified to supervise all of the work of this Division.

C. Materials provided under the contract for which the UL label is not normally available shall be mounted in separate enclosures and wired to the labeled units in an acceptable manner.

1.8 COOPERATIVE WORK

A. Cooperative work includes:

1. General supervision and responsibility for proper location and size of work related to this Division, but provided under other sections of these specifications.

2. Installation of sleeves, inserts, and anchor bolts for work under each section in this Division.

B. Correct without charge any work requiring alteration due to lack of proper supervision or failure to make proper provision in time. Correct without charge any damage to adjacent work caused by the alteration.

END OF SECTION 270513
SECTION 270526 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. This section outlines the requirements of the telecommunication grounding work.

1.2 RELATED DOCUMENTS

A. Division 16 shall apply to work of this section.

B. Division 16 grounding shall apply in conjunction with this section, for a complete system.

1.3 DEFINITIONS

A. Manufacturers: Firms regularly engaged in the manufacture of electrical connectors, terminals and fittings, of types and ratings required, and ancillary grounding materials including stranded cable, copper braid and bus, ground rods and plate electrodes, whose products have been in satisfactory use in similar service for not less than three years.

B. NEC Compliance: Comply with NEC requirements as applicable to materials and installation of data/telecommunication grounding systems, associated equipment and wiring. Provide grounding products which are UL listed and labeled.

C. UL Compliance: Comply with applicable requirements of UL Standard Numbers 467 and 869, pertaining to data/telecommunication grounding and bonding.

D. TIA/EIA Compliance: Comply with TIA/EIA-607 Standards and the BICSI Telecommunications Distribution Methods Manual (TDMM) for the installation of data/telecommunication grounding and bonding systems.

1.4 SUBMITTALS

A. Submit all shop drawings and data in accordance with Division 1.

B. Provide submittal for Ground Bus Bar.

C. Provide submittal for #6 Ground/Bond Wire and Connectors.

PART 2 PRODUCTS

2.1 TELECOMMUNICATION GROUNDING SYSTEM

A. Provide a low impedance telecommunication grounding system with a stable ±0 volt to ground signal reference point for communication system equipment and infrastructures.

B. Telecommunication bonding backbone (TBB) shall be sized per NEC Table 250-66 (based on largest service entrance conductor or equivalent area for parallel conductors), minimum of a #2 AWG copper conductor.
C. All bonding conductors shall be minimum #6 AWG, insulated (green jacket), stranded copper.

D. In multi-story buildings requiring two or more vertical TBB's, the TBB's shall be bonded together at the top and bottom floors, with a minimum of every third floor when the building exceeds four floors.

E. System connections shall be irreversible compression-type connectors or exothermic welding with bronze bolt, star washer and nut connection hardware.

F. Zinc-clad or nickel-plated steel hardware is not acceptable.

G. Set screw, box lug, and split-bolt connectors are not acceptable.

H. Where required by local code, the data/telecommunication grounding system backbone cable conductor shall be a bare stranded copper conductor in lieu of an insulated conductor when installed in open cable trays and/or exposed in a return air plenum space or riser rated space. The Contractor shall verify requirements and coordinate with the Engineer.

I. Two-hole compression lugs shall be utilized for backbone cable terminations of #2 AWG and larger. One-hole compression lugs may be utilized for cable terminations of #6 AWG up to #2 AWG.

PART 3 EXECUTION

3.1 INSTALLATION

A. Bonding and grounding conductors installed in ferrous metallic conduit shall be bonded at each end of conduit, utilizing a minimum #6 AWG copper conductor and bond bushings. Conduits less than 3'-0" in length shall be bonded at one end. Bond bushing lug shall be replaced with a compression-type ground lug, bolted to bushing with bronze machine screw and star washer.

B. Bonding and grounding conductor splices shall be kept to a minimum. All splices shall be located in the telecommunication spaces only and shall be fully accessible.

C. Bonding conductors shall be individually routed to each piece of equipment.

D. Conductors shall terminate onto dedicated grounding lugs, one conductor per termination.

E. All conductors shall be maintained as short and as straight as possible.

F. Conductors shall be free from loops and coils; no bend shall be greater than 90 degrees.

G. The data/telecommunication grounding system shall be extended to and through data/communication raceways such as cable trays, cable channels, ladder systems, metallic surface-mounted raceways, etc., by means of extending a #6 AWG minimum bonding conductor through the length of the raceway system and bonding to each section of raceway, lugging at 10 foot maximum intervals along the length of the raceway, and
lugging to any section of raceway greater than 3 feet in length, in lieu of the installation of individual bonding jumpers between each raceway section.

H. Where a bare copper TBB conductor or bonding conductor is routed through a cable tray system, the conductor shall be tied down and anchored to the cable tray, 36" maximum on center, utilizing a UL listed wire fastener as required.

I. The data/telecommunication grounding system shall meet the requirements of NEC Articles 250 and 800. The Contractor shall bond individual electronic components and equipment to the grounding system per the equipment manufacturer's recommendations and instructions.

J. Each telecommunication bonding conductor shall be labeled. Labels shall be located on conductors, as close as practicable to their point of termination. Label shall be non-metallic and include the following information: “WARNING - IF THIS CONNECTOR OR CABLE IS LOOSE OR MUST BE REMOVED, PLEASE CALL THE BUILDING TELECOMMUNICATION MANAGER.”

K. Items to be bonded to the data/telecommunication grounding system at the ground distribution bus bars shall include, but not be limited to, the following:

1. Telephone equipment (e.g. PBX’s, KSU's, ISDN equipment, etc.).
2. CATV equipment.
3. Equipment racks and cabinets.
4. Cable ladders, trays, and channels.
5. Surface-mounted metallic raceways and wireways.
6. Metallic conduit systems.
7. Service entrance protected terminals.
8. Telecommunications and fiber-optic splice enclosures.
9. Inter-building cable sheaths and messengers.
10. Coupled bonding conductors.
11. Paging and access control systems.

3.2 SYSTEM TESTING

A. Upon completion of the installation of the data/telecommunication grounding system and/or servicing of the existing grounding systems, the Contractor shall perform approved standard ground resistance tests with an Engineer-approved ground resistance test unit (i.e., stakeless clamp-on ground resistance tester, three-point fall of potential tester), using approved procedures as noted in this specification.

B. The Contractor shall perform telecommunication grounding system testing as follows:

1. Measure ground current and ground resistance readings on all TBB conductors at each telecommunications main grounding bus bar.
2. Measure ground current and ground resistance readings on all bonding jumpers at each telecommunications main grounding bus bar.
3. Record all readings in a Test Report.
4. Where test results indicate a ground current of 1 amp or greater, the Contractor shall take appropriate action to identify and reduce the ground current to less than 1 amp. The Contractor shall notify the Engineer in writing of the excessive ground current, the source, and the action taken to reduce the current.
C. The Contractor shall demonstrate to the Owner or Owner's representative, by testing, that the data/telecommunication ground system to earth resistance value is 5 ohms or less, utilizing a “clamp-on” or three-point fall of potential tester.

D. The Contractor shall be able to demonstrate to the Owner or Owner's representative, by test, that the data/telecommunication grounding system resistance from any grounded non-current-carrying conductor in the system to the electrical service entrance neutral/ground bonding conductor is less than 0.1 ohms.

E. The Contractor shall record the test results in a Test Report, and provide a description of the testing procedures for submission to the Engineer for approval.

F. The Contractor shall include copies of the completed and approved Test Report in the Instruction Manuals.

END OF SECTION 270526
SECTION 270528 – PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Communications equipment coordination and installation.
2. Sleeves for pathways and cables.
4. Common communications installation requirements.

1.2 RELATED DOCUMENTS

A. Related Sections:
1. Section 270526 “Grounding & Bonding for Communication Systems”.
2. Section 16130 “Raceway and Boxes for Electrical Systems”

1.3 QUALITY CONTROL

1. EIA/TIA 569A Compliance: Comply with EIA/TIA-569A Standards for Telecommunication Pathways and Spaces for Commercial Buildings.

1.4 SUBMITTALS

A. Product Data: For sleeves, seals, cable ladder and back-boxes.

1.5 COORDINATION

A. Coordinate arrangement, mounting, and support of communications equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
3. To allow right of way for piping and conduit installed at required slope.
4. So connecting pathways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for communications items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section “Access Doors and Frames.”
D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping.".

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR COMMUNICATIONS INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both communications equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping and sheet metal HVAC ductwork systems.

3.2 CABLE LADDER

A. Cable ladders shall be installed per manufacturer's instructions, utilizing product series accessories and components.

B. Cable ladders, supports and brackets shall be cleanly cut, deburred, and sharp edges removed.

C. Verify installed loading requirements and install the raceway system per the manufacturer's recommendations. Provide additional load capacity to support a 2X growth factor.

D. Install end caps, mounting spacers, couplings, hangers, brackets, dropouts, connectors, supports, and other manufacturer's accessories as required to provide a complete and functioning installation.

3.3 CONDUIT

A. Conduit shall be sized per Table 1 below, or as noted on the drawings. Where sections of conduit runs are longer than 100'-0", or have more than 180 degrees of bends, or have a reverse bend (greater than 90 degrees), pull boxes shall be provided and installed. Bends in conduit larger than 2" shall be long sweep type. Except where specifically noted, the inside radius of bends shall not be less than:

Six times the internal diameter for conduits 2" and smaller.

Ten times the internal diameter for conduits 2-1/2" and larger.
Table 1.

<table>
<thead>
<tr>
<th>Inside Diameter in mm</th>
<th>Trade Size</th>
<th>Cable Outside Diameter in mm (inches)</th>
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</thead>
<tbody>
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<td></td>
<td>3.3 (0.13)</td>
</tr>
<tr>
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B. Conduits entering telephone and data closets shall terminate as close as possible to the wall through which the conduits enter, unless otherwise noted. In-floor conduit shall terminate 4” AFF or curb unless noted otherwise. All conduits shall be left clean, dry, and free of debris or other obstructions, with insulated grounding bushings installed.

C. Pull boxes shall be sized and installed per BISCI Standards.

D. Conduit, sleeves, and stubs through fire rated floors and walls shall be rigid galvanized steel conduit with insulated and/or grounding bushings per specifications. Conduit sleeves shall extend a minimum of 6” beyond each wall surface. Upon completion of the work, install fire stop per specifications and codes.

E. Furnish and install pipe sleeves as shown on the drawings. The sleeves shall extend 4” above the floor and a minimum of 2” below the bottom of the ceiling slab. The inner edges of the sleeve shall be reamed, providing a smooth surface to prevent damage to cable insulation. Sleeves shall be equipped with metal caps to ensure fireproofing between floors and/or insulated bushings when occupied with cable.

F. Feeder conduit should enter from the top or bottom, close to one side; never in the center. Distribution conduit should enter in the center.

G. Conduit for outlets shall turn toward the main pathway and have an insulated bushing installed.
3.4 MISCELLANEOUS
A. Raceway systems shall be bonded to the telecommunication grounding system per NEC Article 250, EIA/TIA 607 Standard, and Division 27, Section 27 05 26.
B. Provide a 1/8" nylon or polypropylene line in all conduits.
C. Where cable tray is specified or conduits are routed back to MDF or IDF Rooms or extended beyond the stub-out (greater than 3' from wall), install grounding bushing and bond to telecommunication grounding system.

3.5 SLEEVE INSTALLATION FOR COMMUNICATIONS PENETRATIONS
A. Communications penetrations occur when pathways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
E. Cut sleeves to length for mounting flush with both surfaces of walls.
F. Furnish and install pipe sleeves as shown on the drawings. The sleeves shall extend 4" above the floor and a minimum of 2" below the bottom of the ceiling slab. The inner edges of the sleeve shall be reamed, providing a smooth surface to prevent damage to cable insulation. Sleeves shall be equipped with metal caps to ensure fireproofing between floors and/or insulated bushings when occupied with cable.
G. Seal space outside of sleeves with grout for penetrations of concrete and masonry
   1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
H. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."
I. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pathway and cable penetrations. Install sleeves and seal pathway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."
J. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.
K. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
L. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between pathway or cable and sleeve for installing mechanical sleeve seals.

3.6 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.7 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for communications installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

END OF SECTION 270528
### Part 1 - General

#### 1.1 Related Documents

<table>
<thead>
<tr>
<th>Product</th>
<th>Manufacturer</th>
<th>Product Number</th>
<th>Description</th>
<th>Approved Equal Manufacturer</th>
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<td>48 Port Patch Panel, 6-Port Modules, 19”</td>
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**Note:** No deviations to specifications unless approved by owner.

End of Section 270610
## PART 1 - GENERAL

### A. TELECOMMUNICATIONS

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<thead>
<tr>
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<th>PRODUCT NUMBER</th>
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<td>Comtran</td>
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<td>12 Pair, 24 AWG, 24 Conductor, Shielded Plenum Rated with Drain Wire. SRP Tempe Building 3, (short installation distances)</td>
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**NOTE:** NO DEVIATIONS TO SPECIFICATIONS UNLESS APPROVED BY OWNER.

END OF SECTION 270620
SECTION 271100 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Telecommunications mounting elements.
   2. Backboards.
   3. Telecommunications equipment racks and cabinets.
   4. Telecommunications service entrance pathways.
   5. Grounding.

1.2 DEFINITIONS

A. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails.
C. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).
D. LAN: Local area network.
E. RCDD: Registered Communications Distribution Designer.
F. Solid-Bottom or Non-ventilated Cable Tray: A fabricated structure consisting of a bottom without ventilation openings within integral or separate longitudinal side rails.
G. Owner: Salt River Project, Facilities Department

1.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Floor-mounted cabinets and cable pathways shall withstand the effects of earthquake motions determined according to Structural Engineering Institute/American Society of Civil Engineering SEI/ASCE 7.
   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks.
and cabinets. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.

C. Seismic Qualification Certificates: For floor-mounted cabinets, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions. Base certification on the maximum number of components capable of being mounted in each rack type. Identify components on which certification is based.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.5 QUALITY CONTROL

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings shall be under the direct supervision of RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of a BICSI Trained and Certified Technician, who shall be present at all times when Work of this Section is performed at Project site.
3. Field Inspector: Currently registered by BICSI as RCDD to perform the on-site inspection.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.


1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install equipment frames and cable trays until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and work above ceilings is complete.
1.7 COORDINATION

A. Coordinate layout and installation of communications equipment with Owner's telecommunications and LAN equipment and service suppliers. Coordinate service entrance arrangement with local exchange carrier.

1. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
2. Record agreements reached in meetings and distribute them to other participants.
3. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.
4. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.

B. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

PART 2 - PRODUCTS

2.1 PATHWAYS

A. General Requirements: Comply with TIA/EIA-569-A.

B. Cable Support: NRTL labeled. Cable support brackets shall be designed to prevent degradation of cable performance and pinch points that could damage cable. Cable tie slots fasten cable ties to brackets.

1. Comply with NFPA 70 and UL 2043 for fire-resistant and low-smoke-producing characteristics.
2. Support brackets with cable tie slots for fastening cable ties to brackets.
3. Lacing bars, spools, J-hooks, and D-rings.
4. Straps and other devices.

C. Cable Trays:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Cablofil Inc.
   b. Cooper B-Line, Inc.
   c. GS Metals Corp.
2. Cable Tray Materials: Metal, suitable for indoors and protected against corrosion by electroplated zinc galvanizing, complying with ASTM B 633, Type 1, not less than 0.000472 inch (0.012 mm) thick.
   a. Basket Cable Trays: 12 inches (305 mm) wide and 4 inches (100 mm) deep. Wire mesh spacing shall not exceed 2 by 4 inches (50 by 100 mm).
   b. Ladder Cable Trays: Nominally 12 inches (305 mm) wide, and a rung spacing of [12 inches (305 mm)]
D. Conduit and Boxes:
   1. Comply with requirements in Division 16 Section 16 13 0 "Raceway and Boxes for Electrical Systems. "Flexible metal conduit shall not be used unless approved by SRP.
   2. Outlet boxes shall be no smaller than 4-11/16 inches wide, 4-11/16 inches (120 mm) high, and 2-1/2 inches (64 mm) deep

2.2 BACKBOARDS
   A. Backboards: Plywood, fire-retardant treated, painted with two (2) coats of fire retardant paint (stamp) 3/4 by 48 by 96 inches (19 mm by 1220 mm by 2440 mm). Comply with requirements for plywood backing panels specified in Division 06 Section "Rough Carpentry."

2.3 EQUIPMENT FRAMES
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1. Chatsworth.
   B. General Frame Requirements:
      1. Distribution Frames: Freestanding and wall-mounting, modular-steel units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
      2. Module Dimension: Width compatible with EIA 310 standard, 19-inch (480-mm) panel mounting.
      3. Finish: Manufacturer's standard, baked-polyester powder coat.
   C. Floor-Mounted Racks: Modular-type, aluminum construction.
      1. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug.
      2. Guardrail on each side of rack at bottom, rack base dust cover.
   D. Modular Freestanding Cabinets:
      1. Removable and lockable side panels.
      2. Hinged and lockable front and rear doors.
      3. Adjustable feet for leveling.
      4. Screened ventilation openings in the roof and rear door.
      5. Cable access provisions in the roof and base.
      10. All cabinets keyed alike.
   E. Modular Wall Cabinets:
1. Wall mounting.
2. Steel or aluminum construction.
3. Treated to resist corrosion.
4. Lockable front and rear doors.
5. Louvered side panels.
6. Cable access provisions top and bottom.
7. Grounding lug.
8. Roof-mounted, 250-cfm (118-L/s) fan.
10. All cabinets keyed alike.

F. Modular Freestanding Rack:
1. Floor mounting installation kit.
2. Aluminum / steel construction.
4. E/A-210D compliant universal hole pattern.
5. Rack base dust cover.

G. Cable Management for Equipment Frames:
1. Metal, with integral wire retaining fingers.
2. Baked-polyester powder coat finish.
3. Vertical cable management panels shall have front and rear channels, with covers.
4. Provide horizontal crossover cable manager at the top of each relay rack, with a minimum height of two rack units each.

2.4 GROUNDING
A. Comply with requirements in Division 16 Section “Grounding and Bonding for Electrical Systems” and Division 27 Section 27 05 26 Grounding and Bonding for Communications Systems” and for grounding conductors and connectors.
B. Comply with ANSI-J-STD-607-A.

2.5 LABELING
A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES
A. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and a housing when so directed by service provider.
B. Install underground pathways complying with recommendations in TIA/EIA-569-A, "Entrance Facilities" Section and BICSI Chapter 9 Telecommunications Entrance Facilities and Termination.

3.2 Install underground entrance pathway complying with Division 26 Section "Raceway and Boxes for Electrical Systems." INSTALLATION

A. Comply with NECA 1.

B. Comply with BICSI TDMM for layout and installation of communications equipment rooms.


D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.3 FIRESTOPPING

A. Comply with requirements in Division 07 Section 07 27 0 "Penetration Firestopping.". Comply with TIA/EIA-569-A, Annex A, "Firestopping."

B. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.4 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with ANSI-J-STD-607-A.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch (50-mm) clearance behind the grounding bus bar. Connect grounding bus bar with a grounding electrode conductor to match electrical service entrance section up to #3/0 AWG (minimum No. 2 AWG grounding electrode conductor) from grounding bus bar to suitable electrical building ground. (At service entrance switchboard or first building electrical panel)

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

1. Bond the shield of shielded cable to the grounding bus bar in communications rooms and spaces.

E. Refer to Division 27 Section 27 05 26 Grounding and Bonding for Communications Systems for additional requirements.

3.5 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements in Division 16 Section 16075 "Identification for Electrical Systems." Comply with requirements in Division 09 Section 09901 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.
B. See Division 27 Section 271500 "Communications Horizontal Cabling" for additional identification requirements. See Evaluations for discussion of TIA/EIA standard as it applies to this Section. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 4 (multi-site system) level of administration[ including optional identification requirements of this standard].

C. Labels shall be preprinted or computer-printed type.

3.6 INSTALLATION OF PATHWAYS

A. Pathway Installation in Communications Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard when entering room from overhead.
4. Extend conduits 3 inches (76 mm) above finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

B. Backboards: Install backboards with 96-inch (2440-mm) dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

C. Vertical cables shall be supported for a ladder or rings by use of cable ties 24" on center. If messenger strand cable is utilized for cable support, the cable shall be grounded to the telecommunication grounding system at both ends and shall not be used as a grounding conductor.

D. Backbone cables spanning more than three floors shall be securely attached at the top of the cable run with a wire mesh grip and on alternating floors, or as required by local codes.

END OF SECTION 271100
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Pathways.
   2. UTP cable.
   3. 62.5/125-micrometer, optical fiber cabling.
   5. Cable connecting hardware, patch panels, and cross-connects.
   7. Single Mode Fiber.

1.3 DEFINITIONS

A. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails.


C. Channel Cable Tray: A fabricated structure consisting of a one-piece, ventilated-bottom or solid-bottom channel.

D. Consolidation Point: A location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways.

E. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

F. EMI: Electromagnetic interference.

G. IDC: Insulation displacement connector.

H. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).

I. LAN: Local area network.


K. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.
1.4 BACKBONE CABELING DESCRIPTION

A. Backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

1.5 PERFORMANCE REQUIREMENTS

A. General Performance: Backbone cabling system shall comply with transmission standards in TIA/EIA-568-B.1, when tested according to test procedures of this standard.

1.6 SUBMITTALS

A. Product Data: For each type of product indicated.
   1. Refer to Division 27, Section 270513 “Communication Services”
   2. Include the following installation data for each type used:
      a. Nominal OD.
      b. Minimum bending radius.
      c. Maximum pulling tension.

B. Shop Drawings:
   1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
   2. Cabling administration drawings and printouts.
   3. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.

C. Source quality-control reports.

D. Field quality-control reports.

E. Maintenance Data: For splices and connectors to include in maintenance manuals.

F. Testing Documentation
1. Provide three hard copies and one electronic copy (CD-rom) of test reports for horizontal UTP cables, coaxial cables, and fiber-optic cables. Test reports provided in electronic format shall include a shareware copy of the appropriate software for managing the reports in CSV format.

2. Documentation (printed form) shall be submitted to the Architect within five working days of the completion of each testing phase (e.g., subsystem, cable type, area, floor, etc.).

1.7 QUALITY CONTROL

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Installation Supervision: Installation shall be under the direct supervision of Registered Technician who shall be present at all times when Work of this Section is performed at Project site.

2. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.

2. Smoke-Developed Index: 450 or less.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.


1.8 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test optical fiber cable while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector, including the loss value of each. Retain test data and include the record in maintenance data.

2. Test each pair of UTP cable for open and short circuits.

3. Cable shall be stored according to manufacturers’ recommendations as a minimum. In addition, cable must be stored in a location protected from vandalism and weather. Air temperature at cable storage location shall not exceed 50°F minimum, 130°F maximum. Storage location shall be well ventilated to prevent condensation. If necessary, cable shall be stored offsite at the Contractor’s expense.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
B. Cable shall be stored according to manufacturer’s recommendations as a minimum. In addition, cable must be stored in a location protected from vandalism and weather. Air temperature at cable storage location shall not exceed 50°F minimum, 130°F maximum. Storage location shall be well ventilated to prevent condensation. If necessary, cable shall be stored offsite at the Contractor’s expense.

1.10 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

B. Coordinate layout and install of telecommunication pathway and cabling with other trades (Electrical, Mechanical, Plumbing, Etc.)

PART 2 - PRODUCTS

2.1 UTP CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by:

1. Berk-Tek; a Nexans company.

B. Description: 100-ohm, 200 pair UTP, formed into 25-pair binder groups covered with a gray thermoplastic jacket and overall metallic shield.

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA/EIA-568-B.1 for performance specifications.
3. Comply with TIA/EIA-568-B.2, Category 5e.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

   a. Communications, General Purpose: Type CM or CMG.
   b. Communications, Plenum Rated: Type CMP complying with NFPA 262.
   c. Communications, Riser Rated: Type CMR complying with UL 1666.
   d. Communications, Limited Purpose: Type CMX.
   e. Multipurpose: Type MP or MPG.
   f. Multipurpose, Plenum Rated: Type MPP complying with NFPA 262.
   g. Multipurpose, Riser Rated: Type MPR complying with UL 1666.

2.2 UTP CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by:

1. Ortronics.

B. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA -568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

C. Connecting Blocks: 110-style IDC for Category 5e or Category 6 New Construction. 66-style IDC for renovations when 66 blocks are existing. Provide blocks for the number of cables
terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.

D. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

1. Number of Terminals per Field: One for each conductor in assigned cables.

E. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.

1. Number of Jacks per Field: One for each four-pair UTP cable indicated.

F. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.

Patch Cords: Factory-made, 4-pair cables in [36-inch (900-mm)] [60-inch (1524-mm)] lengths; terminated with 8-position modular plug at each end or as directed by SRP. (SRP TO MODIFY)

1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.
2. Patch cords shall have color-coded boots for circuit identification.

2.3 OPTICAL FIBER CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Corning Cable Systems.

B. Description: Multimode, 62.5/125-micrometer, tight buffer and optical fiber cable.

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA/EIA-568-B.3 for performance specifications.
3. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
   a. General Purpose, Nonconductive: Type OFN or OFNG.
   b. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
   c. Riser Rated, Nonconductive: Type OFNR complying with UL 1666.
   d. General Purpose, Conductive: Type OFC or OFCG.
   e. Plenum Rated, Conductive: Type OFCP complying with NFPA 262.
   f. Riser Rated, Conductive: Type OFCR complying with UL 1666.

4. Conductive cable shall be aluminum armored type.
5. Maximum Attenuation: 3.50 dB/km at 850 nm; 1.5 dB/km at 1300 nm.
6. Minimum Modal Bandwidth: 160 MHz-km at 850 nm; 500 MHz-km at 1300 nm.

C. Jacket:

2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA/EIA-598-B.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches (1000 mm).

D. Description: Singlemode, 8/125-micrometer, tight buffer and optical fiber cable.

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA/EIA-568-B.3 for performance specifications.
3. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
   a. General Purpose, Nonconductive: Type OFN or OFNG.
   b. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
   c. Riser Rated, Nonconductive: Type OFNR complying with UL 1666.
   d. General Purpose, Conductive: Type OFC or OFCG.
   e. Plenum Rated, Conductive: Type OFCP complying with NFPA 262.
   f. Riser Rated, Conductive: Type OFCR complying with UL 1666.

4. Conductive cable shall be aluminum armored type.
5. Maximum Attenuation: 3.50 dB/km at 1310 nm, .2 dB/km at 1550 nm.
6. Minimum Modal Bandwidth: 160 MHz-km at 850 nm; 500 MHz-km at 1300 nm.
8. Cable cordage jacket, fiber, unit, and group color shall be according to TIA/EIA-598-B.
9. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches (1000 mm).

2.4 OPTICAL FIBER CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Corning Cable Systems.

B. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.
   1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

C. Patch Cords: Factory-made, dual-fiber cables in 36-inch (900-mm) lengths or lengths as directed by SRP.

D. Cable Connecting Hardware:
   2. Quick-connect, simplex and duplex, UNICAM connectors. Insertion loss not more than 0.75 dB.

2.5 TESTING

1. Bi-directional splice loss of a single splice must not exceed 0.13 dB when measured with an OTDR at 1310nm and 1550nm.

2. Fiber Loss: Optical Cable with Single Mode Fiber.
   a. Attenuation at 1310 nm = 0.5 dB/mi max
b. Attenuation at 1550 nm = 0.4 dB/mi max

2.6 COAXIAL CABLE

E. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Belden CDT Inc.; Electronics Division.
2. CommScope, Inc.

F. General Coaxial Cable Requirements: Broadband type, recommended by cable manufacturer specifically for broadband data transmission applications. Coaxial cable and accessories shall have 75-ohm nominal impedance with a return loss of 20 dB maximum from 7 to 806 MHz.

G. RG-11/U: NFPA 70, Type CATV.

1. No. 14 AWG, solid, copper-covered steel conductor.
2. Gas-injected, foam-PE insulation.
3. Double shielded with 100 percent aluminum polyester tape and 60 percent aluminum braid.
4. Jacketed with sunlight-resistant, black PVC or PE.
5. Suitable for outdoor installations in ambient temperatures ranging from minus 40 to plus 85 deg C.

H. NFPA and UL compliance, listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1655 and with NFPA 70, "Radio and Television Equipment" and "Community Antenna Television and Radio Distribution" Articles. Types are as follows:

1. CATV Cable: Type CATV, or CATVP or CATVR.
2. CATV Plenum Rated: Type CATVP, complying with NFPA 262.
3. CATV Riser Rated: Type CATVR, complying with UL 1666.
4. CATV Limited Rating: Type CATVX.

2.7 COAXIAL CABLE HARDWARE

I. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Blonder - Tongue.

J. Coaxial-Cable Connectors: Type BNC, 75 ohms.

2.8 IDENTIFICATION PRODUCTS

K. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.9 SOURCE QUALITY CONTROL

L. Testing Agency: Engage a qualified testing agency to evaluate cables.
M. Factory test cables on reels according to TIA/EIA-568-B.1.
N. Factory test UTP cables according to TIA/EIA-568-B.2.
O. Factory test multimode and single mode optical fiber cables according to TIA/EIA-526-14-A and TIA/EIA-568-B.3.
P. Cable will be considered defective if it does not pass tests and inspections.
Q. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 WIRING METHODS
   1. Install plenum cable in environmental air spaces, including plenum ceilings.
   2. Comply with requirements for raceways and boxes specified in Division 16 Section "Raceway and Boxes for Electrical Systems."
B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.2 INSTALLATION OF CABLES
A. Comply with NECA 1.
B. General Requirements for Cabling:
   2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
   3. Install 110-style IDC termination hardware unless otherwise indicated.
   4. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
   5. Cables may not be spliced. Cabling shall be installed in continuous runs from cross-connect fields to cross-connect fields, to patch panels, workstation outlets, etc. Cabling shall be free from splices, taps, splitters, baluns and any other in-line connections.
   6. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
   7. Unsupported spans between cable trays and conduit sleeves shall not exceed 12" horizontally, 24" vertically.
   8. All cables shall be new and as specified on the drawings. Cables shall be shipped on 1,000 ft. reels or boxed. Coiled cables are not acceptable. Factory shorts and/or factory seconds, salvaged, leftover and reused cables are not acceptable. Cables of a given
type shall be of a single manufacturer and part number. All unapproved or unacceptable cable shall be removed and replaced at the Contractor’s expense.

9. Cables routed above a suspended ceiling in exposed space, and not installed in a conduit system, shall be supported by a cable tray, channel or hangers.

10. Cables shall not be supported from ceiling support wires, lighting fixture support wires, ductwork, plumbing line, fire suppression systems, mechanical systems or electrical conduits. Cables shall not come in contact with ductwork or piping, or lay on top of ceiling systems and lighting fixtures.

11. Where cables are routed through inaccessible ceilings, the Contractor shall install conduit sleeves extending 1 foot beyond the inaccessible area, sized in accordance with ANSI/TIA/EIA-569-A Guidelines, as outlined in Table 1. Install insulated conduit bushing on both ends of sleeve and ground conduit per Division 27 Specification Section 27 05 26 “Grounding & Bonding for Communications Systems”.

12. Install conduit sleeves where cables pass through walls. Conduits shall be sized in accordance with ANSI/TIA/EIA-569-A Guidelines, as outlined in Division 27 Specification Section 27 05 28 “Pathways for Communications Systems” Table 1. Install insulated conduit bushing on both ends of sleeve and ground conduit per Division 27 Specification Section 27 05 26 “Grounding & Bonding for Communications Systems.

13. Cables supported by hangers shall utilize Caddy Cable-Cat hangers or approved equal communication cable hangers. Hangers shall be supported from the building structure. Hangers shall not utilize other system support wires or rods.

14. A maximum of 36 (three groups of 12) cables shall be supported in a single hanger with a spacing of 48” on center. Cables shall be loosely bundled.

15. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.

16. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.

17. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.

18. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating.

19. In the communications equipment room, install a 10-foot- (3-m-) long service loop on each end of cable.

20. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

21. Cables requiring additional length shall be stored in an extended loop or in a "Figure 8" configuration. Do not store additional length in bundled loops. Each individual loop shall be tagged with cable number.

22. The Contractor shall make certain that during the installation and upon completion, all cables have been installed in good condition, free from jacket cuts or tears, kinks, twist, knots, sharp bends, etc., or any other physical damage. During the installation, the Contractor shall not allow the cables to be exposed to foot, vehicle or equipment traffic, or be exposed to any other form of abuse which shall cause damage to cables, altering the electrical characteristics. Cables exhibiting such damage or an attempt by the Contractor to correct, hide or otherwise conceal such damage, shall result in cables being replaced at the Contractor’s expense.

23. Cable pulls shall not exceed 100 feet in length. Cables shall be neatly coiled in a figure "8" pattern at the completion of a pull in preparation for the next pull.

24. Data/telecommunication and fiber-optic cables shall not be stored or installed in an unheated building where the temperature is less than 40°F. The structure and the cable must be brought to a minimum 50°F ambient for a minimum of 48 hours prior to installation of the cables. Failure to observe this precaution may result in damage to the cable and shall result in the cable being replaced at the Contractor’s expense.
C. UTP Cable Installation:
   2. Do not untwist UTP cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.
   3. Maximum of 12" and minimum of 6" of cable shall be stored in back box or raceway. Slack shall be coiled in the box without exceeding the bend radius.
   4. Bend radiiuses of the horizontal cable shall not be less than four times the outside diameter of the cable.
   5. Cable jacket shall be maintained to within 1" of termination points.

D. Optical Fiber Cable Installation:
   2. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

E. Open-Cable Installation:
   1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
   2. Suspend UTP cable not in a wireway or pathway, a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 48 inches (1524 mm) apart.
   3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

F. Installation of Cable Routed Exposed under Raised Floors:
   1. Install plenum-rated cable only.
   2. Install cabling after the flooring system has been installed in raised floor areas.
   3. Coil cable 6 feet (1800 mm) long in Figure 8 configuration not less than 12 inches (300 mm) in diameter below each feed point.

G. Group connecting hardware for cables into separate logical fields.

H. Separation from EMI Sources:
   1. Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
   2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
      a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
      b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
      c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (610 mm).
   3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
      a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
      b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
      c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).
4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (76 mm).
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).

6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

3.3 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Penetration Firestopping." Comply with TIA/EIA-569-A, Annex A, "Firestopping."

B. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.4 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

   1. Administration Class 4.
   2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. See Division 27 Section "Communications Horizontal Cabling" for additional identification requirements. See Evaluations for discussion about TIA/EIA standard as it applies to this Section. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 4 level of administration including optional identification requirements of this standard.

C. Comply with requirements in Division 27 Section "Communications Horizontal Cabling" for cable and asset management software.

D. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

E. Cable and Wire Identification:

   1. Label each cable within 4 inches (100 mm) of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
   2. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet (4.5 m).
   3. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
a. Individually number wiring conductors connected to terminal strips and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device with name and number of particular device as shown.

b. Label each unit and field within distribution racks and frames.

4. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

F. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA 606-A, for the following:

1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Visually inspect UTP and optical fiber jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-B.1 and Addenda.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test UTP copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

   a. Fluke (or Equivalent brand) Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex.

   b. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

   c. All test cords are to be newly installed prior to any work for Salt River Project.

4. Optical Fiber Cable Tests:

   a. Multi-Mode (62.5 / 125 UM) and Single-Mode (8.7 / 125 UM) Fiber-Optic Cable:

      1) All fiber-optic cables shall be fully tested for continuity and attenuation, utilizing a fiber-optic power motor and fiber-optic LED/laser light source. The fiber-optic test equipment shall be capable of testing multi-mode and/or single-mode fiber cable.

      2) The fiber-optic test equipment shall be an electronic micro-controller with automatic self-testing and data storage. The Contractor shall provide shop
drawings, catalog cut sheets and operational procedures describing the test equipment proposed to be utilized, for the Architect's review and approval.

3) Fiber conductor shall be tested with the cable completely installed and in final placement, with connector installed and polished out. The "ST" and/or "SC" connectors shall be inspected for proper termination techniques, workmanship, labeling, etc., and verified by the Contractor to be free from any visual defects, such as scratches and chips. All connector installations exhibiting any defected and/or improper assembly procedures shall be replaced at the Contractor's expense.

b. Each fiber shall be tested in both directions, with both readings recorded. The worst-case reading shall be utilized to determine acceptability of the fiber.

c. Attenuation shall be recorded for each fiber at 850 and 1,300 nm for multi-mode fiber-optic cable, and at 1,310 nm and 1,550 nm for single-mode fiber-optic cable. Fiber-optic cable link test procedures shall be based upon EIA/TIA-568A Annex "H" Standard procedures. The technician performing the fiber-optic verification tests should periodically check and verify the reference dB loss. All fiber-optic "ST" and/or "SC" connectors and couplers shall be thoroughly cleaned before and after testing, and dust caps installed after the test procedures have been completed.

d. The Fluke fiber-optic cable test report shall provide the following information:
   1) Contractor's name.
   2) Test Equipment Identification: Manufacturer, model number, and serial number.
   3) Client/Owner identification.
   4) Date test performed.
   5) Cable manufacturer and part number.
   6) Cable identification number.
   7) Cable location (i.e., building - from/to).
   8) Cable description (i.e., number of fibers, S/M, M/M).
   9) Name, signature and date of signature of the technician performing the tests.
   10) Cable length.
   11) Proper conductor termination verification, both ends.
   12) Link attenuation (loss) measurement in dB per fiber.
   13) Reference dB.
   14) Visual connector (both ends) inspection verification.
   15) Calculated fiber loss based on fiber length and factory OTDR readings.
   16) Calculated optical attenuation per connector pair (fiber link attenuation loss measurement), less the calculated fiber loss, less the reference dB, equals optical attenuation per connector pair.
   17) Test results (i.e., pass/fail).

e. Maximum optical attenuation per connector pair for multi-mode fiber connectors shall be 0.5 dB or less when measured at 850/1,300 nm in accordance with ANSI/EIA/TIA-526-14A, Method A.1. Maximum optical attenuation per connector pair for single-mode fiber connectors shall be 0.5 dB or less when measured at 1,310/1,550 nm in accordance with ANSI/EIA/TIA-526-7, Method B. (NOTE: It is recognized by the Engineer that this specification is much more stringent than the EIA/TIA-568A Annex "H" Standard.) Reflection shall be ≥ 45 dB.

C. Coaxial Cables: All coaxial cables shall be tested for "opens", "shorts", continuity, capacitance, impedance, loop resistance and length. Coaxial cables shall be tested utilizing a programmable
micro-computer-based automatic scanner/tester capable of generating complete printed test reports as noted above.

D. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

E. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

F. End-to-end cabling will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

END OF SECTION 271300
SECTION 271500 - COMMUNICATIONS HORIZONTAL CABLEING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pathways.
2. UTP cabling.
3. Coaxial cable.
4. Cable connecting hardware, patch panels, and cross-connects.
5. Telecommunications outlet/connectors.
6. Cabling system identification products.
7. Cable management system.

1.2 DEFINITIONS

A. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails.


C. Channel Cable Tray: A fabricated structure consisting of a one-piece, ventilated-bottom or solid-bottom channel.

D. Consolidation Point: A location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways.

E. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

F. EMI: Electromagnetic interference.

G. IDC: Insulation displacement connector.

H. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).

I. LAN: Local area network.


K. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.

L. RCDD: Registered Communications Distribution Designer.

M. UTP: Unshielded twisted pair.

N. Owner: Salt River Project.
1.3 HORIZONTAL CABLING DESCRIPTION

A. Horizontal cable and its connecting hardware provide the means of transporting signals
between the telecommunications outlet/connector and the horizontal cross-connect located in
the communications equipment room. This cabling and its connecting hardware are called
"permanent link," a term that is used in the testing protocols.

1. Minimum of three telecommunications outlet/connectors be installed for each work area.
   (one voice / two data)
2. Horizontal cabling shall contain no transition point or consolidation point between the
   horizontal cross-connect and the telecommunications outlet/connector.
3. Bridged taps and splices shall not be installed in the horizontal cabling.
4. Splitters shall not be installed as part of the optical fiber cabling.

B. A work area includes the components that extend from the telecommunications
   outlet/connectors to the station equipment.

C. The maximum allowable horizontal cable length is 295 feet (90 m). This maximum allowable
   length does not include an allowance for the length of 16 feet (4.9 m) to the workstation
   equipment. The maximum allowable length does not include an allowance for the length of 16
   feet (4.9 m) in the horizontal cross-connect.

1.4 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in
   TIA/EIA-568-B.1, when tested according to test procedures of this standard.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings:

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and
   format selected by Owner.
2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the
   cabling and asset identification system of the software.
3. Cabling administration drawings and printouts.
4. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and
   physical relationship between the installed components.

C. Source quality-control reports.

D. Field quality-control reports.

E. Maintenance Data: For splices and connectors to include in maintenance manuals.

F. Testing Documentation

1. Provide three hard copies and one electronic copy (CD-rom) of test reports for horizontal
   UTP cables, coaxial cables, and fiber-optic cables. Test reports provided in electronic
format shall include a shareware copy of the appropriate software for managing the reports in CSV format.

2. Documentation (printed form) shall be submitted to the Architect within five working days of the completion of each testing phase (e.g., subsystem, cable type, area, floor, etc.).

1.6 QUALITY CONTROL

A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Flame-Spread Index: 25 or less.
   2. Smoke-Developed Index: 450 or less.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.


1.7 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.
   1. Test each pair of UTP cable for open and short circuits.
   2. Delivery and receipt of products shall be at the site described in the Scope section.
   3. Cable shall be stored according to manufacturers’ recommendations as a minimum. In addition, cable must be stored in a location protected from vandalism and weather. Air temperature at cable storage location shall not exceed 50°F minimum, 130°F maximum. Storage location shall be well ventilated to prevent condensation. If necessary, cable shall be stored offsite at the Contractor’s expense.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. Cable shall be stored according to manufacturer’s recommendations as a minimum. In addition, cable must be stored in a location protected from vandalism and weather. Air temperature at cable storage location shall not exceed 50°F minimum, 130°F maximum. Storage location shall be well ventilated to prevent condensation. If necessary, cable shall be stored offsite at the Contractor’s expense.

1.9 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.
B. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area.

C. Refer to Division 27 Section 27 05 13 “Communication Services”.

PART 2 - PRODUCTS

2.1 UTP CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by:

1. Berk-Tek; a Nexans company.

B. Description: 100-ohm, 4-pair UTP, covered with a blue thermoplastic jacket.

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA/EIA-568-B.1 for performance specifications.
3. Comply with TIA/EIA -568-B.2, Category 5e for renovation of existing facility and Category 6 for new construction.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

   a. Communications, Plenum Rated: Type CMP, complying with NFPA 262.
   b. Communications, Riser Rated: Type CMR, complying with UL 1666.
   c. Communications, Limited Purpose: Type CMX.
   d. Multipurpose: Type MP or MPG.
   e. Multipurpose, Plenum Rated: Type MPP, complying with NFPA 262.
   f. Multipurpose, Riser Rated: Type MPR, complying with UL 1666.

2.2 UTP CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ortronics.

B. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA -568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

C. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.

1. Number of Jacks per Field: One for each four-pair UTP cable indicated.

D. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.

E. Patch Cords: Factory-made, four-pair cables in [36-inch (900 mm)] [48-inch (1200-mm)] Length as directed by SRP; terminated with eight-position modular plug at each end.
1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.
2. Patch cords shall have color-coded boots for circuit identification.

2.3 COAXIAL CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Belden CDT Inc.; Electronics Division.
   2. CommScope, Inc.
   3. Berk-Tek A Nexans Company

B. Cable Characteristics: Broadband type, recommended by cable manufacturer specifically for broadband data transmission applications. Coaxial cable and accessories shall have 75-ohm nominal impedance with a return loss of 20 dB maximum from 7 to 806 MHz.

C. RG-6/U: NFPA 70, Type CATVP.
   1. No. 16 AWG, solid, copper-covered steel conductor; gas-injected, foam-PE insulation.
   2. Double shielded with 100 percent aluminum-foil shield and 60 percent aluminum braid.
   3. Jacketed with Copolymer jacket.
   4. Suitable for indoor installations.

D. RG59/U (Plenum Rated): NFPA 70, Type CMP.
   1. No. 20 AWG, solid, copper-covered steel conductor; foam fluorinated ethylene propylene insulation.
   2. Double shielded with 100 percent aluminum-foil shield and 65 percent aluminum braid.
   3. Copolymer jacket.

E. NFPA and UL compliance, listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1655 and with NFPA 70 "Radio and Television Equipment" and "Community Antenna Television and Radio Distribution" Articles. Types are as follows:
   1. CATV Plenum Rated: Type CATVP, complying with NFPA 262.

2.4 COAXIAL CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Ortronics.
   2. Blonder – Tongue.

B. Coaxial-Cable Connectors: Type BNC, 75 ohms.
2.5 TELECOMMUNICATIONS OUTLET/CONNECTORS


B. Workstation Outlets: Four port-connector assemblies mounted in single faceplate.
   1. Plastic Faceplate: High-impact plastic. Coordinate color with Division 26 Section 26 "Wiring Devices."
   2. For use with snap-in jacks accommodating any combination of UTP, optical fiber, and coaxial work area cords.
      a. Flush mounting jacks, positioning the cord at a 90-degree angle.
   3. Legend: Machine printed, in the field, using adhesive-tape label for cable.

2.6 IDENTIFICATION PRODUCTS

A. Comply with TIA/EIA-606-A and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

B. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

C. Cable identification shall be by means of permanently applied, pre-printed, wraparound wire markers (i.e., "Brady-Wrap" B-292, LAT-18, or LAT-19 self-laminating markers). These labels must withstand the requirements of UL 969 as outlined in the EIA/TIA-606 Standard.

D. Patch panel labels shall be pre-printed and enclosed in self-adhesive clear strips (Panduit, Ortronics or as accepted by the Engineer).

E. Data/Telecommunications Outlet Face Plates: Permanent, clear, pre-printed laminated label with black lettering (Brady Label #CL-311-621 or LAT-7-722-10, or as accepted by the Engineer).

2.7 SOURCE QUALITY CONTROL

A. Factory test UTP on reels according to TIA/EIA-568-B.1.

B. Factory test UTP cables according to TIA/EIA-568-B.2.

C. Factory-sweep test coaxial cables at frequencies from 5 MHz to 1 GHz. Sweep test shall test the frequency response, or attenuation over frequency, of a cable by generating a voltage whose frequency is varied through the specified frequency range and graphing the results.

D. Cable will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports. Provide software to read original test results on disc provided to owner.
PART 3 - EXECUTION

3.1 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway and Boxes for Electrical Systems."

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.2 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
5. Cables may not be spliced. Cabling shall be installed in continuous runs from cross-connect fields to cross-connect fields, to patch panels, workstation outlets, etc. Cabling shall be free from splices, taps, splitters, baluns and any other in-line connections.
6. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
7. Unsupported spans between cable trays and conduit sleeves shall not exceed 12" (305 mm) horizontally, 24" (607 mm) vertically.
8. All cables shall be new and as specified on the drawings. Cables shall be shipped on 1,000 ft. reels or boxed. Coiled cables are not acceptable. Factory shorts and/or factory seconds, salvaged, leftover and reused cables are not acceptable. Cables of a given type shall be of a single manufacturer and part number. All unapproved or unacceptable cable shall be removed and replaced at the Contractor's expense.
9. Cables routed above a suspended ceiling in exposed space, and not installed in a conduit system, shall be supported by a cable tray, channel or hangers.
10. Cables shall not be supported from ceiling support wires, lighting fixture support wires, ductwork, plumbing line, fire suppression systems, mechanical systems or electrical conduits. Cables shall not come in contact with ductwork or piping, or lay on top of ceiling systems and lighting fixtures.
11. Where cables are routed through inaccessible ceilings, the Contractor shall install conduit sleeves extending 1 foot beyond the inaccessible area, sized in accordance with ANSI/TIA/EIA-569-A Guidelines, as outlined in Table 1. Install insulated conduit bushing...
on both ends of sleeve and ground conduit per Division 27 Specification Section 27 05 26 “Grounding & Bonding for Communications Systems”.

12. Install conduit sleeves where cables pass through walls. Conduits shall be sized in accordance with ANSI/TIA/EIA-569-A Guidelines, as outlined in Division 27 Specification Section 27 05 28 “Pathways for Communications Systems” Table 1. Install insulated conduit bushing on both ends of sleeve and ground conduit per Division 27 Specification Section 27 05 26 “Grounding & Bonding for Communications Systems.”

13. Cables supported by hangers shall utilize Caddy Cable-Cat hangers or approved equal communication cable hangers. Hangers shall be supported from the building structure. Hangers shall not utilize other system support wires or rods.

14. A maximum of 36 (three groups of 12) cables shall be supported in a single hanger with a spacing of 48” on center. Cables shall be loosely bundled.

15. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.

16. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.

17. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.

18. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating.

19. In the communications equipment room, install a 10-foot- (3-m-) long service loop on each end of voice cable.

20. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

21. Cables requiring additional length shall be stored in an extended loop or in a "Figure 8" configuration. Do not store additional length in bundled loops. Each individual loop shall be tagged with cable number.

22. The Contractor shall make certain that during the installation and upon completion, all cables have been installed in good condition, free from jacket cuts or tears, kinks, twist, knots, sharp bends, etc., or any other physical damage. During the installation, the Contractor shall not allow the cables to be exposed to foot, vehicle or equipment traffic, or be exposed to any other form of abuse which shall cause damage to cables, altering the electrical characteristics. Cables exhibiting such damage or an attempt by the Contractor to correct, hide or otherwise conceal such damage, shall result in cables being replaced at the Contractor’s expense.

23. Cable pulls shall not exceed 100 feet in length. Cables shall be neatly coiled in a figure "8" pattern at the completion of a pull in preparation for the next pull.

24. Data/telecommunication and fiber-optic cables shall not be stored or installed in an unheated building where the temperature is less than 40°F. The structure and the cable must be brought to a minimum 50°F ambient for a minimum of 48 hours prior to installation of the cables. Failure to observe this precaution may result in damage to the cable and shall result in the cable being replaced at the Contractor’s expense.

C. UTP Cable Installation:


2. Do not untwist UTP cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.

D. Open-Cable Installation:
1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.

2. Suspend UTP cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 48 inches (1524 mm) apart. Refer to Part B Item 10 for support requirements.

3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

E. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.

2. Install cabling after the flooring system has been installed in raised floor areas.

3. Coil cable [6 feet (1800 mm)] long in Figure 8 configuration not less than [12 inches (300 mm)] in diameter below each feed point.

F. Group connecting hardware for cables into separate logical fields.

G. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA/EIA-569-A for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.

2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (610 mm).

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (76 mm).
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).

6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).
3.3 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Penetration Firestopping."
B. Comply with TIA/EIA-569-A, Annex A, "Firestopping."
C. Comply with BICSI TDMM, Chapter 11 "Firestopping Systems" Article.

3.4 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
   1. Administration Class: 4.
   2. Color-code cross-connect fields. Apply colors to voice and data service backboards, connections, covers, and labels.

B. Using cable management system software specified in Part 2, develop Cabling Administration Drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable and label cable, jacks, connectors, and terminals to which it connects with same designation. At completion, cable and asset management software shall reflect as-built conditions.

C. Comply with requirements in Division 09 Section 09 91 23 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

D. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 4 level of administration.

E. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

F. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of TIA/EIA-606-A. Furnish electronic record of all drawings, in software and format selected by Owner.

G. Cable and Wire Identification:
   1. Label each cable within 4 inches (100 mm) of each termination point.
   2. Exposed Backbone Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet (4.5 m).
   3. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
      a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with name and number of particular device as shown.
      b. Label each unit and field within distribution racks and frames.
4. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

H. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA-606-A.

1. Cables use flexible vinyl or polyester that flex as cables are bent.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Installing Contractor to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:


2. Visually confirm Category 5e or Category 6, marking of outlets, cover plates, outlet/connectors, and patch panels.

3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

4. Test UTP backbone copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

   a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in “Test Instruments (Normative)” Annex, complying with measurement accuracy specified in “Measurement Accuracy (Informative)” Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

5. UTP Performance Tests:

   a. Test for each outlet. Perform the following tests according to TIA/EIA-568-B.1 and TIA/EIA-568-B.2:

      1) Wire map.

      2) Length (physical vs. electrical, and length requirements).

      3) Insertion loss.

      4) Near-end crosstalk (NEXT) loss.

      5) Power sum near-end crosstalk (PSNEXT) loss.

      6) Equal-level far-end crosstalk (ELFEXT).

      7) Power sum equal-level far-end crosstalk (PSELFEXT).

      8) Return loss.

      9) Propagation delay.

      10) Delay skew.
6. Coaxial Cable Tests: Conduct tests according to Division 27 Section "Master Antenna Television System."

D. Document data for each measurement. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections. Minimum acceptable level above testing standard is 3dBA. Although test equipment may "pass" a cable based on standard valves, SRP reserves the right to reject any cable test report indicating 3.0 dBA or less. Contractor shall repair or replace unaccepted cable at their expense.

F. Prepare test and inspection reports.

END OF SECTION 271500
SECTION 283111 - FIRE ALARM SYSTEM

PART 1 - GENERAL

1.1  SUMMARY

A. This Section covers addressable fire alarm systems for wet and dry sprinkler systems, clean agent systems, and building fire alarms.

1.2  GENERAL REQUIREMENTS

A. The Fire Alarm System Installing Contractor shall furnish all labor, equipment, and materials, and perform all operations in connection with the installation of a new addressable, networked fire alarm system.

1.3  RELATED WORK

A. Submittal Procedures Section  013300
B. Operations and Maintenance Section 017823
C. Wet Sprinkler Systems Section  211313
D. Dry Sprinkler Systems Section  211316
E. Clean Agent Systems Section  211318 (future)
F. Electrical work All Div 16 Sections

1.4  REFERENCES

A. SRP Administrative Fire Code
B. NFPA 13, 2007 edition Standard for the Installation of Sprinkler Systems
C. NFPA 13e, 2005 edition Fire Dept Operations in Properties Protected by Sprinkler and Standpipe Systems
1.5 QUALIFICATIONS

A. Designer Qualifications: Shop drawings and calculations must be prepared and submitted for approval, by a minimum NICET Level III certified technician.

B. Installer Qualifications: Project Manager or Office Superintendent must be a minimum NICET Level III certified technician.

1.6 SCOPE OF WORK

A. The project includes the design, fabrication and installation of a complete, code compliant, ready and operational closed circuit, addressable, automatic networked fire alarm system(s) as specified herein and indicated on the drawings.

B. When the work includes facilities that are presently controlled by various fire alarm control units (FACU) the Contractor shall install new FACUs in each of the buildings while the existing systems remain operating. Once the new fire alarm systems have been accepted by SRP, the existing fire alarm system, detection devices, notification appliances, conductor, and conduit shall be removed.

C. The alarm broadcast from each respective FACU shall be throughout each respective building for total evacuation of the occupants upon receipt of an alarm signal from any automatic or manual fire detection device.

D. The Contractor shall determine the means of routing the fire alarm conductors from each new FACU, detection devices, control wiring, and notification appliances. The Contractor shall obtain approval for the location of all equipment and associated wiring prior to installation from SRP. A smoke detector shall be furnished and installed by the Contractor in the immediate vicinity of all new fire alarm control equipment.

E. The scope of work includes the installation of all initiating devices, notification appliances and system control interfaces, etc. inside each building, as indicated on the drawings and identified in this specification.

F. The scope of work also includes training SRP personnel on the operation of the system, required maintenance tasks and frequencies, and the locations of all equipment necessary to maintain and operate the fire alarm system.

G. The Designer’s Scope of Work includes the writing of a Designer’s Narrative Report that includes the following minimum content. The Narrative Report is a project specific statement of how the designer has captured the Owner’s requirements for a fire alarm system. Minimum content in the Narrative Report is:
   a. Basis of Design
   b. Sequence of Operations
c. Specialized Fire Protection Equipment (including sequence of operation)
d. System Testing Requirements

H. The Designer is responsible for producing a Fire Protection Impairment Plan in accordance with the referenced codes and standards if the designed scope of work will require the impairment or disabling of the existing fire alarm system. The Designer’s Impairment Plan must be submitted to the SRP Fire Protection Coordinator for approval prior to producing final Construction Documents. The minimum content of the Impairment Plan is:

a. Scope of Impairment
b. Methods to Provide Equivalent Protection
   a) Maintaining Security Department Notification
   b) Maintaining Occupant Notification
   c) Maintaining Fire Detection and Suppression
c. Required Personnel and Materials
d. Impairment Precautions

I. The scope of work also includes that the Contractor read, understand, and implement the requirements found in the Designer’s Narrative Report and Fire Protection Systems Impairment plan that may accompany these specifications.

J. The scope of work includes the removal of the existing fire alarm system, equipment, conduit, and conductors. SRP reserves the right to delete this work from the scope of work prior to the award of the contract.

K. As identified on the drawings, the scope of work may include furnishing and installing a NOTI-FIRE-NET web server. The location of the internet connection will be coordinated between the Contractor and SRP.

1.7 CONTRACTOR RESPONSIBILITIES

A. The Contractor is responsible to install:

1. A fire alarm control unit including supervised power supplies, and distributed power supplies (where applicable).

2. Addressable manual fire alarm boxes at all exits and in the common areas, as shown on the construction drawings.

3. A new fire detection devices (in those environments suitable for proper operation), as shown on the drawings.

4. Audible notification appliance circuits as shown on the drawings.

5. Addressable monitor modules and addressable control relay modules, as shown on the drawings, described in this specification, and as necessary for proper system performance.
6. Metal raceway, conductors, fittings, and all other accessories required to provide a complete and operable fire alarm and emergency voice communication system.

B. The installation and wiring of all devices in accordance with the latest published revision of the manufacturer’s installation instructions to achieve the system operation and function as specified herein.

   a. The development of installation shop drawings for each fire alarm system installation in accordance with the applicable codes, cited in this specification. The Contractor shall submit the working drawings for review and approval by SRP.

C. Coordinating the installation of the fire alarm systems and testing of associated equipment and circuits with all related trades, Contractors, equipment maintenance and testing representatives, SRP and the authorities having jurisdiction. Where applicable, work and/or equipment provided in other sections and related to each fire alarm system shall include, but not be limited to:

   a. Sprinkler waterflow and valve supervisory switches. The Contractor shall be responsible for all testing and wiring up to and including connection to all sprinkler waterflow switches and valve supervisory switches. All sprinkler waterflow and supervisory switches shall be monitored for integrity in accordance with NFPA 72. The Contractor shall verify the quantity and location of all sprinkler waterflow and supervisory switches.

   b. HVAC Shutdown. The Contractor shall be responsible for all installation, programming, wiring, operation, and testing of all fire alarm system interfaces with HVAC units, duct detectors, fire or smoke dampers, and the BAS. All control and power wiring shall be inspected for compliance with NFPA 72. The Contractor shall verify the quantity and location of all HVAC units and duct detectors.

D. The removal of any existing fire detection and alarm system control equipment, components and related equipment that are not specified as being part of the new system. Existing fire alarm system wire and cable shall be removed and disposed of off-site by the Contractor in accordance with the requirements of SRP. Removal of existing equipment shall include all cutting, patching and painting of existing walls, hard ceilings and/or replacement of suspended ceiling tiles.

E. Providing all required documentation, as specified in this specification.

F. It shall be the responsibility of the Contractor to visit the site, observe the existing conditions, and confirm the required quantities of devices and specific options for locations of the same.

G. Coordinating the Acceptance Test of the networked fire alarm systems with the building operators, SRP, and other parties identified by SRP. Prerequisites to the Acceptance Test are:
1. Provide documentation of all system startup, and pre-requisite tests, and record of completion.

2. Provide a test plan that outlines the sequence of testing, who will test, and how the Acceptance Test results will be documented at the time of the testing. Failure to provide this for review will result in postponement of the Acceptance Test.

H. The Systems shall be tested in accordance with the latest published edition of the equipment manufacturers’ testing procedures and guidelines.

1.8 SUBMITTALS

A. Prior to performing any work, the Contractor shall include the following documentation in addition to those documents required elsewhere in this specification:

1. A schedule indicating the delivery dates of the equipment to be supplied; installation sequence; time frame and the total amount of on-site technical assistance time (in man-hours per phase) that the supplier of the equipment has included in their bid to comply with the requirements of this specification and SRP’s requirements; and final acceptance test dates to meet SRP’s scheduled project completion dates.

2. A preliminary Equipment List identifying the type, quantity, make, and model number of each piece of equipment to be provided under this submittal. The Equipment List shall include the type, quantity, make and model of spare equipment, as specified in this specification. Types and quantities of equipment submitted shall coincide with the types and quantities of equipment used in the battery calculations and those shown on the shop drawings. A final Equipment List shall be submitted with the Operating and Maintenance (O&M) manual, as specified in this specification.

3. If the Contractor is also the designer of the fire alarm system, provide a sequence of operation that describes how the system responds during an alarm, supervisory and trouble condition. The description shall include fire alarm control unit LEDs, audible and visible indications; initiating devices, notification appliances, and auxiliary functions (such as elevator recall, HVAC fan unit shutdown, and smoke control system operation). The description shall provide sufficient information so that the exact function of each installed device and appliance is known.

4. Manufacturer’s original product datasheets, specifications, installation instruction sheets, and descriptive information for all major components of the system. Copies are not acceptable. All equipment and devices to be furnished under this contract shall be clearly marked (highlighted) on the product datasheets.
5. Submit manufacturer’s specification sheets for the type of conductor and or wiring planned for use. Once a manufacturer is approved, the Contractor shall not change without prior approval from SRP.

6. Detail sheets from the manufacturer of the U.L. Listed through-penetration fire stop assembly.

7. Shop drawings (in accordance with SRP’ published CADD Standard) shall be submitted including a riser diagram of each complete fire alarm system and a complete set of point-to-point fire alarm control equipment installation diagrams; typical wiring diagrams are not acceptable.

8. A complete list of amperage requirements during normal, supervisory, trouble, and alarm conditions for each component of the system.

9. Preliminary battery calculations showing total standby power and total alarm power required meeting the specified system requirements. Final battery calculations shall be submitted with the O&M manual, as specified in this specification.

10. Preliminary system voltage drop calculations to assure that the system shall operate per the prescribed backup time periods and under all voltage conditions per UL and NFPA standards. Final voltage drop calculations shall be submitted with the O&M manual and As-built drawings.

   a. Voltage drop calculations can be performed with negligible inductance.

   b. The voltage drop calculation shall take into consideration the cross sectional area of each particular conductor for notification appliances (Circular Mils).

   c. The voltage drop calculations shall take into consideration the resistance in ohms of one circular mil foot of conductor in the calculations. Information on this can be found in Chapter 9, Table 8 of the National Electrical Code.

11. Test Plan must be submitted three weeks prior to the scheduled date of the Acceptance Test for review and approval by SRP’s Fire Marshall.

1.9 SCHEDULING

A. Where the Fire Protection Contractor is not working for a General Contractor, the Contractor shall provide a schedule to SRP indicating the installation sequence and time frame prior to beginning work. The Contractor shall provide weekly updates to SRP. It is the Contractor’s responsibility to have all wiring, circuit testing and device installation completed in time for the equipment supplier to make all final connections and conduct all tests as outlined in these specifications.

B. The Contractor is responsible for coordinating the Acceptance Test for each fire alarm system with SRP and other necessary parties identified by SRP.
1.10 SPARE PARTS

A. The manufacturer shall provide a suggested spare parts list with firm unit prices maintained for the duration of the manufacturer's warranty period as specified herein, for items such as power supplies, central processor units, fault isolator modules, monitor addressable modules, addressable control relay output modules and other modules that may be long lead replacement items. Costs for programming changes shall also be submitted with the bids. Guarantee firm costs for two years.

B. All spare parts shall be neatly and protectively packed in one or more cartons. The quantity, manufacturer, and model of each unit in the carton shall be identified on the outside of the carton. In addition, the name, address, and telephone number of the Contractor and of the manufacturer's local representative, plus the date of delivery, shall be neatly identified on the cover of each carton.

C. For Protects Less than 10,000 square feet:
   1. The Contractor shall furnish one additional smoke detectors and addressable bases as spares.
   2. The Contractor shall furnish one additional manual fire alarm boxes as spare.
   3. The Contractor shall furnish an additional one of each type of notification appliances (horns, horn/strobes, speakers, speaker/strobes and strobes of various candela ratings) installed in the building as spares.

D. For Projects over 10,000 square feet
   1. The Contractor shall furnish an additional 5% of the smoke detectors and addressable bases as spares.
   2. The Contractor shall furnish an additional 5% of the manual fire alarm boxes as spares.
   3. The Contractor shall furnish an additional 5% of each type of notification appliances (horns, horn/strobes, speakers, speaker/strobes and strobes of various candela ratings) installed in the building as spares.

1.11 AS-BUILT DRAWINGS

Any changes to the designed location of notification appliances and detection devices shall be approved prior to installation. Additionally, the as-builts shall show how the cable and conduit has been routed and the location of all terminal and junction boxes. The as-builts shall account for all field changes that were made during the installation.

A. Per SRP requirements, the Contractor shall develop a matrix of operations for each detection device (point), grouped for each building, which shows the device address, location, and function.
B. The Contractor shall show the equipment and addresses associated with each device, as listed in this specification, on a separate layer and provide copies of only this layer shown on the floor plans as part of the set of as-built drawings.

C. Upon completion of the installation of the system and a minimum of one (1) week prior to the Acceptance Test, the Contractor shall deliver two (2) complete sets of reproducible, full-size, appropriately scaled, as-built drawings to SRP.

1.12 TEST PLAN

A. Upon completion of the installation of each system and a minimum of two (2) weeks prior to the Acceptance Test, the Contractor shall deliver two (2) complete sets of the Test Plan, which shall describe how the system shall be tested. This shall include a step-by-step description of all tests and shall indicate type and location of test apparatus to be employed. All tests shall be conducted in the presence of SRP and other parties identified by SRP and shall not be conducted until the “Test Plan” is approved.

1.13 OPERATION AND MAINTENANCE MANUALS

A. In addition to items specified in Division 01 Section 017823 "Operation and Maintenance Data," include the following:

1. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.

2. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.

3. Record copy of site-specific software.
   a. Program Software Backup: On magnetic media or compact disk, complete with data files.
   b. Software operating and upgrade manuals.
   c. Device address list.
   d. Printout of software application and graphic screens.

4. Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:
   a. Frequency of testing of installed components.
   b. Frequency of inspection of installed components.
   c. Requirements and recommendations related to results of maintenance.
   d. Manufacturer's user training manuals.

5. Manufacturer's required maintenance related to system warranty requirements.

6. Abbreviated operating instructions for mounting at fire alarm control unit.
PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. This specification identifies the essential functional requirements of the automatic networked fire alarm systems for installation. The manufacturer’s equipment (hardware and software) and system configuration shall comply with or exceed the functional intent of this specification.

B. Any case of error, omission, discrepancy, inconsistency or lack of clarity in the specifications or drawings shall be promptly identified to SRP

2.2 QUALIFICATION OF MANUFACTURERS

A. Acceptable manufacturers:
   1. Notifier Fire Systems (Northford, CT) or approved equal

2.3 QUALITY ASSURANCE

A. Each component of the networked fire alarm systems shall be Listed as a product of a single fire alarm system manufacturer under the appropriate category for the intended use by Underwriters Laboratories, Inc. (UL) and shall bear the “UL label”. All control equipment shall be listed under UL category UOJZ Control Units System as a single unit. Partial Listings, or multiple listings for various major sections of the control equipment, shall not be acceptable. Electrical components, devices, and accessories shall be Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

B. All control equipment shall have transient protection devices that comply with the requirements outlined in UL 864, Standard for Control Units for Fire-Protective Signaling Systems.

C. All materials and equipment supplied shall be new, first quality and the manufacturer’s best type and latest model capable of complying with all requirements of this specification and shall have been in continuous production and in continuous service in commercial applications for at least one year. Obsolete equipment shall not be used.

2.4 FIRE ALARM CONTROL UNIT NETWORK

A. The control units are scheduled for installation:

(Designer to list panels to be installed and/or networked together.)
2.5 FUNCTIONAL DESCRIPTION OF THE SYSTEM

A. The following sections are a functional description of each fire alarm system in each building unless otherwise noted.

B. The new FACU shall include new control/communications equipment which is UL Listed or FM approved to operate with the submitted manual fire alarm boxes, sprinkler waterflow switches, valve supervisory switches, heat detectors and smoke detectors, alert SRP security, alert building occupants using audible and visible notification appliances, supervise each system for conditions which would impair proper system operation, annunciate such abnormal conditions, and where applicable, control related equipment as indicated on contract documents such as air handling units and smoke control.

C. Alarm Condition

1. The system operation shall be such that the alarm operation of any alarm-initiating device shall not prevent the subsequent alarm operation of any other initiating device due to wiring or power limitations.

2. The system alarm operation subsequent to the alarm activation of any manual fire alarm box, any system-type automatic detection device (smoke detector or heat detector), or sprinkler waterflow switch shall automatically perform the functions contained in this section and operate as follows:
   a. All audible notification appliances in the building, as designated on the drawings, shall initiate the alarm evacuation sequence.

3. Auxiliary Functions
   a. HVAC Fan Units

   The operation of duct smoke detectors shall cause the appropriate fan control relays to activate the shutdown of the associated fan(s).

   The Contractor shall deliver in a type written, tabular form, the fire detection device type, device number, location, and point identification of each fire detector installed. All duct smoke detectors shall be identified as to which air-handling units they are protecting.

D. Supervisory Condition

1. The FACU shall have a “SYSTEM SUPERVISORY” LED and a supervisory signal “ACKNOWLEDGE” switch.

E. Trouble Condition
1. The FACU shall have a “SYSTEM TROUBLE” LED and a trouble signal “ACKNOWLEDGE” switch.

2. Unacknowledged alarm messages shall have priority over trouble messages, and if such an Alarm occurs during a Trouble sequence, the Alarm condition shall have display priority.

F. System Supervision

1. All wiring extending from the FACU and emergency voice evacuation system components shall be supervised for opens, shorts, and grounds. Systems containing unsupervised wiring of any type shall not be acceptable.

2. The occurrence of any fault shall activate the system trouble circuitry, but shall not interfere with the proper operation of any circuit that does not have a fault condition.

3. Incoming 120 VAC line power shall be supervised so that any power failure shall be audibly and visually indicated at the control unit.

4. Batteries shall be supervised so that a low battery condition or disconnection of the battery shall be audibly and visually indicated at the control unit and at the Police Command Center.

5. Interconnected Fire Safety Systems (releasing panels) shall be monitored for alarm and trouble conditions. The supervisory signal shall activate any time the monitored system indicates an off-normal condition.

G. System Reset

1. A “SYSTEM RESET” button shall be used to return the system to its normal state after an alarm condition has been remedied. Printed messages shall provide operator assurance of the sequential steps (i.e.: “IN PROGRESS”, “RESET COMPLETED”) as they occur, should all alarm conditions be cleared.

2. Should an alarm condition continue to exist, the system shall remain in an abnormal state. System control relays shall not reset. The control unit “ALARM” LED shall remain on. These points shall not require acknowledgment if they were previously acknowledged.

2.6 MINIMUM COMPONENTS

A. The automatic fire detection and alarm system shall consist of, but not be limited to:

1. In each building, a new FACU containing a Central Processing Unit (CPU) power supply, LED indicators, control switches and relays.

2. Input Devices (waterflow switches, tamper switches).
3. Addressable, analog photoelectric smoke detectors, with standard bases.


5. Addressable monitor modules and control relay output modules.

6. Fault Isolator Modules.

7. Annunciation at the FACU.

8. A permanent record of the alarm signal, time, and date.


10. Battery backup supervision.

11. Automatic supervision of alarm initiating circuits and notification appliance circuits.

2.7 FIRE ALARM CONTROL UNIT (FACU)

A. Acceptable Manufacturers and Models
   a. NFS 3030
   b. NFS 640
   c. NFS 320

B. The control unit shall be modular in construction and receive supervised plug-in component boards to provide system functions as hereinafter specified and/or to accommodate future system expansions.

C. A minimum of two (2) signaling line circuits shall be used, with devices equally distributed on each circuit. Each signaling line circuit shall be loaded to no more than 75% of its manufacturer specified capacity. Additional SLCs shall be furnished and installed as necessary to comply with this requirement.

D. A minimum of three fault isolator modules shall be used on each signaling line circuit. One fault isolator module shall be installed at the point the SLC leaves the FACU and at the point where new installed Class A (Style 6) SLCs return to the FACU. Fault isolator modules shall be placed in order to minimize loss of addressable devices. Fault isolator modules shall be placed at each floor, where the SLC spans multiple floors. In all cases, no more than 25 devices shall be installed on a circuit between fault isolators.

E. The control unit shall support a minimum of two (2) visible (strobe) and two (2) audible notification appliance circuits to provide an evenly distributed number of notification appliances per floor and circuit. All visible (strobe) notification appliance circuits shall be independent from the audible notification appliance circuits. Each circuit's power load shall not exceed 75% of the individual circuit power available from the
FACU and new installed circuits shall be Class A (Style Z) circuits. Additional NACs shall be furnished and installed as necessary to comply with this requirement.

F. Power for all notification appliances shall come from integral power supplies in the control unit. Remote power supplies, if needed, shall be of the same manufacturer as the FACU. The location of all remote control equipment, such as remote power supplies (extenders) shall be approved prior to installation by SRP. All locations containing remote control equipment (such as a power supply extender) shall be protected with a smoke detector, in accordance with NFPA 72.

G. The control unit and system wiring requirements shall be specified by the equipment supplier in their bid to the Contractor.

H. At a minimum, the FACU shall contain the following:

1. Annunciation. Annunciation shall be an integral part of the control system and shall indicate alarm, supervisory and trouble conditions and the corresponding address. The following initiating devices shall be annunciated individually:
   a. Smoke detectors;
   b. Sprinkler waterflow devices and tamper switches;
   c. Manual fire alarm boxes;
   d. Fire suppression releasing panel signals;

I. The functional operation of the control unit shall be established by programmable software.

1. The operating program shall be contained in nonvolatile EEPROM memory and shall be configurable in any of the following ways:
   a. At the factory;
   b. At the job site via modem; or
   c. At the job site via standard terminal or standard laptop computer.

J. Access and control of the operating program shall be restricted to proper personnel designated by SRP.

1. The control unit shall have a minimum of two (2) security levels. Each level shall have individual passwords. Illegal access attempts shall be rejected by the system and shall be displayed and recorded in the history file with time and date.

2. The “First” security level shall be the lowest security level and shall only allow access to the system status levels and lists and shall not impair system operation.
3. The “Second” security levels shall allow access to the operating system.

4. Accessing a programming function that disables normal system operation shall initiate a trouble sequence.

K. The system response to alarms shall be 2.5 seconds maximum for the first alarm.

L. The control unit shall contain an integral standby battery to provide continuous power in the event of AC power failure.

1. The batteries shall be capable of providing [24] hours of backup power for the system and enough remaining power to operate all notification appliances for [15] minutes at the end of the [24] hour period.

2. The calculations for battery standby shall include a “safety factor” (reserve power estimate) of a minimum 15%.

3. Transfer from AC to battery power shall be instantaneous when AC voltage drops below 85 percent input. Transfer to battery standby shall be indicated by display and recorded in the history file with time and date. The indication shall be "AC OFF".

4. Loss of building power for the system shall automatically and immediately cause transfer of the system to battery power and cause all audible trouble signals to sound. Upon return of building power, the system shall automatically retransfer thereto, and the batteries shall automatically recharge.

5. During battery operation, the control unit shall process all inputs. However, the display shall provide five (5) seconds of indication for each new input condition, then turn off to conserve battery power.

6. The control unit shall have a dual rate battery charger that shall maintain the batteries in a fully charged condition and shall provide recharge of the batteries to full capacity in forty-eight (48) hours.

M. Output Function Modules. The control unit shall utilize output function modules to control output functions. The modules shall plug into the control unit motherboard. The functions and presence of each module shall be supervised, and the “Second” and “Third” level passwords shall enable the user to request a list that locates the module by panel and slot within system. All modules shall be individually programmable by circuit as hereinafter specified.

1. Addressable control relays shall be provided for each of the following auxiliary functions:

   a. HVAC shutdown (where applicable);

   b. Damper control;
c. Fire suppression releasing panel signals;
d. Designer to add other locations such as doors.

2. The Contractor shall field verify the number and location of all auxiliary function control circuits. Additional addressable control relays shall be furnished and installed, as necessary, to comply with this requirement.

2.8 SYSTEM FIELD DEVICES - GENERAL

A. Connection of initiating devices and notification appliances to appropriate signaling line circuits and notification appliance circuits from each floor shall be as indicated on the installation drawing from the equipment supplier.

B. Addressable devices shall operate under the following ranges of environmental conditions:
   1. Ambient Temperature: 32-100 degrees Fahrenheit.
   2. Relative humidity: 0-93 percent, non-condensing.
   3. Air velocity: 300 feet per minute.

C. Each addressable device shall include a means to assign a unique address code to the device in the field. This address code shall serve as the means by which the system program recognizes the device.

D. The address of each addressable device shall be clearly and permanently indicated in the base of each detector or on the face of monitor modules, control relay output modules, and manual fire alarm boxes.

E. Failure of any single device shall not hinder the operation of any other devices connected to the signaling line circuit.

F. Failure of the control unit to properly communicate with any addressable device shall initiate the proper trouble sequence. While in this trouble condition, the control unit shall cause actual alarm input from devices to override trouble alarm.

2.9 AUTOMATIC DETECTORS – GENERAL

A. All automatic smoke detectors shall be of the addressable, analog photoelectric type and shall be interchangeably mounted into a common twist-lock base.

B. The control unit shall recognize changes of detector type in each location and provide proper indication that reprogramming for the affected address is required.

C. Detector bases shall have Brady, or SRP approved equal, adhesive markers attached to them indicating the address of the detector. Markers shall be installed, by
the Contractor, on the inside of the base and lettering shall be a minimum of 12 point.

2.10 ADDRESSABLE PHOTOELECTRIC SMOKE DETECTORS

A. Photoelectric smoke detectors shall have a general alarm setting in all common spaces of 3.0% - 4.0% per foot obscuration.

B. The detectors shall provide a combination alarm/power LED. The LED shall flash under normal conditions, indicating that the detector is operational and in regular communication with the control unit. The LED shall be placed into steady illumination under an alarm condition. An output connection shall also be provided in the base to connect an external remote alarm LED.

C. ACCLIMATE detectors or approved equal shall be installed in each employee break room where shown on the construction drawings.

2.11 DETECTOR BASES

A. Automatic detectors shall utilize a common, plug-in, twist-lock, tamper-resistant type base that accommodates photoelectric and thermal detectors. Detectors shall be interchangeable to simplify field conversion.

B. Removal of the detector from the base shall cause a trouble indication at the FACU. Removal of the detector shall not disrupt the alarm circuit wiring or prevent the receipt of alarms from other devices operating in the circuit.

C. Insertion of an incorrect detector type into the base shall cause a "Wrong Device" trouble condition at the FACU until the proper type of detector is installed, or the system is re-programmed. The system program shall recognize the insertion of a wrong device and shall automatically default to the setpoint values corresponding to the inserted device, and shall monitor alarm and trouble conditions according to the default parameters.

D. Provide bases constructed of white, high impact polycarbonate designed for mounting on a standard 3-1/2 inch or 4-inch octagonal or 4-inch square outlet box. Provide screw terminal connections for No. 12 AWG wire.

2.12 ADDRESSABLE MANUAL FIRE ALARM BOXES

A. Manual fire alarm boxes shall be of the non-coded, double-action type, surface or semi-flush mounted, as selected by SRP, with integral contact monitor module to provide addressable operation.

B. Faceplates shall be red with raised white identification lettering.

C. Stations shall mechanically latch after operation, with a key operated reset feature, keyed the same as FACU.
D. Every manual fire alarm box shall have an engraved nameplate permanently installed on its face or Brady, or SRP approved equal, adhesive markers attached to them indicating the address of the station. The Contractor shall install markers on the outside of the manual fire alarm box and lettering shall be a minimum of 12 point.

2.13 ADDRESSABLE MONITOR MODULES

A. Furnish and install addressable monitor modules to supervise and monitor the status of each non-addressable device, such as conventional spot-type heat detectors, sprinkler workflow alarm switch and valve supervisory switch contacts, special hazard fire suppression alarm contacts and fire pump supervision contacts.

B. Each addressable monitor module shall be able to support any number of normally open (N/O) devices. Wiring to the devices(s) being monitored shall be Class A supervised (Style D). Module status (normal, alarm, supervisory, trouble) shall be transmitted to the FACU.

C. The addressable monitor modules shall provide address-setting means.

D. Each addressable monitor module shall be provided with a switch to provide a means of disconnecting the initiating circuit to allow work to be performed on the initiating circuit without causing an alarm.

E. An LED shall be provided which shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control unit.

2.14 ADDRESSABLE CONTROL RELAY OUTPUT MODULES

A. Provide addressable control relay output modules to permit hardwired control capability from the signaling line circuit. Relay contacts shall be DPDT, rated 2 amperes at 24 VDC.

B. Furnish and install addressable control relay output modules for the functions as specified in this specification.

C. Each relay shall operate according to the control program resident in the FACU. Relays shall be supervised for trouble conditions (open, short, device missing/failed) at the FACU.

D. Relay output modules shall include a mounting plate for installation in a junction box.

E. The relay output module shall provide address-setting means and shall also store an internal identifying code that the control unit shall use to identify the type of device.

F. An LED shall be provided which shall flash under normal conditions, indicating that the Relay Output Module is operational and is in regular communication with the control unit.

G. Provide transient suppressors for inductive loads.
2.15 FAULT ISOLATOR MODULES

A. Fault isolator modules shall provide short circuit isolation for signaling line circuit wiring. Fault isolator modules shall be listed to UL 864, *Standard for Control Units for Fire-Protective Signaling Systems*.

B. The isolator module shall mount directly to a minimum 2 1/8 inch deep, standard 4-inch square electrical box, without the use of special adapters or trim rings.

C. Power and communications shall be supplied by the signaling line circuit.

D. Fault isolator modules shall report faults to the host FACU.

E. After the wiring fault is repaired, the fault isolator modules shall test the lines and automatically restore the connection.

2.16 AUDIBLE AND VISIBLE NOTIFICATION APPLIANCES

A. General

1. All notification appliances shall be rated at 24 VDC and shall be powered by supervised notification appliance circuits originating from the FACU or remote power extenders listed for this purpose.

2. Notification appliances installed in the men and women rooms shall be weather proof.

B. Visible (strobe) notification appliances

1. All strobes shall conform to the requirements of NFPA 72, UFAS and the ADA and shall be listed to UL 1971, *Standard for Signaling Devices for the Hearing Impaired*.

2. All visible notification appliance circuits shall be synchronized and have a rated light output as indicated on design drawings.

3. A strobe notification appliance shall be installed on the outside of every entry door to a space that is protected by a HALON suppression system. The body of the notification appliance shall have the words HALON on it.

2.17 LOUD HORNS

A. To be added by Designer where required

2.18 BEACONS

2.19 FIRE ALARM SYSTEM PRINTER
A. When shown on the drawings, provide a fire alarm system printer Listed and labeled as an integral part of the fire alarm system. The system printer shall be UL listed to Standard 864 under UL category UOXX System Control Unit Accessories and supervised by the FACU.

B. The system printer shall record all alarm, supervisory, and trouble events. The printout shall include the type of signal (alarm, supervisory, or trouble) the device identification, date and time of the occurrence. The printout differentiates alarm signals from all other printed indications.

C. The system printer shall be arranged to have the ability to provide hard copy records of system events, addressable analog sensor reports (sensitivity reports, etc.), Walk-test system testing reports and History files.

D. Printer Ribbons: The Contractor shall furnish 2 spare printer ribbons.

E. The fire alarm system printer shall be installed in the vicinity of the FACU. If adequate table space is not provided by SRP for the printer, the Contractor shall furnish and install an adequately sized table.

2.20 WIRE GAUGE

A. Unless otherwise indicated on the design drawings or manufacturer’s specifications, the following minimum sizes of conductors shall be used for all new wiring:

1. Power Supply Conductors (Primary and Secondary) No. 12 AWG
2. Signaling Line Circuit Conductors No. 14 AWG
3. LCD Remote Alarm Annunciators No. 14 AWG
4. Notification Appliance Circuits No. 14 AWG
5. Speaker Circuits No. 14 AWG

B. All Conductors shall be plenum rated as described in the National Electrical Code

PART 3 - EXECUTION

3.0 INSTALLATION

A. The Contractor shall plan and use caution while removing existing ceiling tiles for the installation of the fire alarm system and voice evacuation components. All ceiling tiles shall be re-installed by the Contractor. Broken ceiling tiles and their location shall be reported to SRP.
B. The supervisory work of the qualified manufacturer's technical representative shall include, but not necessarily be limited to, checking all the system wiring connections; advising the Contractor regarding technical details of the installation; and the adjustment and testing of all components of the system in order to ensure a complete and satisfactorily operable system. The manufacturer's technical representative shall be on site, as required by SRP, during the entire installation and connection of the new control equipment. The technical representative shall monitor all wiring changes and assist the Contractor to ensure a smooth transition to the new control equipment. The cost of the technical representative shall be paid by the Contractor and shall be included in the bid price. The minimum amount of man-hours for this technical representative to be carried is 40 hours. The Contractor shall identify the amount of manufacturer's technical representative’s man-hours that shall be provided and the per-hour cost (including the cost for possible overtime [premium] hours) for the technical representative’s time.

C. The manufacturer's technical representative shall also be required to instruct designated building and management personnel in the general operation of the system and to give the designated personnel an overview of the system functions when the system is in normal, supervisory mode, alarm mode, and trouble mode, as specified in this specification.

D. Automatic Detectors

1. In general, automatic detectors shall be mounted on the structural ceiling or finished ceiling and not on the bottom or side of any type of construction or structure, which extends down from the ceiling.

2. Automatic detectors shall be located near points where air currents normally intersect. Detectors shall not be located in the direct path of the draft from an HVAC air supply grille, a door, window, or hallway. Detectors shall be installed a minimum of three (3) feet from an HVAC air supply diffuser, in accordance with NFPA 72.

3. All automatic detectors shall be installed as indicated on the plans, within five (5) feet of the location shown on the drawings to accommodate construction, and readily visible from the floor. The mounting location of every device shall be approved by SRP.

E. Addressable Photoelectric Smoke Detectors

1. Addressable analog photoelectric smoke detectors shall be installed as shown on the drawings. These common area detectors shall be spaced at thirty (30) foot centers, and in accordance with NFPA 72 and the manufacturer’s installation instructions. Smoke detectors shall only be installed in those environments suitable for proper smoke detector operation.

F. Addressable Manual Fire Alarm Boxes
1. Unless otherwise directed, manual fire alarm boxes shall be installed at every exit. Install in accordance with NFPA 72 and as shown on the drawings.

2. Manual fire alarm boxes shall be installed within five feet (5’) of each exit that they serve and mounted no higher than forty eight inches (48”) above the finished floor. All boxes shall have a protective cover installed over them in the vehicle repair bays, shops, and warehouse areas.

G. Addressable Monitor Modules

1. Addressable monitor modules shall include a mounting plate for installation in a junction box or shall be mounted in a locked cabinet or approved box, as shown on the manufacturers recommended specifications.

H. Audible and Visible Notification Appliances

1. The notification appliances shall be installed in accordance with the recommended audibility levels and the required illumination levels as described in NFPA 72. The minimum acceptable decibel level is 15 dBA over background noise. The maximum acceptable decibel level is 110 dBA.

2. All notification appliances shall be installed in environmental conditions in accordance with their Listing and manufacturer’s specifications and installation instructions.

I. Notification Appliance Circuits

1. Notification appliance circuits shall not be installed in the same raceway with signaling line circuits unless approved in writing by the networked fire alarm systems supplier.

2. Notification appliance circuits and control equipment shall be arranged and installed so that loss of any one (1) notification appliance circuit shall not cause the loss of any other notification appliance circuit in the systems.

J. Labeling and Marking

All of the hardware covered in Part 2 and Part 3.1 of this Specification shall have Brady adhesive markers, or SRP approved equal, attached to them indicating the address of the hardware. Markers shall be installed, by the Contractor, on the inside of the base and lettering shall be a minimum of 12 point

3.2 WIRING

A. All wiring shall comply with this section.

B. The entire wiring and raceway system for the networked fire alarm systems shall be in full accordance with NFPA 70, National Electrical Code.

C. The Contractor shall furnish and install low voltage surge arrestors on all SLCs, NACs, transmitter, and auxiliary control circuits for all circuits that leave the building shell. Units shall be UL 497B compliant with a 30 volt clamping level and have a re-
response time of 5 nanoseconds. The Contractor shall install such devices in strict ac-
cordance with manufacturer's recommendations. Acceptable manufacturer: Edco,
Inc., Ocala, Fl, model numbers P264, PC-642030XLC. The Contractor shall verify
device compatibility with Notifier.

D. The Contractor shall furnish all metal raceway, wiring, outlet boxes, junction boxes,
cabinets, labels and similar devices necessary for the complete installation of the fire
alarm systems. All wiring shall be of the type as specified herein and recommended
by the manufacturer and shall be installed in metal raceway throughout.

E. Terminal cabinets with side hinged, lockable red covers, supplied by Space Age
Electronics, Marlboro, MA, or approved equal shall be provided at all junction points.
All conductor splices shall be made on screw-type terminal blocks – wire nuts, butt,
crimp or screw type connectors shall not be used. All terminals within a terminal
 cabinet shall be properly and permanently labeled. All junction box covers shall be
painted red.

F. Raceways containing conductors identified as "Fire Alarm System" conductors shall
not contain any other conductors, and no AC carrying conductors shall be allowed in
the same raceway with the DC fire alarm detection and signaling conductors.

G. The conductors for the notification appliance circuits shall not be installed in the
same raceway as the conductors for signaling line circuits unless written certification
from the manufacturer is supplied to SRP indicating that the inclusion of these cir-
cuits in the same raceway is acceptable and that no additional consideration is
needed for these circuits.

H. All existing wiring shall be tested for abnormal conditions (grounds, shorts, opens,
etc.) prior to reuse. In general, existing initiating device circuits shall be reused as
signaling line circuits, if the circuit is not loaded to more than 75% of the available
circuit loading and the distance limitations as set forth by the manufacturers recom-
mended specifications are not exceeded; existing notification appliance circuits shall
be reused, only if the existing circuit is not loaded to more than 75% of the available
power for the circuit from the FACU. In the event that a signaling line circuit or a no-
tification appliance circuit load exceeds 75% of the available circuit loading new cir-
cuits shall be installed.

I. All wiring shall test free from grounds and short circuit faults. The testing results shall
be recorded, signed by the Contractor and forwarded to the supplier and SRP. No
connections to the FACU shall be made until the system wiring has been accepted
by the equipment supplier.

J. All conductors installed in ducts, plenum, air handling spaces and the under floor of
computer rooms shall comply with the applicable sections of NEC Section 300.22.

K. Color coding of conductors shall be approved by SRP. Unless otherwise indicated,
the color code for all fire alarm and emergency voice evacuation system conductors
shall be as follows:
1. Signaling line circuits and initiating device circuits shall be red and black. Red shall be positive and black shall be negative.

2. Audible notification appliance circuits shall be blue and white. Blue shall be positive and white shall be negative (NAC).

3. Flashing strobe circuits shall be orange and yellow. Orange shall be positive and yellow shall be negative (NAC).

4. Two wire notification appliance circuits shall be blue and white. Blue shall be positive and white shall be negative.

5. Sprinkler/standpipe circuits shall be red and black. Red shall be positive and black shall be negative.

6. Smoke detector power circuits shall be brown and violet. Violet shall be positive and brown shall be negative.

7. Auxiliary remote power supply circuits shall be brown and violet. Violet shall be positive and brown shall be negative.

8. Electro-magnetic door hold-open circuits shall be gray and gray.

9. HVAC shut-down and damper circuits shall be orange and yellow.

10. Bond wires from the control unit to the ground rod, and all required bonding conductors shall be green.

11. AC supply circuit to the main FACU shall be white, black and red. The black shall be one phase, and the red shall be the opposite phase, if required. The white shall be the neutral. If a separate feed is required for the battery charger, it shall be black and white unless the main FACU requires only one AC feed. In that case, the conductors to the battery charger shall be red and white.

L. All fire alarm conductors shall be installed in EMT as a minimum. Minimum conduit size is ¾-inches. All conduits in occupied areas shall be concealed.

M. All junction and pull box covers shall be red. Label all conduits every 10’ “Fire Alarm” or approved equal, in red letters.

N. Exposed raceways shall be run parallel and perpendicular to the walls and ceilings. Wherever practical, exposed raceways shall be run on the ceiling as close as possible to a wall or as high as possible on a wall. Where exposed raceways shall cross under a structural beam or rib, they shall be run down on one side of the beam or rib, across its bottom, and up to the ceiling on the other side of the beam or rib. No spanning from beam to beam or rib to rib shall be permitted. The use of a raceway body on one side of a beam or rib shall be permitted provided it shall be readily accessible. Where metal raceway is installed exposed, it shall be painted to match the walls and/or ceilings on which it is installed, as instructed by SRP. The method and
location of all exposed raceways shall be approved by SRP prior to start of any installation work.

O. Fault isolator modules shall be furnished as required and shall be mounted as directed by the manufacturer. The field location of the fault circuit isolators shall be labeled so that the devices may be easily located, and that location shall be noted on the point-to-point and as-built drawings.

P. The power employed to operate the fire alarm systems shall have a high degree of reliability and capacity for the intended service. Connections to this power service shall be made on a dedicated branch circuit(s). The circuit shall be mechanically protected.

Q. Circuit disconnecting means shall have a red marking, shall be accessible to authorized personnel, and shall be identified as “FIRE ALARM CIRCUIT CONTROL.” The location of the circuit disconnecting means shall be permanently identified on a nameplate installed on the inside of the FACU.

R. All wiring within the control unit shall be neatly served in the panel gutters and be secured by means of Thomas & Betts "Ty-Raps" or by other approved means.

S. All conductors and EMT shall be installed in a neat and workmanlike manner. Vertically and horizontally positioned EMT and or conductors shall be supported in accordance with good tradesman practices and including but not limited to the NEC Sections 376 and 378.

T. Where penetrations of floor slabs, fire-resistance rated walls and/or smoke barrier walls are made, the wiring shall be sleeved in metal raceway and the penetrations shall be fire-stopped with approved or UL Listed through-penetration firestop assembly material acceptable to SRP.

3.3 ACCEPTANCE TEST WITNESSED BY SRP

A. Prerequisites to the Acceptance Test
   1. Submittal of a Test Plan for approval (three weeks prior to proposed test date).
   2. Completion of tests on all components in accordance with the Test Plan by Contractor and manufacturers’ reps.
   3. Submittal of as-built drawings.

B. Before the installation will be considered complete and acceptable by SRP, the entire system must pass an Acceptance Test. This test shall be coordinated and performed by the Contractor, in the presence of a representative of the manufacturer, SRP, and other interested parties identified by SRP. The test shall not be conducted until all parties agree on the scheduled test date.

C. The Contractor shall provide all the necessary personnel and equipment to conduct the tests.
D. At a minimum, the Contractor shall perform the following:

1. Operate every building fire alarm device to ensure proper operation, correct annunciation at each remote annunciator (as shown on the drawings) and at the control unit, and proper operation of all alarm detection and control devices, horns, speakers, and auxiliary functions. Where applying heat would destroy any detector, they may be manually operated.

2. The signaling line circuits and the notification appliance circuits shall be opened in at least two locations per floor to check for the presence of correct supervisory circuitry.

3. One-half of all tests shall be performed on battery standby power.

E. If the Final Acceptance Test fails, the Contractor shall pay all costs incurred to SRP for any and all reacceptance testing.

F. Upon satisfactory completion of the tests, the Contractor shall leave the fire alarm and fiber network systems (if installed) in proper working order and without additional expense to SRP, shall replace any defective materials or equipment provided by the Contractor under this Contract within two years from the date of final acceptance by the awarding authority.

3.4 TRAINING REQUIREMENTS

A. Security Personnel: Prior to final acceptance of the fire alarm and emergency voice evacuation system, the Contractor and supplier shall provide operation training to each shift of the building’s designated Security personnel. Each training session shall be a minimum of 1 hour and shall be conducted on shift or at a time acceptable to the building’s operators. Each session shall include an overview of the system and the devices connected to it, emergency procedures (including alarm, trouble and supervisory condition procedures), control unit operation, and safety requirements. Each session shall include a complete demonstration of the system. Dates and times of each training period shall be coordinated through SRP, not less than two weeks prior to the training session.

B. SRP Maintenance Technicians: The Contractor shall arrange for manufacturer training representatives to provide the necessary factory training for operation and troubleshooting of the installed equipment to the buildings property management and maintenance technicians. This training shall include providing the Manager with all access codes and written certification that he is authorized to operate and troubleshoot the equipment supplied by the manufacturer. If this training shall be conducted off-site, all additional costs (transportation, lodging, meals, etc.) associated with the off-site training shall be included in the bid for four (4) maintenance personnel to travel to the off-site training location.

1. Training shall specifically include the procedure for printing the FACU’s history log to the printer on a weekly basis.
3.5 CLEANING AND ADJUSTING

A. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and marred finish to match original finish. Clean unit(s) internally using methods and materials recommended by manufacturer.

3.6 EQUIPMENT REMOVAL

A. Once the new fire alarm and voice evacuation system has been accepted by SRP, the Contractor shall completely remove the existing fire detection, notification appliances, conductors, and EMT. The equipment removed shall be boxed, labeled, and delivered for inspection to SRP. All removed and or unused, fire alarm components shall be removed and disposed of properly off-site by the Contractor.

B. Remove all conductors connected from the removed devices and appliances.

C. The Contractor shall perform all removal work efforts in accordance with the best and most modern practices.

D. The preparation, installation, and clean up of all UL Listed through-penetration fire-stop assemblies needed as a result of this work shall be the responsibility of the Contractor and shall be coordinated with SRP.

END OF SECTION
SECTION 28 3164

[FIRE ALARM VOICE EVACUATION SYSTEM] [FIRE DETECTION AND ALARM SYSTEM]

PART 1 - GENERAL

1.1 REFERENCES

A. The publications listed below form a part of this specification section to the extent referenced. The publications are referred to within the text by the basic designation only. Use the latest edition, unless noted otherwise.

B. [ACOUSTICAL SOCIETY OF AMERICAN (ASA)]


C. AMERICANS WITH DISABILITIES ACT (ADA)

1. ADAAG Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities

D. [ASME INTERNATIONAL (ASME)]

1. ASME A17.1 Safety Code for Elevators and Escalators

E. [ASTM INTERNATIONAL (ASTM)]

1. ASTM F402-05 Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings

F. FM GLOBAL (FM)


G. INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

2. IEEE C62.41.2 Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

H. INTERNATIONAL CODE COUNCIL


I. [INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)]

1. IEC 60268-16 Sound System Equipment-Part 16: Objective rating of speech intelligibility by speech transmission indexes

J. [INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)]
1. ISO 7240-16  Fire Detection and Alarm Systems - Part 16: Sound System Control and Indicating Equipment

K. NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

L. SRP Codes
1. SRP AFC  SRP Administrative Fire Code

M. UNDERWRITERS LABORATORIES (UL)
1. UL 1449  Surge Protective Devices
2. [UL 1480] Standard for Speakers for Fire Alarm, Emergency, and Commercial and Professional Use
3. UL 1638  Visual Signaling Appliances - Private Mode Emergency and General Utility Signaling
4. UL 1971  Signaling Devices for the Hearing Impaired
5. UL 2017  General Purpose Signaling Devices and Systems
6. UL 268   Smoke Detectors for Fire Protective Signaling Systems
7. UL 464   Audible Signal Appliances
8. UL 497B  Protectors for Data Communications and Fire-Alarm Circuits
9. UL 521   Heat Detectors for Fire Protective Signaling Systems
10. UL 864  Control Units and Accessories for Fire Alarm Systems

1.2 NOTICE TO BIDDERS

A. Before submittal of bid, examine all drawings, specification, addenda, alternatives, special conditions, and all other bidding documents of all sections of this project, verifying all governing conditions at the site, and become fully informed as to the extent and character of the work required, as well as its relation to other work in the building. Submittal of a bid is an agreement to all requirements of the contract documents and no consideration will be granted for any claimed misunderstanding thereof.

B. Submittal of a bid is deemed a representation by the bidder that he is qualified in all respects to properly perform the work for which he is bidding and has experience with similar work. Bidders are deemed to be aware, on the basis of their background and experience, of materials which may be required in the discharge of their responsibilities, even though unspecified.

C. Any case of error, omission, discrepancy, inconsistency or lack of clarity in the specification or drawings shall be promptly identified to SRP.

1.3 SYSTEM DESCRIPTION

A. This work includes providing a new, complete, networked, analog/addressable [voice evacuation] fire alarm system as described herein and on the contract drawings for the entire building. Include in the system wiring, raceways, pull boxes, terminal cabinets, outlet and mounting boxes, control
equipment, alarm, and supervisory signal initiating devices, alarm notification appliances, supervising station fire alarm system transmitter, and other accessories and miscellaneous items required for a complete operating system even though each item is not specifically mentioned or described. Provide system complete and ready for operation.

B. Provide equipment, materials, installation, workmanship, inspection, and testing in strict accordance with the required provisions of NFPA 72, NFPA 70, NFPA 90A, IMC, IFC, ISO 7240-16, IEC 60268-16, and SRP AFC, except as modified herein. The system layout on the drawings shows the intent of coverage and devices/equipment are shown in suggested locations. Submit plan view drawing showing device locations, terminal cabinet locations, junction boxes, other related equipment, conduit routing, wire counts, circuit identification in each conduit, and circuit layouts for all floors. Drawings shall comply with the requirements of NFPA 72 using symbols noted in NFPA 170. Final quantity, system layout and coordination are the responsibility of the contractor.

C. Technical data and computer software (meaning technical data that relates to computer software) that are specifically identified in this project, and may be defined/required in other sections, shall be delivered, strictly in accordance with the CONTRACT CLAUSES. Identify data delivered by reference to the particular specification section paragraph against which it is furnished. Data to be submitted shall include complete system, equipment and software descriptions. Descriptions shall show how the equipment will operate as a system to meet the performance requirements of this contract. The data package shall also include the following:

1. Identification of programmable portions of system equipment and capabilities.
2. Description of system revision and expansion capabilities and methods of implementation detailing both equipment and software requirements.
3. Provisions of operational software data on all modes of programmable portions of the fire alarm and detection system.
4. Description of fire alarm control panel equipment operation.
5. Description of auxiliary and remote equipment operation.
7. Operation and maintenance manuals.

D. Keys and locks for equipment shall be identical. Provide not less than six keys of each type required. Master all keys and locks to a single key.

1.4 SUBMITTALS

A. Submit six copies of the following, no later than 21 days prior to the start of system installation, in accordance with the General Conditions of the Contract. Drawings, unless noted otherwise, shall be no smaller than the Contract Drawings.

1. Shop Drawings
   a. System Layout: Detail drawings conforming to the requirements prescribed in NFPA 72 and NFPA 170. Drawings shall include plan views showing device locations, terminal cabinet locations, junction boxes, other related equipment, conduit routing, wire counts, circuit identification in each circuit, and circuit and conduit layouts for all floors. All devices shown on plans and riser diagram shall include device addresses.
   b. Wiring Diagrams: Point-to-point wiring diagrams showing the points of connection and terminals used for electrical field connections in the system, including interconnections between the equipment or systems that are supervised or controlled by the system. Diagrams shall show connections from field devices to the FACU and remote fire control units, initiating circuits, switches, relays and terminals. Provide complete riser diagrams indicating the wiring sequence of devices and their connections to the control equipment.
c. Sequence of operation that describes how the system responds during an alarm, supervisory and trouble condition. The description shall include fire alarm control unit LEDs, audible and visible indications; initiating devices, notification appliances, and auxiliary functions (such as elevator recall, HVAC fan unit shutdown, and smoke control system operation). The description shall provide sufficient information so that the exact function of each installed device and appliance is known.

d. System Operation: A complete list of device addresses and corresponding messages.

e. Notification Appliances / Initiating Devices: Data on each circuit to indicate that there is at least 25 percent spare capacity for notification appliances and 25 percent spare capacity for initiating devices. Annotate data for each circuit on the drawings.

f. [Amplifiers: Data to indicate that amplifiers have sufficient capacity to simultaneously drive all notification speakers plus 25 percent spare capacity. Annotate data for each circuit on the drawings.]

The Contractor shall not order any equipment and shall not begin any work until the submittals have been approved in writing by SRP. The contractor shall not perform any installation prior to the receipt of a written authority to proceed from SRP. If submittals are found not to conform to all of the requirements of this specification section and the applicable referenced Codes, Standards and Regulations, the contractor shall be required to revise and resubmit the package with modifications.

2. Product Data: Annotated catalog data showing manufacturer’s name, model, and catalog number for all equipment and components to be considered for the project, as well as standby and alarm current for all initiation and notification appliances to verify calculations. In addition, a complete equipment list with equipment description, model number, and quantity shall be provided. This shall include the following:
   a. Fire alarm control unit (FACU)
   b. Terminal cabinets
   c. Manual stations
   d. Batteries
   e. Battery chargers
   f. Smoke detectors
   g. Heat detectors
   h. Wiring and cable
   i. Notification appliances
   j. Addressable interface devices
   k. DACT
   l. LCD annunciator Transmitters (including housing) – If applicable
   m. Amplifiers – If applicable
   n. Tone generators – If applicable
   o. Digitalized voice generators – If applicable
   p. Electromagnetic door hold-open devices – If applicable
   q. Line voltage surge protective devices
   r. Auxiliary power (Booster) panels – If applicable
   s. Fire-stopping

3. Calculations: Battery calculations as required in paragraph Battery Power Calculations. Submit a voltage drop calculation to indicate that sufficient voltage is available for proper operation of the system and all components, at a minimum rated voltage of the system operating on batteries.

4. Installers Qualifications: Data approved, prior to submittal of any other data or drawings, to substantiate that the proposed installer is regularly engaged in the installation of the type and complexity of the fire protection system included in this project. Data shall identify the
location of three systems recently installed by the proposed installer which are comparable to the system specified. Contractor shall certify that each system has performed satisfactorily, in the manner intended, for a period of not less than 6 months. Submit copy of license to perform work in the local jurisdiction and submit certification for the personnel working on the project as detailed in 1.5 Quality Assurance.

5. Field Report: A unique identifier for each device, including the control panel and initiating and indicating devices, with an indication of test results, and signature of the factory-trained technician. Include the NFPA 72 Record of Completion and Inspection and Testing forms with the appropriate test reports.

6. As-Built Drawings: In addition to six hard copies, furnish one set of CD or DVD discs containing software back-up and CAD based drawings in the latest version of AutoCAD and DXF format and pdf copy of as-built drawings and schematics. The drawings shall include complete wiring diagrams showing connections between devices and equipment, both factory and field wired. Include a riser diagram and drawings showing the as-built locations of devices and equipment. The drawings shall show the system as installed, including deviations from both the project drawings and the approved shop drawings. These drawings shall be submitted within 14 calendar days after the final acceptance test of the system. At least two sets of as-built (marked-up) drawings shall be provided to SRP at the time of, or prior to the final acceptance test.

7. Operation and Maintenance (O&M) Manual: Four printed copies and one pdf copy for the project specific operation and maintenance manual. The operation and maintenance manual shall be a single volume indexed and in booklet form. Manuals shall be submitted and approved prior to on-site training. In addition to items specified in Division 01 Section 017823 "Operation and Maintenance Data", the Manuals shall include the following documents and information at a minimum:
   a. A general description of the design and operation of the system.
   b. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
   c. A copy of the as-built drawings in 11 x 17-inch format, folded neatly within the binder.
   d. All applicable product installation sheets annotated as necessary.
   e. Step-by-step procedures required for system startup, operation, and shutdown.
   f. The manufacturer’s name, model number, service manual, parts list, and complete description of equipment and their basic operating features.
   g. Maintenance manual listing routine maintenance procedures, possible breakdowns and repairs, troubleshooting guide, and system warranty information.
   h. Complete procedures for system revision and expansion, detailing both equipment and software requirements.
   i. Software delivered for this project shall be original software from the manufacturer provided on electronic media; no copies.
   j. Printouts of configuration settings for all devices.
   k. Routine maintenance checklist. The routine maintenance checklist shall be arranged in columnar format. The first column shall list all installed devices, the second column shall state the maintenance activity or state no maintenance required, the third column shall state the frequency of the maintenance activity, and the fourth column for additional comments or reference.

8. Impairment Plan: In the event the scope of work may remove from service or interfere with a fire suppression or alarm system, the design engineer shall consult and communicate with the SRP Fire Marshal to develop an Impairment Plan. The Impairment Plan developed by the design engineer shall be submitted at the same time as the design drawings for review and approval. The final plan shall be written on the drawings.
9. Training Documentation: Provide in manual format, lesson plans, operating instructions, maintenance procedures, and training data for the training courses. The operations training shall familiarize SRP’s designated personnel with proper operation of the installed system. The maintenance training course shall provide SRP’s designated personnel adequate knowledge required to diagnose, repair, maintain, and expand functions inherent to the system.

10. Schedule: Provide a schedule indicating the delivery dates of the equipment to be supplied; installation sequence; time frame and the total amount of on-site technical assistance time (in man-hours per phase) that the supplier of the equipment has included in their bid to comply with the requirements of this specification section and SRP’s requirements; and final acceptance test dates to meet SRP’s scheduled project completion dates.

11. Preliminary Equipment List: Provide a preliminary equipment list identifying the type, quantity, make, and model number of each piece of equipment to be provided under this submittal. Types and quantities of equipment submitted shall coincide with the types and quantities of equipment used in the battery calculations and those shown on the shop drawings. A final equipment list shall be submitted with the Operating and Maintenance (O&M) manual.

12. In the event that the Contractor’s submittal package is required to be revised and resubmitted due to nonconformance with this specification, illegibility of the submittal, incomplete submittals, noncompliance with the referenced local, state and national Codes, Standards and Regulations or nonconformance with pertinent documentation relative to the project, the contractor shall pay all fees associated with the additional submittal review. Payment of the fee shall be solely the contractor’s responsibility.

1.5 QUALITY ASSURANCE

A. The recommended practices stated in the manufacturer’s literature or documentation shall be considered as mandatory requirements.

B. Qualifications - Contractor: The contractor shall be an Arizona licensed contractor in possession of a valid fire alarm system contractor’s license. Design and installation must be performed by a fire alarm contractor whose business is located within a 75-mile radius of the project site. The contractor shall have a minimum of 3 years of experience in the installation of [voice evacuation] fire alarm systems in similar facilities.

C. Qualifications - Design Services: Shop (working) drawings and calculations shall be prepared under the direction of and signed by a qualified registered Professional Engineer or a NICET Level III in Fire Alarm Systems. For the purposes of meeting this requirement, a qualified engineer is defined as an individual meeting one of the following conditions:

1. A registered professional engineer having passed the NCEES examination in fire protection engineering.

2. Registered professional engineer with verification of experience and at least 5 years of current experience in the design of the fire protection and detection systems.

D. Qualifications - Supervisor: A NICET Level III (minimum) fire alarm technician shall supervise the installation of the fire alarm system. The fire alarm technician shall be factory-trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.
E. Qualifications - Technician: Fire alarm technicians with a minimum of 4 years of experience shall be utilized to assist in the installation and termination of fire alarm devices, cabinets and panels. The fire alarm technicians installing the equipment shall be factory-trained in the installation and adjustment of the equipment specified herein and on the drawings.

F. Qualifications - Installer: Fire alarm installer with a minimum of 2 years of experience shall be permitted to assist in the installation of fire alarm devices, cabinets and panels. An electrician shall be permitted to install wire, cable, conduit and backboxes for the fire alarm system.

G. Qualifications - Test Personnel: Fire alarm technicians with a minimum of 8 years of experience shall be utilized to test and certify the installation of the fire alarm devices, cabinets, and panels. The fire alarm technicians testing the equipment shall be factory-trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

1.6 REGULATORY REQUIREMENTS

A. All system components shall be listed or approved for their intended use and shall be compatible with the system and its components. Where the terms "listed" or "approved" appear in this specification section, they shall mean UL-listed (UL Fire Prot Dir), FM-approved (FM App Guide), or listed by a nationally recognized testing laboratory (NRTL). The omission of these terms under the description of any item of equipment described shall not be construed as waiving the requirement for listing or approval. All listings or approvals shall be based on an existing ANSI or UL published standard.

B. Compliance with NFPA standards is mandatory. This includes advisory provisions listed in the appendices of such standards, as though the word "shall" had been substituted for the word "should" wherever it appears. In the event of a conflict between specific provisions of this specification section and applicable standards, this specification section shall govern.

C. Install all work in full conformance with the requirements of all local and governmental authorities having jurisdiction over these matters, utility company requirements, and requirements of the latest issues of all applicable Codes, including the IBC, IFC and SRP AFC. The building permit will be secured by SRP, any additional permits, inspections, close out shall be the responsibility of the contractor.

D. The fire protection installation and the installing contractor shall comply fully with all city, county and state laws, ordinances and regulations applicable to fire protection installations.

E. Should any change in plans or specification be required to comply with governmental regulations, the contractor shall notify the Engineer at the time of submitting his bid.

F. Secure and pay for necessary approvals, permits, inspections, etc., and deliver the official records of the granting of permits to the SRP Representative without additional cost to SRP.

G. A Work Authorization is required for all [voice evacuation] fire alarm system work. The SRP Project Manager (PM) shall apply for and receive the Work Authorization. The fire protection contractor will receive the Work Authorization from the SRP PM. The Work Authorization must be prominently displayed at the jobsite before any work, to include demolition, can begin. Upon completion of the work, a final inspection by the SRP Fire Marshal, and the satisfactory resolution of all issues identified by the Final Inspection, the SRP Fire Marshal shall sign and close out the Work Authorization which indicates acceptance of the permitted work.
1.7 VERIFYING ACTUAL FIELD CONDITIONS

A. Before commencing work, examine all adjoining work on which the contractor’s work is in any way dependent for perfect workmanship according to the intent of this specification section, and report to the SRP Representative any condition which prevents performance of first class work. No "waiver of responsibility" for incomplete, inadequate or defective adjoining work will be considered unless notice has been filed before submittal of a proposal.

B. The contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall advise the SRP Representative of any discrepancy before performing the work.

1.8 COORDINATION OF TRADES

A. The contract documents are not intended to serve as coordinated construction drawings showing all minor adjustments in locations required for a fully coordinated installation that respects the work of all trades.

B. Conduit, fittings, and any other accessories required shall be furnished as required to provide a complete installation and to eliminate interference with other construction.

C. Wherever the contractor’s work interconnects with work of other contractors, the contractor shall coordinate his work with other contractors to ensure that all contractors have the information necessary so that they may properly install all necessary connections and equipment. Identify all work items needing access (dampers, etc.) concealed above hung ceilings by permanent colored pins/tabs in the ceiling directly below the item.

D. Provide required supports and hangers for conduit and equipment, so that loading will not exceed allowable loadings of structure. Submittal of a bid shall be a deemed representation that the contractor submitting such bid has ascertained allowable loadings and has included in his estimates the costs associated in furnishing required supports.

E. Field drilling and cutting of holes in structural decks, roofs, walls, etc., required for work under this section shall be coordinated through various trades in their respective materials and approved by the SRP Representative. All such drilling, cutting, and reinforcing costs shall be borne by the contractor.

F. Due to the type of installation, a fixed sequence of construction is required to properly install the complete systems. It shall be the responsibility of the contractor to coordinate, protect, and schedule his work with other trades in accordance with the construction sequence.

G. Cooperate with all other contractors and subcontractors to facilitate the completion of the work as a whole, subject to the direction of the SRP Representative.

1.9 SCHEDULING

A. Provide a schedule to SRP indicating the installation sequence and time frame prior to beginning work. Provide weekly updates to SRP. All wiring, circuit testing and device installation shall be completed in time for the equipment supplier to make all final connections and conduct all tests as outlined in this specification section.

B. Coordinate the Acceptance Test for each fire alarm system with SRP and other necessary parties identified by SRP.
1.10 DELIVERY, STORAGE, AND HANDLING

A. Protect equipment delivered and placed in storage from the weather, humidity, and temperature variation, dirt and dust, and other contaminants in accordance with manufacturer’s instructions.

B. Coordinate the storage arrangement and location with SRP.

C. Deliver and store products in shipping containers/boxes, with labeling in place.

1.11 WASTE REMOVAL

A. At the conclusion of each day's work, clean up and stockpile on site all waste, debris, and trash, which may have accumulated during the day as a result of work by the contractor and of his presence on the job.

B. Sidewalks and street adjoining the property shall be kept broom clean and free of waste, debris, trash and obstructions of any kind caused by work of the contractor, which will affect the condition and safety of streets, walks, utilities and property.

1.12 EXTRA MATERIALS

A. Repair Service/Replacement Parts: During warranty period, the service technician shall be on-site within 24 hours after notification. All repairs shall be completed within 24 hours of arrival on-site.

B. Interchangeable Parts: Spare parts furnished shall be directly interchangeable with the corresponding components of the installed system. Spare parts shall be suitably packaged and identified by nameplate, tagging, or stamping. Spare parts shall be delivered to SRP at the time of the final acceptance testing.

C. Spare Parts: Furnish the following spare parts and accessories:

1. Fuses: Four of each for each type, rating, and size of fuse used in the system.

2. Ten percent of each initiating device and notification appliance installed, but no less than two of each.

3. Surge protective devices: Two low voltage, one [telephone][ethernet], and one 120 VAC surge protective devices.

4. Addressable control and monitor modules: Ten percent of the installed quantity of each type, but no less than two devices of each type.

5. Light bulbs: Four of each for each type of lamp used in the system.

6. Keys: A minimum of three sets of keys shall be provided and appropriately identified.

D. Special Tools: Software, connecting cables, and proprietary equipment, necessary for the maintenance, testing and reprogramming of the equipment shall be furnished to SRP.

E. Spare Parts Cabinet: A wall-mounted, metal, locking cabinet no less than 22 gage steel in black baked-on enamel shall be provided and installed by the contractor adjacent to the system control unit or another approved location as directed by the SRP Representative. The cabinet shall be sized to hold all spare parts and one copy of the O&M manual and training manual. An inventory list shall be made of all items to be kept inside cabinet. Include on the list the number of all spare parts and
keys to be provided. Give inventory list to the SRP Representative during acceptance of the fire alarm system for verification of items in the cabinet. The SRP Representative will sign off on list when all items on list appear in the cabinet. The cabinet shall be provided with a permanent label stating "FIRE ALARM SPARE PARTS".

F. Documentation Cabinet: A wall-mounted, metal, locking cabinet, no less than 22 gage steel, shall be provided and installed adjacent to the system control unit or another approved location as directed by the SRP Representative. Cabinet shall be sized to fit all system record documentation. The cabinet shall be prominently and permanently labeled "SYSTEM RECORD DOCUMENTS". The spare parts cabinet and document cabinet can be combined into one unit.

1.13 EXISTING FIRE ALARM SYSTEM

A. The existing fire alarm system shall remain operational until the new fire alarm system has been installed, partially tested, and preliminarily accepted by the SRP Representative. Upon partial acceptance of the new fire alarm system, the contractor shall remove the existing fire alarm system, including all devices, wire/cable and the fire alarm control unit. All unused raceways shall be demolished unless directed otherwise. All areas where portions of the existing fire alarm system are removed shall be repaired to match the surrounding areas. All repairs shall be subject to approval by the SRP Representative.

B. All parts of the existing fire alarm system including the devices and control unit, raceway, wire and wiring related materials shall be properly disposed of off-site by the contractor.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Standard Products: Material and equipment shall be the standard products of a manufacturer, where possible, and not a combination of manufacturers for any particular classification of materials. Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 2 years prior to bid opening. All materials and equipment supplied shall be new, first quality and the manufacturer’s best type and latest model capable of complying with all requirements of this specification section and shall have been in continuous production and in continuous service in commercial applications for at least one year. Obsolete equipment shall not be used.

B. Nameplates: Major components of equipment shall have the manufacturer’s name, model or serial number, and date of installation provided on a new plate permanently affixed to the item or equipment. Major components include, but are not limited to FACUs, DACT, or terminal cabinets. Nameplates shall be etched metal or plastic, permanently attached by screws to panels or adjacent walls.


D. Expansion/Spare Capacity: Spare capacity shall pertain to quantities of devices, circuits, amplifiers, raceway, conductors, ampacities (size) and lengths. The system shall have spare installed capacity enabling it to support a 25 percent increase in the number of initiating devices and monitor and control points (addressable devices), notification appliance circuits, and power supplies. Spare circuit capacity to accommodate installation of the required device increases shall be evenly distributed throughout the system.
2.2 SYSTEM OPERATION

A. The fire alarm and voice evacuation system shall be a complete, supervised, non-coded, networked, analog/addressable fire alarm system conforming to NFPA 72, UL 864, and UL 2017. The system shall be activated into the alarm mode by actuation of any alarm initiating device. The system shall remain in alarm mode until the initiating device is reset and the control panel is reset and restored to normal.

B. Functions and Operating Features: The system shall provide the following functions and operating features:

1. The FACU shall provide power, annunciation, supervision, and control for the system. Addressable systems shall be microcomputer (microprocessor or microcontroller) based with a minimum word size of eight bits with sufficient memory to perform as specified.

2. Provide Class A initiating device circuits.

3. Provide Class A for each floor.

4. Provide Class A signaling line circuits for the network.

5. Provide Class A notification appliance circuits.

6. Alarm, supervisory, and/or trouble signals shall be automatically transmitted to the remote supervising station.

7. Alarm functions shall override trouble or supervisory functions. Supervisory functions shall override trouble functions.

8. The system shall be capable of operating, supervising, and/or monitoring both addressable and non-addressable alarm and supervisory devices.

9. There shall be no limit, other than maximum system capacity, as to the number of addressable devices that may be in alarm simultaneously.

10. Where the fire alarm system is responsible for initiating an action in another emergency control device or system, such as an HVAC system or an elevator system, the addressable fire alarm relay shall be within 3 feet of the control device.

11. An alarm signal shall automatically initiate the following functions:
   a. Transmission of an alarm signal to the remote supervising station.
   b. Visual indication of the device operated on the fire alarm control unit, and on the annunciator panel, and visual display unit (VDU).
   c. Continuous actuation of all alarm notification appliances.
   d. Recording of the event electronically in the history log of the FACU.
   e. Operation of a heat detector or waterflow switch serving an elevator machine room, top of shaft, or elevator shall operate shunt trip circuit breaker(s) to shut down power to the elevators in accordance with ASME A17.1.

12. A supervisory signal shall automatically initiate the following functions:
   a. Visual indication of the device operated on the FACU, on the annunciator panel, [and VDU,] and sound an audible signal at the respective panel.
   b. Transmission of a supervisory signal to the remote supervising station.
   c. Recording of the event electronically in the history log of the FACU.
d. Operation of a duct smoke detector shall shut down the appropriate air handler in accordance with [NFPA 90A][IMC] in addition to other requirements of this paragraph and as allowed by NFPA 72.

13. A trouble condition shall automatically initiate the following functions:
   a. Visual indication of the system trouble on the FACU, on the annunciator panel and sound an audible signal at the respective panel.
   b. Transmission of a trouble signal to the remote supervising station.
   c. Recording of the event electronically in the history log of the FACU.

14. The maximum permissible elapsed time between the actuation of an initiating device and its indication at the FACU is 10 seconds.

15. The maximum elapsed time between the occurrence of the trouble condition and its indication at the FACU is 200 seconds.

2.3 SYSTEM MONITORING

A. Valves: Each valve affecting the proper operation of a fire protection system, including automatic sprinkler control valves, standpipe control valves, sprinkler service entrance valve, and valves at backflow preventers shall be electrically monitored to ensure its proper position. Provide each tamper switch with a separate address; unless they are within the same room, then a maximum of five can use the same address.

B. Electric Fire Pump: The fire pump system shall be monitored by the fire alarm system for the following conditions: fire pump running, loss of primary power, and phase reversal. Each condition shall be provided with a separate address.

C. Diesel Fire Pump: The fire pump system shall be monitored by the fire alarm system for the following conditions: fire pump running, controller main switch not in auto, and main switch mis-set.

D. Fire Suppression Releasing System: The fire suppression releasing control panel shall be monitored by the fire alarm system for the following conditions: system activation, supervisory and trouble. Each condition shall be provided with a separate address.

2.4 FIRE ALARM CONTROL UNIT (FACU)

A. Provide a complete control unit fully enclosed in a lockable steel cabinet as specified herein. Operations required for testing or for normal care and maintenance of the system shall be performed from the front of the enclosure. If more than a single unit is required at a location to form a complete control unit, the cabinets shall match.

1. Each control unit shall provide power, supervision, control and logic for the entire system, utilizing solid state, modular components, internally mounted and arranged for easy access. Each control unit shall be suitable for operation on a 120 VAC, 60 hertz, normal building power supply. Provide each panel with supervisory functions for power failure, internal component placement, and operation.

2. Visual indication of alarm, supervisory, or trouble initiation on the fire alarm control panel shall be by liquid crystal display or similar means with a minimum of 80 characters.

3. Provide secure operator console for initiating recorded messages, strobes, and displays; and for delivering live voice messages. Provide capacity for at least eight prerecorded messages. Provide the ability to automatically repeat prerecorded messages. Provide a secure
microphone for delivering live messages. Provide adequate discrete outputs to temporarily deactivate fire alarm audible notification and initiate/synchronize strobes. Provide a complete set of self-diagnostics for controller and appliance network. Provide local diagnostic information display and local diagnostic information and system event log file.

4. Provide electrical supervision of the primary power (AC) supply, presence of the battery, battery voltage, and placement of system modules within the control panel.

5. Provide an audible and visible trouble signal to activate upon a single break or open condition, or ground fault. The trouble signal shall also operate upon loss of primary power (AC) supply, absence of a battery supply, low battery voltage, or removal of alarm or supervisory panel modules. Provide a trouble alarm silence feature that shall silence the audible trouble signal, without affecting the visual indicator. After the system returns to normal operating conditions, the trouble signal shall again sound until the trouble is acknowledged. A smoke detector in the process of being verified for the actual presence of smoke shall not initiate a trouble condition.

6. Provide program capability via switches in a locked portion of the FACU to bypass the automatic notification appliance circuits, air handler shutdown, and door hold-open release. Operation of this programming shall indicate this action on the FACU display.

7. Provide alarm verification capability for smoke detectors. Alarm verification shall initially be set for 0 seconds.

8. The system shall be capable of being programmed from the panel's keyboard. Programmed information shall be stored in non-volatile memory.

B. Cabinet: Install control unit components in cabinets large enough to accommodate all components and also to allow ample gutter space for interconnection of units as well as field wiring. The enclosure shall be identified by an etched metal or plastic nameplate. Lettering on the nameplate shall say "Fire Alarm Control Unit" and shall not be less than 1-inch high. Provide prominent rigid plastic or metal identification plates for lamps, circuits, meters, fuses, and switches. The cabinet shall be provided in a sturdy steel housing, complete with backbox, hinged steel door with cylinder lock, and surface mounting provisions.

C. Wiring: Connect circuit conductors entering or leaving the panel to screw-type terminals with each terminal marked for identification. Locate diodes and resistors, if any, on screw terminals in the FACU. Circuits operating at 24 VDC shall not operate at less than the UL-listed voltage at the detector or appliance connected. Circuits operating at any other voltage shall not have a voltage drop exceeding 10 percent of normal voltage.

D. Silencing Switches:

1. Alarm Silencing Switch: Provide an alarm silencing switch at the FACU that shall silence the audible and visual signal but not affect the visual alarm indicator and shall not silence a waterfall alarm. This switch shall be overridden upon activation of a subsequent alarm.

2. Supervisory/Trouble Silencing Switch: Provide supervisory and trouble silencing switch that shall silence the audible trouble and supervisory signal, but not extinguish the visual indicator. This switch shall be overridden upon activation of a subsequent alarm, supervisory, or trouble condition. Audible trouble indication must resound automatically every 24 hours after silencing feature has been operated.
E. Non-Interfering: Power and supervise each circuit such that a signal from one device does not prevent the receipt of signals from any other device. Circuits shall be manually reset by switch from the FACU after the initiating device or devices have been restored to normal.

F. Audible Notification System: The audible notification system shall comply with the requirements of NFPA 72 for emergency voice/alarm communications, except as specified herein. The system shall be a one-way multi-channel voice notification system incorporating user selection of a minimum of eight distinct sounds for tone signaling, and the incorporation of a voice module for delivery of prerecorded messages. Audible appliances shall produce a temporal 3 tone for three cycles following a voice message that is repeated until the control panel is reset or silenced. Automatic messages shall be broadcast through speakers throughout the building/facility. A live voice message shall override the automatic audible output through use of a microphone input at the control unit.

1. Where audible appliances are installed in sleeping areas they shall produce a low frequency alarm signal of 520 Hz.

2. When using the microphone, live messages shall be broadcast throughout a selected floor or floors or all call. The system shall be capable of operating all speakers at the same time. The microprocessor shall actively interrogate circuitry, field wiring, and digital coding necessary for the immediate and accurate rebroadcasting of the stored voice data into the appropriate amplifier input. Loss of operating power, supervisory power, or any other malfunction that could render the digitalized voice module inoperative shall automatically cause the code 3 temporal tone to take over all functions assigned to the failed unit in the event an alarm is activated.

G. Visual Notification System: Notification appliance circuits (NAC) shall be provided for the activation of strobe appliances. The activation of the visual NAC circuits shall follow the operation of the audible NAC circuits. The strobe NAC circuits shall provide at least 2 amps of 24 VDC power to operate strobes and have the ability to synchronize all strobes.

H. Outputs and Operational Modules: All outputs and operational modules shall be fully supervised with on-board diagnostics and trouble reporting circuits. Provide form C contacts for system alarm and trouble conditions. Provide circuits for operation of auxiliary appliance during trouble conditions.

I. Memory: Provide each control unit with non-volatile memory and logic for all functions. The use of long life batteries, capacitors, or other age-dependent devices shall not be considered as equal to non-volatile processors, PROMS, or EPROMS.

J. Field Programmability: Provide control units and control panels that are fully field programmable for control, initiation, notification, supervisory, and trouble functions of both input and output. The system program configuration shall be menu driven. System changes shall be password protected and shall be accomplished using personal computer-based equipment.

K. Input/output Modifications: The FACU shall contain features that allow the bypassing of input devices from the system or the modification of system outputs. These control features shall consist of a panel mounted keypad. Any bypass or modification to the system shall indicate a trouble condition on the FACU.

L. Resetting: Provide the necessary controls to prevent the resetting of any alarm supervisory, or trouble signal while the alarm, supervisory, or trouble condition on the system still exists.
M. Walk Test: The FACU shall have a walk test feature. When using this feature, operation of initiating devices shall result in limited system outputs, so that the notification appliances operate for only a few seconds and the event is indicated on the system printer, but no other outputs occur.

N. History Logging: The control unit shall have the ability to store a minimum of 400 events in a log. These events shall be stored in a battery-protected memory and shall remain in the memory until the memory is downloaded or cleared manually. Resetting of the control unit shall not clear the memory.

O. Access: Access and control of the operating program shall be restricted to proper personnel designated by SRP.

1. The control unit shall have a minimum of two (2) security levels. Each level shall have individual passwords. Illegal access attempts shall be rejected by the system and shall be displayed and recorded in the history file with time and date.

2. The “First” security level shall be the lowest security level and shall only allow access to the system status levels and lists and shall not impair system operation.

2.5 AMPLIFIERS, PRE-AMPLIFIERS, TONE GENERATORS

A. Any amplifiers, pre-amplifiers, tone generators, digitalized voice generators, and other hardware necessary for a complete, operational, textual audible circuit conforming to NFPA 72 shall be housed in a remote FACU, terminal cabinet, or in the FACU.

B. Operation: The system shall automatically operate and control all building speakers except those installed in stairs and within elevator cabs. Speakers in stairs and elevator cabs shall operate only when the microphone is used to deliver live messages.

C. Construction: Amplifiers shall utilize computer grade solid state components and shall be provided with output protection devices sufficient to protect the amplifier against any transient surges up to 10 times the highest rated voltage in the system.

D. Inputs: Equip each system with separate inputs for the tone generator, digitalized voice driver and panel mounted microphone. Microphone inputs shall be of the low impedance balance line type. Both microphone and tone generator input shall be operational on any amplifier.

E. Tone Generator: The tone generator shall be of the modular, plug-in type with securely attached labels to identify the component as a tone generator and to identify the specific tone it produces. The tone generator shall produce a code 3 temporal tone and shall be constantly repeated until interrupted by the digitalized voice message, the microphone input, or the alarm silence mode as specified. The tone generator shall be single channel with an automatic backup generator per channel such that failure of the primary tone generator causes the backup generator to automatically take over the functions of the failed unit and also causes transfer of the common trouble relay.

F. Protection Circuits: Each amplifier shall be constantly supervised for any condition that could render the amplifier inoperable at its maximum output. Failure of any component shall cause automatic transfer to a designated backup amplifier, illumination of a visual "amplifier trouble" indicator at the control unit, and appropriate logging of the condition electronically.
2.6 ANNUNCIATOR

A. Annunciator Panel: Provide an annunciator that includes an LCD display. The display shall indicate the device in trouble/alarm or any supervisory device. Display the device name, address, and actual building location.

B. Programming: Where programming for the operation of the annunciator is accomplished by a separate software program than the software for the FACU, the software program shall not require reprogramming after loss of power. The software shall be reprogrammable in the field.

2.7 VISUAL DISPLAY UNIT

A. Provide visual display unit in locations as shown on the drawings. The units shall be intelligent and shall be capable of displaying and responding to all fire alarm network events and points via video display. The units shall be capable of importing and displaying floor plan drawings, and be fully customizable by the user with respect to text, icons, and colors.

2.8 COMBINATION FIXED TEMPERATURE AND RATE-OF-RISE HEAT DETECTORS

A. Provide heat detectors for detection of fire by combination fixed temperature and rate-of-rise principle. Heat detector spacing shall be rated in accordance with UL 521. Detectors shall be supported independently of wiring connections. Contacts shall be self-resetting after response to rate-of-rise principle. Under fixed temperature actuation, the detector shall have a permanent external indication which is readily visible. The UL 521 test rating for the fixed temperature portion shall be 135 degrees F. The UL 521 test rating for the rate-of-rise detectors shall be rated for 50 by 50 feet.

2.9 SMOKE DETECTORS

A. Photoelectric Smoke Detectors: Provide addressable photoelectric smoke detectors as follows:

1. Provide analog/addressable photoelectric smoke detectors utilizing the photoelectric light scattering principle for operation in accordance with UL 268. Smoke detectors shall be listed for use with the fire alarm control unit.

2. Provide self-restoring type detectors that do not require any re-adjustment after actuation at the FACU to restore them to normal operation.

3. Components shall be rust and corrosion resistant. Vibration shall have no effect on the detector's operation. Protect the detection chamber with a fine mesh metallic screen that prevents the entrance of insects or airborne materials. The screen shall not inhibit the movement of smoke particles into the chamber.

4. Provide twist lock bases constructed of white, high impact polycarbonate designed for mounting on a standard 3 1/2-inch or 4-inch octagonal or 4-inch square outlet box for detectors. The detectors shall maintain contact with their bases without the use of springs. Provide companion mounting base with screw terminals for each conductor. Terminate field wiring on screw terminals. The detector shall have a visual indicator to show actuation. Insertion of an incorrect detector type into the base shall cause a "Wrong Device" trouble condition at the FACU until the proper type of detector is installed, or the system is reprogrammed. The system program shall recognize the insertion of a wrong device and shall automatically default to the set point values corresponding to the inserted device and shall monitor alarm and trouble conditions according to the default parameters.
5. Sounder bases shall produce a minimum of 90 dBA at 10 feet.

6. The detector address shall identify the particular unit, its location within the system, and its sensitivity setting. Detectors shall be of the low voltage type rated for use on a 24 VDC system.

7. An operator at the control unit, having the proper access level, shall have the capability to manually access the following information for each initiating device.
   a. Primary status.
   b. Device type.
   c. Present average value.
   d. Present sensitivity selected.
   e. Detector range (normal, dirty, etc.)

B. Duct Smoke Detectors: Duct-mounted photoelectric smoke detectors shall be furnished and installed where indicated and in accordance with NFPA 90A. Units shall consist of a smoke detector as specified in paragraph Photoelectric Smoke Detectors, mounted in a special housing fitted with duct sampling tubes. Detector circuitry shall be mounted in a metallic enclosure exterior to the duct. Detectors shall have a manual reset. Detectors shall be rated for air velocities that include air flows between 500 and 4000 fpm. Detectors shall be powered from the fire alarm control unit.

1. Sampling tubes shall run the full width of the duct. The control functions, operation, reset, and bypass shall be controlled from the fire alarm control unit.

2. Lights to indicate the operation and alarm condition, and the test and reset buttons shall be visible and accessible with the unit installed and the cover in place. Remote indicators shall be provided where required by NFPA 72 and these shall be provided with key-operated test and reset switches.

3. Remote lamps and switches as well as the affected fan units shall be properly identified in etched plastic placards. Detectors shall provide for control of auxiliary contacts for shutdown. Auxiliary contacts provided for this function shall be located within 3 feet of the controlled circuit or appliance.

4. The detectors shall be compatible with the FACU to ensure complete system compatibility.

2.10 AIR SAMPLING SMOKE DETECTORS

A. Addressable Air Sampling Smoke Detectors: The addressable air sampling smoke system shall consist of a detector assembly housing an integral aspiration fan, filter, laser-based detection chamber and control, output and supervision circuitry. Each sampling point shall be capable of being independently addressable. The system shall consist of a piping or tubing distribution network that runs from the detector assembly(s) to the protected area(s) and is supported by calculations from a computer-based design modeling tool. The system shall include configurable alarm and trouble relay outputs for interface to other systems where required.

1. System shall be complete in all ways. It shall include all engineering, and electrical installation, all detection and control equipment, auxiliary devices and controls, alarm interface, functional checkout and testing, training and all other operations necessary for a functional system.

2. System base detectors and modules shall each accommodate up to 40 addressable micro-bore sampling tubes where each tube has a sampling point at the end. Additional modules may be used to provide up to 20 addressable sampling holes per system.
3. The system shall provide four alarm outputs along with outputs for trouble and supervisory signals. The four alarm outputs shall be designated as ALERT, PRE-ALARM, FIRE 1, and FIRE 2, and each of the alarms shall be field adjustable based on obscuration levels at the detector. Each alarm is to be transmitted to the FACU. The detector is to interface with the factory approved software which will provide the address location of the alarm initiating point.

4. All air sampling smoke detection devices and associated components shall be new, standard products or the manufacturer's latest design and suitable to perform the functions intended.

5. The laser detection chamber shall be of the mass light scattering type and capable of detecting a wide range of smoke particle types of varying size. A particle counting method shall be employed for the purposes of:
   a. Preventing large particles from affecting the true smoke reading.
   b. Monitoring contamination of the filter (dust and dirt, etc.) to automatically notify when maintenance is required. The particle counting method shall not be used for the purpose of smoke density measurement.

6. Detector(s) shall be self-monitoring for filter contamination and provide indication through system fault when replacement is necessary. Detectors which allow automatic reset of filter status upon removal and re-insertion are not permitted.

7. Detector(s) shall contain relays for alarm and fault conditions. The relays shall be software programmable to the required functions.

8. Detector(s) shall permit configuration by programmers that are either integral to the system, portable, or PC based.

9. Detector(s) shall allow programming of:
   a. Smoke threshold alarm levels.
   b. Time delays.
   c. Faults, including airflow, detector, power, filter and network, as well as an indication of the urgency of the fault.
   d. Configuration of relay outputs for remote indication of alarm and fault conditions.
   e. General purpose input functionality.

2.11 ADDRESSABLE INTERFACE DEVICES

A. The system shall be capable of defining any module as an alarm module and report alarm, trouble, loss of polling, or as a supervisory module, and reporting supervisory short, supervisory open, or loss of polling such as waterflow switches, valve supervisory switches, relays for output function actuation, etc. The monitor module shall provide address setting means compatible with the control panel's SLC supervision and store an internal identifying code. Monitor module shall contain an integral LED that flashes each time the monitor module is polled and is visible through the device cover plate. Pull stations with a monitor module in a common backbox are not required to have an LED.

2.12 ADDRESSABLE CONTROL MODULE

A. The control module shall be capable of operating as a relay (dry contact form C) for interfacing the control with other systems, and to control door holders or initiate elevator fire service. The indicating device or the external load being controlled shall be configured as a Class B notification appliance circuit. The system shall be capable of supervising, audible, visual, and dry contact circuits. The control module shall have both an input and output address. The supervision shall detect a short on the supervised circuit and shall prevent power from being applied to the circuit. The control
module shall provide address setting means compatible with the control unit's SLC supervision and store an internal identifying code. The control module shall contain an integral LED that flashes each time the control module is polled and is visible through the device cover plate. Control modules shall be located in environmental areas that reflect the conditions to which they were listed and shall include a mounting plate for installation in a junction box.

2.13 ISOLATION MODULES

A. Provide isolation modules to subdivide each signaling line circuit into groups of not more than 20 addressable devices for each floor between adjacent isolation modules.

B. Isolation modules shall provide short circuit isolation for signaling line circuit wiring.

C. Power and communications shall be supplied by the SLC and shall report faults to the FACU.

D. After the wiring fault is repaired, the fault isolation modules shall test the lines and automatically restore the connection.

2.14 MANUAL STATIONS

A. Provide metal or plastic, surface-mounted, double-action, addressable manual stations, that are not subject to operation by jarring or vibration. Stations shall be equipped with screw terminals for each conductor. Stations that require the replacement of any portion of the device after activation are not permitted. Stations shall be finished in fire engine red with molded raised white lettering operating instructions of contracting color. The stations shall mechanically latch after operation with a key or wrench reset feature. Stations shall have a separate screw terminal for each conductor.

B. Every manual fire alarm box shall have an engraved nameplate permanently installed on its face or Brady adhesive markers, or SRP approved equal, attached to them indicating the address of the station. The contractor shall install markers on the outside of the manual fire alarm box and lettering shall be a minimum of 12-point.

2.15 NOTIFICATION APPLIANCES

A. Fire Alarm Speakers: Audible appliances shall conform to the applicable requirements of UL 464. Appliances shall be connected into notification appliance circuits. Surface-mounted audible appliances shall be white. Recessed audible appliances shall be installed with a grill that is painted white.

1. Speakers shall conform to the applicable requirements of UL 1480. Speakers shall have six different sound output levels and operate with audio line input levels of 70.7 VRMS and 25 VRMs, by means of selectable tap settings. Tap settings shall include taps of 1/4, 1/2, 1, and 2-watt. Speakers shall incorporate a high efficiency speaker for maximum output at minimum power across a frequency range of 400 Hz to 4,000 Hz, and shall have a sealed back construction. Speakers shall be capable of installation on standard 4-inch square electrical boxes. Where speakers and strobes are provided in the same location, they may be combined into a single unit. All inputs shall be polarized for compatibility with standard reverse polarity supervision of circuit wiring via the FACU.

2. Provide speaker mounting plates constructed of cold rolled steel having a minimum thickness of 16-gage or molded high impact plastic and equipped with mounting holes and other openings as needed for a complete installation. Fabrication marks and holes shall be ground and finished to provide a smooth and neat appearance for each plate. Each plate shall be primed and painted.
3. Speakers shall utilize screw terminals for termination of all field wiring.

B. Fire Alarm Horns: Horns shall conform to the applicable requirements of UL 464. Horns shall be surface-mounted, with the matching mounting backbox surface-mounted vibrating type suitable for use in an electrically supervised circuit. Horns shall produce a sound rating of at least 85 dBA at 10 feet. Horns used in exterior locations shall be specifically listed or approved for outdoor use and be provided with metal housing and protective grilles. Horns located in the hangar bay shall be NEMA 4 rated.

C. Visual Notification Appliances: Visual notification appliances shall conform to the applicable requirements of UL 1971 and conform to ADAAG. Colored lens, such as amber, shall comply with UL 1638. The manufacturer shall have the colored lens tested to the full UL 1971 polar plotting criteria, voltage drop, and temperature rise as stated in UL 1971. Fire alarm notification appliances shall have clear high intensity optic lens, xenon flash tubes, and output white light and be marked "Fire" in red letters. The light pattern shall be dispersed so that it is visible above and below the strobe and from a 90-degree angle on both sides of the strobe. Strobe flash rate shall be 1 flash per second and a minimum of 15 candela based on the UL 1971 test. Strobes shall be semi-flush-mounted. Where more than two appliances are located in the same room, or corridor, or field of view, provide synchronized operation. Devices shall use screw terminals for all field wiring.

2.16 ELECTROMAGNETIC DOOR HOLD-OPEN DEVICES

A. Provide where shown on drawings. The armature portion shall be mounted on the door and shall have an adjusting screw for setting the angle of the contact plate. Mount the electromagnetic release on the wall or in a wall recess behind the door, except where no wall and then mount on floor. Total projection of the door holder release shall not exceed 4 inches. Door holders shall be powered by the fire alarm system (24 VDC) but not require battery backup power, unless specifically noted on the drawings.

2.17 PRIMARY ELECTRIC POWER

A. Power shall be 120 VAC service for the FACU from the normal AC service to the building in accordance with NFPA 72.

2.18 SECONDARY POWER SUPPLY

A. Provide for system operation in the event of primary power source failure. Transfer from normal to auxiliary (secondary) power or restoration from auxiliary to normal power shall be automatic and shall not cause transmission of a false alarm.

B. Batteries: Provide sealed, maintenance-free, lead-acid batteries as the source for emergency power to the FACU. Batteries shall contain suspended electrolyte. The battery system shall be maintained in a fully charged condition by means of a solid-state battery charger. Provide an automatic transfer switch to transfer the load to the batteries in the event of the failure of primary power.

1. Capacity, Fire Alarm System: Battery size shall have sufficient capacity to operate the fire alarm system under supervisory and trouble conditions, including audible trouble signal devices for 24 hours and audible and visual signal devices under alarm conditions for an additional [15][ ] minutes.

2. Battery Power Calculations: Verify that battery capacity exceeds supervisory and alarm power requirements. Substantiate the battery calculations for alarm, alert, and supervisory power requirements. Include amper-hour requirements for each system component and each panel component, and compliance with UL 864. Provide complete battery calculations for the
alarm, alert, and supervisory power requirements. Include a 1.2 derating factor in all calculations.

3. For battery calculations use the following assumptions: Assume a starting voltage of 24 VDC for starting the calculations to size the batteries. Calculate the required amp-hours for the specified standby time, and then calculate the required amp-hours for the specified alarm time. Calculate the nominal battery voltage after operation on batteries for the specified time period.

C. Battery Chargers: Provide a solid state, fully automatic, variable charging rate battery charger. The charger shall be capable of providing 120 percent of the connected system load and shall maintain the batteries at full charge. In the event the batteries are fully discharged (20.4 VDC), the charger shall recharge the batteries back to 95 percent of full charge within 48 hours after a single discharge cycle as described in paragraph Capacity above. Provide a pilot light to indicate when batteries are manually placed on a high rate of charge as part of the unit assembly if a high rate switch is provided.

2.19 LINE VOLTAGE SURGE PROTECTIVE DEVICES

A. Line voltage surge protective devices shall be provided to suppress all voltage transients which might damage fire alarm panel components. The surge protective device shall wire in series to the power supply of the protected equipment with screw terminations. Line voltage surge arrestor shall be installed directly adjacent to the power panel where the FACU breaker is located.

B. Line voltage surge protective devices for nominal 120 VAC shall be UL 1449 listed with a maximum 500 Volt suppression level and have a maximum response time of 5 nanoseconds. The surge protective device shall also meet IEEE C62.41.1 and C62.41.2 category B tests for surge capacity. The surge protective device shall feature multi-stage construction and be provided with a long-life indicator lamp (either light emitting diode or neon) which extinguishes upon failure of protected components. Any unit fusing shall be externally accessible.

C. Line voltage surge protective device for nominal 24 VAC, for alarm telephone dialer, or ethernet connection shall be UL 497B listed and have a maximum response time of 1-nanosecond. The surge protective device shall feature multi-stage construction and be self-resetting. The surge protective device shall be a base and plug style. The base assembly shall have screw terminals for fire alarm wiring. The base assembly shall accept a "plug-in" surge protective module.

D. All surge protective devices (SPD) shall be the standard product of a single manufacturer and be equal or better than the following:

1. For 120 VAC nominal line voltage: DITEK DTK-120S20A series-connected, 20 A AC power SPD.
2. For 24-volt nominal line voltage: DITEK DTK-24MHLP24BWB series-connected, modular, 5A maximum current SPD.
3. For alarm telephone dialers: DITEK DTK-MRJ31XSCPWP or approved equal.
4. For IP-DACTs: DITEK DTK-MRJETHS or approved equal.

2.20 WIRING

A. Alarm Wiring: SLC and IDC wiring shall be solid copper cable in accordance with the manufacturer’s requirements. Copper signaling line circuits and initiating device circuit field wiring shall be No. 18 AWG size twisted and shielded solid conductors at a minimum. Visual notification appliance circuit conductors and notification appliances, other than speakers, shall be solid copper No. 14 AWG size.
conductors at a minimum. Speaker circuits shall be stranded or solid copper No. 16 AWG size twisted and shielded conductors at a minimum. Wire size shall be sufficient to prevent voltage drop below manufacturer's recommendations. Power wiring, operating at 120 VAC minimum, shall be a minimum of No. 12 AWG solid copper having similar insulation. Acceptable power-limited cables are FPL, FPLR or FPLP as appropriate with red colored covering. Non-power-limited cables shall comply with NFPA 70.

B. All wiring not in conduit or raceway shall be plenum rated as described in NFPA 70.

2.21 ENVIRONMENTAL ENCLOSURES OR GUARDS

A. Environmental enclosures shall be provided to permit fire alarm components to be used in areas that exceed the environmental limits of the listing. The enclosure shall be listed for the device or appliance as either a manufactured part number or as a listed compatible accessory for the UL category that the component is currently listed. Guards required to deter mechanical damage shall be either a listed manufactured part or a listed accessory for the category of the initiating device or notification appliance.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. The contractor shall plan and use caution while removing existing ceiling tiles for the installation of the fire alarm system and voice evacuation components. All ceiling tiles shall be re-installed by the contractor. Broken ceiling tiles and their location shall be reported to SRP.

B. The supervisory work of the qualified manufacturer’s technical representative shall include, but not necessarily be limited to, checking all the system wiring connections; advising the contractor regarding technical details of the installation; and the adjustment and testing of all components of the system in order to ensure a complete and satisfactorily operable system. The manufacturer’s technical representative shall be on site, as required by SRP, during the entire installation and connection of the new control equipment. The technical representative shall monitor all wiring changes and assist the contractor to ensure a smooth transition to the new control equipment. The cost of the technical representative shall be paid by the contractor and shall be included in the bid price. The minimum number of man-hours for this technical representative to be carried is 40 hours. The contractor shall identify the amount of manufacturer’s technical representative’s man-hours that shall be provided and the per-hour cost (including the cost for possible overtime premium (hours) for the technical representative’s time.

C. The manufacturer's technical representative shall also be required to instruct designated building and management personnel in the general operation of the system and to give the designated personnel an overview of the system functions when the system is in normal, supervisory mode, alarm mode, and trouble mode, as specified in this specification section.

3.2 DEVICE/EQUIPMENT INSTALLATION

A. FACU: Locate the FACU where indicated on the drawings. Mount the enclosure semi-flush, with the top of the cabinet 6 feet above the finished floor or center the cabinet at 4 feet, whichever is lower. Conductor terminations shall be labeled and a drawing containing conductors, their labels, their circuits, and their interconnection shall be permanently mounted in the FACU.

B. Manual Stations: Locate manual stations as required by NFPA 72 and as shown on the drawings. Mount stations so that their operating handles are no more than 4 feet above the finished floor.
Mount stations so they are located no farther than 5 feet from the exit door they serve, measured horizontally.

C. Notification Appliances: Locate notification appliances as required by NFPA 72. Notification appliance circuits shall not be installed in the same raceway with signaling line circuits unless approved in writing by the FACU manufacturer.

D. Heat Detectors: Locate detectors as required by NFPA 72 and their listing on a 4-inch backbox. Install heat detectors not less than 4 inches from a side wall to the near edge. Heat detectors located on the wall shall have to top of the detector at least 4 inches below the ceiling, but not more than 12 inches below the ceiling.

E. Smoke Detectors: Locate detectors as required by NFPA 72 and their listing on a 4-inch backbox. Smoke detectors are permitted to be on the wall no lower than 12 inches from the ceiling with no minimum distance from the ceiling. Install smoke detectors no closer than 5 feet from air-handling supply outlets.

F. Air Sampling Smoke Detector: Locate air aspirating smoke detectors in accordance with the manufacturer’s instructions. Air sampling smoke detectors shall be installed as follows:

1. Air Sampling Smoke Detector Assembly.
   a. Detector assembly shall be mounted to a wall at a height between 48 to 60 inches to top of detector measured above the finished floor.
   b. Mounting location shall be a fully accessible and visible location.
   c. Mounting or attachment to site equipment, cable trays, movable walls, other equipment or equipment supports is not permitted.
   d. Piping network insertion into the detector inlet shall not be glued.
   e. Air sampling smoke detector assembly shall be installed in accordance with this specification section and the manufacturer’s installation and instruction manuals.
   f. Flexible tubing for termination of the sampling pipe network into detector inlet is not permitted unless allowed by its listing.

2. Pipe and Sample Tube Mounting.
   a. The pipe and sample tubing detection network shall be mounted as per the design and manufacturer’s specification. The hardware used for mounting will depend upon the design and site requirements.
   b. To minimize flexing, pipes shall be secured every 5 feet.
   c. Pipes shall be suspended between 1 and 4 inches below the ceiling. Where false ceilings are installed, the sampling tubes shall be installed above the ceiling, and sampling ports shall be installed on the ceiling and connected to the sampling tube.
   d. The sampling tubes shall be of the same length or use the manufacturer’s guidelines to run tubes of the required lengths using two diameter tubes (0.24-inch and 0.16-inch OD).
   e. When installing a pipe network in areas subject to high temperature fluctuations allow for the contraction and expansion of pipes.
   f. Where expansion or contraction of pipes is likely either after installation or on a continuous basis, do not place pipe clips adjacent to couplings and socket unions as these may interfere with the movement of the pipe.
   g. No bends are permitted within the first 18 inches from the detector inlet.
   h. The routing of the piping and sample tube network shall be coordinated with potential obstructions, including cable trays, grounding bars, and HVAC ductwork.
   i. All changes in direction shall be made with standard elbows or tees.
j. All joints shall be air-tight and made by using solvent cement, except at the entry to the detector assembly. Refer to ASTM F402-05 standard practice for safe handling of solvent cements, primers, and cleaners used for joining thermoplastic pipe and fittings.

k. All pipes shall be supported by mechanical hangers attached to the structure of the building. Not more than 1-foot of pipe shall extend beyond the last hanger of each sampling pipe. The final installation shall result in no noticeable deflection in the piping network.

l. Attachment of air sampling pipes to cable trays "gray iron" and telecommunications equipment is prohibited.

m. Piping shall be labeled with the air sampling smoke detection system manufacturer's identification at least at 20-foot intervals.

n. Placement of the sampling tube shall take into consideration appropriate sampling point locations and spacing.

3. Air Sampling Points: Open area ceiling sampling points shall be oriented downward and shall be within 1 to 4 inches below the underside of the ceiling above where the ceiling is smooth. For ceilings with beams, girders, solid joist, or a waffle-like construction, etc., mount detectors in accordance with the special provisions in NFPA 72.

G. Addressable interface devices: Shall include a mounting plate for installation in a junction box or shall be mounted in a locked cabinet or approved box.

H. Annunciator: Locate the annunciator as shown on the drawings. Flush-mount the panel with the top of the panel 6 feet above the finished floor or center the panel at 4 feet, whichever is lower.

I. [NOTI-FIRE-NET web server: The location of the internet connection will be coordinated between the contractor and SRP.]

J. Instructions: Provide a typeset printed or typewritten instruction card mounted behind a Lexan plastic or glass cover in a stainless steel or aluminum frame. Install the instructions on the interior of the CFACU. The card shall show those steps to be taken by an operator when a signal is received as well as the functional operation of the system under all conditions, normal, alarm, supervisory, and trouble. The instructions shall be approved by SRP before being posted.

K. Labeling and Marking: All of the hardware covered in Part 2 and Part 3.1 of this specification section shall have Brady adhesive markers, or SRP approved equal, attached to them indicating the address of the hardware. Markers shall be installed, by the contractor, on the inside of the base and lettering shall be a minimum of 12-point.

3.3 SYSTEM FIELD WIRING

A. Wiring within Cabinets, Enclosures, and Boxes: Provide wiring installed in a neat and workmanlike manner and installed parallel with or at right angles to the sides and back of any box, enclosure, or cabinet. Conductors that are terminated, spliced, or otherwise interrupted in any enclosure, cabinet, mounting, or junction box shall be connected to screw-type terminal blocks. Mark each terminal in accordance with the wiring diagrams of the system. The use of wire nuts or similar devices is prohibited. Wiring shall conform to NFPA 70.

B. Terminal Cabinets: Terminal size shall be appropriate for the size of the wiring to be connected. Minimum size is 8 inches by 8 inches. Only screw-type terminals are permitted.

C. Alarm Wiring: Voltages shall not be mixed in any junction box, housing, or device, except those containing power supplies and control relays. Provide all wiring in electrical metallic conduit. The use of flexible conduit not exceeding a 6-foot length shall be permitted to a single device or
appliance. Run conduit or tubing (rigid, IMC, EMT, FMC, etc., as permitted by NFPA 72 and NFPA 70) concealed unless specifically indicated otherwise on the drawings. For shielded wiring, ground the shield at only one point that is in or adjacent to the FACU. Pigtail or T-tap connections to signal line circuits, supervisory alarm circuits, and notification appliance circuits are prohibited. Color coding is required for circuits and shall be maintained throughout the circuit. Conductors used for the same function shall be similarly color coded.

D. Conductor Terminations: Labeling of conductors at terminal blocks in terminal cabinets and at the FACU shall be provided at each conductor connection. Each conductor or cable shall have a shrink-wrap label to provide a unique and specific designation. Each terminal cabinet, FACU, NAC panel, and remote FACU shall contain a laminated drawing that indicates each conductor, its label, circuit, and terminal. The laminated drawing shall be neat, using 12-point lettering minimum size, and mounted within each cabinet, panel, or unit so that it does not interfere with the wiring or terminals.

E. The conductors for the notification appliance circuits shall not be installed in the same raceway as the conductors for signaling line circuits unless written certification from the manufacturer is supplied to SRP indicating that the inclusion of these circuits in the same raceway is acceptable and that no additional consideration is needed for these circuits.

F. All existing wiring shall be tested for abnormal conditions (grounds, shorts, opens, etc.) prior to reuse. In general, existing initiating device circuits shall be re-used as signaling line circuits, if the circuit is not loaded to more than 75 percent of the available circuit loading and the distance limitations as set forth by the manufacturers recommended specifications are not exceeded; existing notification appliance circuits shall be re-used, only if the existing circuit is not loaded to more than 75% of the available power for the circuit from the FACU. In the event that a signaling line circuit or a notification appliance circuit load exceeds 75 percent of the available circuit loading new circuits shall be installed.

G. Color coding of conductors shall be approved by SRP. Unless otherwise indicated, the color code for all fire alarm and emergency voice evacuation system conductors shall be as follows:

1. Signaling line circuits and initiating device circuits shall be red and black. Red shall be positive and black shall be negative.
2. Audible notification appliance circuits shall be blue and white. Blue shall be positive and white shall be negative (NAC).
3. Flashing strobe circuits shall be orange and yellow. Orange shall be positive and yellow shall be negative (NAC).
4. Two wire notification appliance circuits shall be blue and white. Blue shall be positive and white shall be negative.
5. Sprinkler/standpipe circuits shall be red and black. Red shall be positive and black shall be negative.
6. Smoke detector power circuits shall be brown and violet. Violet shall be positive and brown shall be negative.
7. Auxiliary remote power supply circuits shall be brown and violet. Violet shall be positive and brown shall be negative.
8. Electro-magnetic door hold-open circuits shall be gray and gray.
9. HVAC shut-down and damper circuits shall be orange and yellow.

10. Bond wires from the control unit to the ground rod, and all required bonding conductors shall be green.

11. AC supply circuit to the main FACU shall be white, black and red. The black shall be one phase, and the red shall be the opposite phase, if required. The white shall be the neutral. If a separate feed is required for the battery charger, it shall be black and white unless the main FACU requires only one AC feed. In that case, the conductors to the battery charger shall be red and white.

H. Exposed raceways shall be run parallel and perpendicular to the walls and ceilings. Wherever practical, exposed raceways shall be run on the ceiling as close as possible to a wall or as high as possible on a wall. Where exposed raceways shall cross under a structural beam or rib, they shall be run down on one side of the beam or rib, across its bottom, and up to the ceiling on the other side of the beam or rib. No spanning from beam to beam or rib to rib shall be permitted. The use of a raceway body on one side of a beam or rib shall be permitted provided it shall be readily accessible. Where metal raceway is installed exposed, it shall be painted to match the walls and/or ceilings on which it is installed, as instructed by SRP. The method and location of all exposed raceways shall be approved by SRP prior to start of any installation work.

I. Circuit disconnecting means shall have a red marking, shall be accessible to authorized personnel, and shall be identified as “FIRE ALARM CIRCUIT CONTROL”. The location of the circuit disconnecting means shall be permanently identified on a nameplate installed on the inside of the FACU.

3.4 FIRESTOPPING

A. Provide firestopping for holes at conduit penetrations through floor slabs, fire-rated walls, partitions, with fire-rated doors, corridor walls, and vertical service shafts.

3.5 PAINTING

A. Paint exposed electrical, fire alarm conduit and surface metal raceway to match adjacent finishes in exposed areas. Paint junction boxes red and conduits and surface metal raceways with a 1-inch wide red band every 10 feet in unfinished areas.

3.6 FIELD QUALITY CONTROL

A. Testing Procedures: Submit detailed test procedures, prepared and signed by the qualified test personnel for the detection and alarm system 21 days prior to performing system tests. All tests shall be conducted in the presence of SRP and other parties identified by SRP and shall not be conducted until the “Test Procedures” are approved. Detailed test procedures shall list all components of the installed system such as initiating devices and circuits, notification appliances and circuits, signaling line devices and circuits, control devices/equipment, batteries, transmitting and receiving equipment, power sources/supply, annunciators, interface equipment, and transient (surge) protective devices. Test procedures shall include sequence of testing, time estimate for each test, and sample test data forms. The test data forms shall be in a check-off format (pass/fail with space to add applicable test data, similar to the form in NFPA 72) and shall be used for the preliminary testing and the acceptance testing. The test data forms shall record the test results and shall:

1. Identify the NFPA Class of all initiating device circuits (IDC), notification appliance circuits (NAC), [and voice notification system circuits (NAC audio), ]and signaling line circuits (SLC).
2. Identify each test required by NFPA 72 Test Methods and required test herein to be performed on each component, and describe how this test shall be performed.

3. Identify each component and circuit as to the type, location within the facility, and unique identity within the installed system. Provide necessary floor plan sheets showing each component location, test location, and alphanumeric identity.

4. Identify all test equipment and personnel required to perform each test (including equipment necessary for testing smoke detectors).

5. Provide space to identify the date and time of each test. Provide space to identify the names and signatures of the individuals conducting and witnessing each test.

B. Test Stages:

1. Preliminary Testing: Conduct preliminary tests to ensure that devices and circuits are functioning properly. Tests shall meet the requirements of paragraph entitled "Minimum System Tests". After preliminary testing is complete, provide a letter certifying that the installation is complete and fully operable. The letter shall state that each initiating and indicating device was tested in place and functioned properly, panel functions were tested and operated properly, and shall include the names and titles of the witnesses to the preliminary tests. The installer and qualified test personnel shall be in attendance at both the preliminary and final tests to make necessary adjustments.

2. Request for Formal Inspection and Tests: When preliminary tests have been completed and corrections made, submit a signed, dated certificate with a request for formal inspection and tests to SRP.

3. Final Testing: Notify SRP in writing when the system is ready for final acceptance testing. Submit request for test at least 15 calendar days prior to the test date. The tests shall be performed in accordance with the approved test procedures in the presence of SRP or their representative. Furnish instruments, equipment, and personnel as required for the tests. A final acceptance test will not be scheduled until the following are provided at the job site:
   a. Marked-up redline drawings of the system as actually installed.
   b. Loop resistance test results.
   c. Complete program printout including input/output addresses.

4. The final tests will be witnessed by the SRP Representative. At this time, any and all required tests shall be repeated at their discretion.

5. System Acceptance: Following acceptance of the system, as-built drawings and O&M manuals shall be delivered to SRP for review and acceptance. At least two sets of as-built (marked-up) drawings shall be provided at the time of, or prior to the final acceptance test.

6. If the Final Acceptance Test fails, the contractor shall pay all costs incurred to SRP for any and all re-acceptance testing.

7. Upon satisfactory completion of the tests, the contractor shall leave the fire alarm and fiber network systems (if installed) in proper working order and without additional expense to SRP, shall replace any defective materials or equipment provided by the contractor under this Contract within two years from the date of final acceptance by the awarding authority.

8. Warranty: Except as otherwise expressly provided in the contract documents, and excepting only items of routine maintenance, ordinary wear and tear or unusual abuse or neglect,
contractor guarantees all work executed by the contractor and all supplies, materials, and devices of whatsoever nature incorporated in, or attached with the work, or otherwise delivered to SRP as part of the work pursuant to the contract to be absolutely free of all defects of workmanship and materials for a period of 2 years after final acceptance of the work by SRP. Include service directory with telephone numbers for 24-hour emergency service.

C. Minimum System Tests: Test the system in accordance with the procedures outlined in NFPA 72.

The required tests are as follows:

1. Loop Resistance Tests: Measure and record the resistance of each circuit with each pair of conductors in the circuit short-circuited at the farthest point from the circuit origin. Test results shall be recorded for use at the final acceptance test.

2. Verify the absence of unwanted voltages between circuit conductors and ground. The tests shall be accomplished at the preliminary test with results available at the final system test.

3. Verify that the control unit is in the normal condition as detailed in the manufacturer’s O&M manual.

4. Test each initiating device and notification appliance and circuit for proper operation and response at the control unit. Smoke detectors shall be tested in accordance with manufacturer’s recommended test method. Use of magnets is prohibited. Testing of duct smoke detectors shall comply with the requirements of NFPA 72. If there is a failure of supervision at one device, then supervision shall be tested at each device.

5. Test the system for specified functions in accordance with the contract drawings and specification and the manufacturer’s O&M manual.

6. Test both primary and secondary power. Verify, by test, the secondary power supply is capable of operating the system for the time period and in the manner specified.

7. Determine that the system is operable under trouble conditions as specified.

8. Visually inspect wiring for compliance with applicable circuit class.

9. Test battery charger and batteries.

10. Verify that software control and data files have been entered or programmed into the FACU. Hard copy records of the software shall be provided to SRP.

11. Verify that red-line drawings are accurate.

12. Disconnect the verification feature for smoke detectors during tests to minimize the amount of smoke needed to activate the detector.

13. Measure the voltage drop at the most remote appliance (based on wire length) on each notification appliance circuit.

14. Open the circuit at not less than 10 percent of alarm initiating devices and notification appliances to test the wiring supervisory feature.
15. Intelligibility Tests: Intelligibility testing of the system shall be accomplished in accordance with NFPA 72 for Voice Evacuation Systems, IEC 60268-16 and ASA S3.2. Intelligibility requirements:
   a. Verify intelligibility by measurement after installation.
   b. Ensure that a CIS value greater than the required minimum value is provided in each area where building occupants typically could be found. The minimum required value for CIS is .7.
   c. Areas of the building provided with hard wall and ceiling surfaces (such as metal or concrete) that are found to cause excessive sound reflections may be permitted to have a CIS score less than the minimum required value if approved by the SRP Representative, and if building occupants in these areas can determine that a voice signal is being broadcast and they must walk no more than 33 feet to find a location with at least the minimum required CIS value within the same area.
   d. Areas of the building where occupants are not expected to be normally present are permitted to have a CIS score less than the minimum required value if personnel can determine that a voice signal is being broadcast and they must walk no more than 50 feet to a location with at least the minimum required CIS value within the same area.
   e. Take measurements near the head level applicable for most personnel in the space under normal conditions (e.g., standing, sitting, sleeping, as appropriate).
   f. The distance the occupant must walk to a location meeting the minimum required CIS value shall be measured on the floor or other walking surface along the centerline of the natural path of travel, starting from any point subject to occupancy with less than the minimum required CIS value; curving around any corners or obstructions with a 12-inch clearance therefrom; terminating directly below the location where the minimum required CIS value has been obtained.
   g. Use commercially available test instrumentation to measure intelligibility as specified by ISO 7240-19 and ISO 7240-16 as applicable. Use the mean value of at least three readings to compute the intelligibility score at each test location.

3.7 TRAINING

A. Instructor: Include in the project the services of an instructor, who has received specific training from the manufacturer for the training of other persons regarding the inspection, testing, and maintenance of the system provided. The instructor shall train the employees designated by SRP, in the care, adjustment, maintenance, and operation of the fire alarm system. Each instructor shall be thoroughly familiar with all parts of this installation. The instructor shall be trained in operating theory as well as in practical O&M work. Submit the instructor’s information and qualifications including training history to SRP prior to training.

B. Required Instruction Time: Provide [4][8] hours of instruction after final acceptance of the system. The instruction shall be given during regular working hours on such dates and times as selected by SRP. The instruction may be divided into two or more periods at the discretion of SRP. The training shall allow for rescheduling for unforeseen maintenance and/or fire department responses.

END OF SECTION
SECTION 312000 - EARTH MOVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Preparing subgrades for slabs-on-grade, walks, pavements, and landscaping.
2. Drainage course for concrete slabs-on-grade.
3. Excavating and backfilling for utility trenches.
4. Excavating and backfilling for buildings and structures.
5. Subbase course for concrete walks and pavements.
6. Subbase and base courses for asphalt paving.

1.2 DEFINITIONS

A. Backfill: Soil material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subgrade and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Engineer. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Engineer. Unauthorized excavation, as well as remedial work directed by Engineer, shall be without additional compensation.

F. Fill: Soil materials used to raise existing grades.

G. Rock: Material, including boulders and granite, that cannot be removed by conventional earth moving or ripping equipment and require removal by techniques such as drilling...
and blasting/splitting or jackhammering. Material is not rock when it is disintegrated, weathered, loose, or fractured to such an extent that it works and handles like soil.

H. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

I. Slurry: Can mean ABC, lime, or cementitious types. See CLSM for engineering term

J. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below base course or topsoil materials.

K. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.3 REFERENCES

A. Uniform Standard Specifications for Public Works Construction from the Maricopa Association of Governments (MAG Specs)

1.4 QUALITY CONTROL

A. Pre-excavation Conference: Conduct a conference at Project site including working foremen of all participating subcontractors and SRP PM.

1.5 PROJECT CONDITIONS

A. Utility Locator Service: Notify “Blue Stake” utility locator service at 602-236-1100 before beginning earth-moving operations.

B. Maintain underground and overhead utilities in continuous service unless prior approval has been obtained from the Engineer. Locate, safeguard, and maintain conflicting utilities shown on drawings and identified in field. Utility lines identified prior to excavation work, which are damaged by Contractor, shall be repaired at Contractor's expense. Contractor shall identify conflicts by potholing for true depths and is responsible for relocation work needed to resolve conflicts.

C. Do not commence earth moving operations until plant-protection measures specified in Division 01 are in place.

D. Provide necessary support systems to meet all federal and state OSHA requirements for maintaining the stability of structures adjacent to excavations and excavation activities, and take necessary precautions to protect buildings, foundations and structures against damage. Contractor shall be liable for all damage.
PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: As specified in MAG Section 210.

C. Unsatisfactory Soils: Unsuitable materials include silt and clay soils with moisture content so significantly over optimum they cannot be compacted to the required maximum density. Sod, matted or decayed vegetation, expansive soil, and other deleterious material are also considered unsuitable backfill material and shall be removed from the jobsite.

D. Base Course: Aggregate Base Course as specified by MAG Section 702.

E. Engineered Fill: Fill as specified by the engineer on the drawings or within the specifications.

F. Bedding Course: Bedding shall be native or process material as required by the specifying utility.

2.2 ACCESSORIES

A. Detectable Underground Location Device: In accordance with ARS 40-360.22, all new and active underground facilities shall be installed with a detectible underground location device unless the facility is capable of being detected from above ground with an electronic locating device. Install acid and alkali resistant, warning tape manufactured for marking and identifying underground utilities. Install a minimum of 6 inches wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; or equivalent products that provide the same detection capability.

2.3 CONTROLLED LOW-STRENGTH MATERIAL (CLSM)

A. Acceptable CLSM mixtures as specified in MAG Section 728, latest revision.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.
B. Protect and maintain erosion and sedimentation controls during earth moving operations.

C. The Contractor shall not pass equipment over any pipe, drain, utility line, duct, or structure before they are adequately protected. Any damage to existing facilities and the costs associated with loss of utility use shall be at the Contractor's expense.

D. Use excavation shoring, bracing, sheeting, barricading, and plating necessary to perform work and protect excavation and personnel as required for safety and conformance to governing law, including OSHA Construction Standards, Subpart P, and Salt River Project Excavation Safety Resource Manual. Cost of protection systems shall be included in Contractor bid price.

3.2 GENERAL EXCAVATION

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

3.3 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.

B. Excavations at Edges of Tree- and Plant-Protection Zones:

1. Excavate by hand to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.

2. Cut and protect roots according to requirements in Division 01 Section "Temporary Tree and Plant Protection."

3.4 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under sidewalks, walkways, curbs/gutters, and pavements to indicated lines, cross sections, elevations, and subgrades.
3.5 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, tolerances, and elevations with allowances for minimum required bedding width, accommodation of compaction equipment and erection of forms.

B. Maximum continuous length and time of open trench shall not exceed the requirements of the governing municipality. A trench shall be considered open until backfilled to the top of subgrade on unsurfaced areas and the top of base course on pavements.

C. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.

   1. Clearance: As indicated in Table 601-1 (from MAG Spec 601) below.

<table>
<thead>
<tr>
<th>Size Of Pipe (I.D.)</th>
<th>Maximum Width At Top Of Pipe Greater Than O.D. Of Barrel</th>
<th>Minimum Width At Springline Each Side of Pipe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 18 inches</td>
<td>16 inches</td>
<td>6 inches</td>
</tr>
<tr>
<td>18 inches to 24 inches inclusive</td>
<td>19 inches</td>
<td>7 1/2 inches</td>
</tr>
<tr>
<td>27 inches to 39 inches inclusive</td>
<td>22 inches</td>
<td>9 inches</td>
</tr>
<tr>
<td>42 inches to 60 inches inclusive</td>
<td>1/2 O.D.</td>
<td>12 inches</td>
</tr>
<tr>
<td>Over 60 inches</td>
<td>36 inches</td>
<td>12 inches</td>
</tr>
</tbody>
</table>

D. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.

   1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material, 4 inches deeper elsewhere, to allow for bedding course.

   2. Remove excessive tooth marks or compact level.

E. Where soil incapable of supporting the utility is encountered, Contractor shall notify the Engineer and a determination will be made as to the depth of over-excavation and the type of engineered fill required.

F. Berm or otherwise protect trenches from surface drainage or runoff.

3.6 SUBGRADE INSPECTION

A. Any soft and unstable material shall be removed. The resulting areas and all sections, holes or depressions shall be brought to the required grade and cross-section.
B. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Engineer without additional compensation.

C. Clean excavation of trash and debris after completion of foundations, removal of forms, and other construction activities.

3.7 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. If approved by the Engineer, backfill unauthorized excavations using 1-½ sack cement CLSM.

1. Fill unauthorized excavations under other construction, pipe, or conduit using aggregate base course compacted to 95% density using ASTM D-6938 or ½ sack CLSM.

3.8 STORAGE OF SOIL MATERIALS

A. Stockpile borrowed soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations in accordance with OSHA regulations.

3.9 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Trenches under Footings: Backfill trenches excavated under footings to within 18 inches of bottom of footings with satisfactory soil or 1 ½ sack CLSM; fill final 18 inches with concrete to elevation of bottom of footings.

D. Trenches under Roadways: Unless otherwise specified by the controlling agency, place ½-sack CLSM as backfill in accordance with MAG Section 604.

E. Backfill material shall be uniformly within 2% of optimum moisture content prior to placement in the trench. Place backfill in level lifts simultaneously on both sides of the conduit, pipe, or structure unless otherwise specified. Backfill operations shall not cause disturbance of the in-place utility.

F. Backfill from bedding to a point approximately 6 inches above the top of the utility shall be placed in accordance with the specific utility requirements.
G. Place and compact approved backfill in uniform, level 8-inch thick maximum loose lifts to final subgrade elevation.

H. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

I. In projects outside of municipal rights-of-way and approved by the controlling utility, ½-sack cement CLSM per MAG Section 728 may be substituted for bedding and backfill for the convenience of the contractor at no additional cost to SRP.

3.10 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:

1. Under grass and planted areas, use on-site soils or fill approved by the Engineer.

C. All other conditions: Use soils as specified in MAG Section 210.

3.11 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 3 percent of optimum moisture content. Free water shall not appear on the surface during or after compaction. Fill at moisture contents greater than this value shall either be removed and replaced or scarified and air-dried to bring into conformance.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.

3.12 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in level lifts not more than 12 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers. Fill shall be placed so that, when compacted in a homogenous mass, it is formed free from lenses, pockets, streaks, or layers that differ substantially in texture and gradation from surrounding material. In no instance shall minimum compacted depth of a layer be less than maximum size of aggregate, plus one inch.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure. Place backfill uniformly against structures to prevent eccentric or excessive loading of structures.

C. Compact soil materials to at least the following percentages of maximum dry unit weight, at or within 3 percent of optimum moisture in accordance with ASTM D 698:
1. Under structures, foundations, and building slabs, scarify the upper 6 inches of existing subgrade. Recompact subgrade and compact subsequent fill lifts to at least 100 percent of maximum dry density.

2. Under steps, sidewalks, walkways, curb/gutter, roadway shoulders, and pavements scarify and recompact the upper 6 inches of existing subgrade. Recompact subgrade and compact subsequent fill lifts to at least 95% of maximum dry density.

3. Unless specified by the controlling agency, utility trench bedding and backfill lifts shall be compacted to no less than the percentages of maximum dry density noted in Table 601-2 of MAG Section 601.

<table>
<thead>
<tr>
<th>Backfill Location</th>
<th>From Surface To 2 feet Below Surface</th>
<th>From 2 feet Below Surface To 1 foot Above Top of Pipe</th>
<th>From 1 foot Above Top of Pipe to Bottom of Trench</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under any existing or proposed pavement, curb, gutter, sidewalk, or such construction included in the contract, or when any part of the trench excavation is within 2-feet of the above.</td>
<td>100% for granular</td>
<td>95% for non-granular</td>
<td>90%</td>
</tr>
<tr>
<td>On any utility easement street, road or alley right-of-way outside limits of (I).</td>
<td>85%</td>
<td>85%</td>
<td>90%</td>
</tr>
<tr>
<td>Around any structures or exposed utilities.</td>
<td>95% in all cases</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

D. Do not cover lifts before compaction tests are performed. If lifts are covered prior to testing, excavate test pits for making density tests on lower portions of backfill at instruction of the Engineer. Refill and compact test pits in accordance with the specifications. Excavating, refilling, and compacting test pits shall be at Contractor's expense.

E. Consolidation of backfill by flooding or jetting is permitted only with prior assessment by and written approval of the Engineer.

F. Mechanical compaction shall not be used within 6 inches of gas lines, electrical cable or plastic conduit.

G. If in the opinion of the Engineer, any portion of the surface of the backfill becomes so dry or glazed during construction that bond with the succeeding layer to be placed thereon cannot be obtained or should ruts and roadways develop on the backfill, such surface shall be scarified to a minimum depth of 6 inches, re-leveled, moisture conditioned, and re-compacted to the specified density just prior to placing of the succeeding layers at the Contractor's expense.

H. All compaction equipment shall be of a type and size suitable to perform the required compaction and shall be subject to approval by the Engineer.
3.13  GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. The compacted surface shall be graded to a straight grade between finished elevations shown in the plans or to the elevation of the existing ground at the edges of the area to be graded. Variations within the specified tolerance shall be compensating so that the average grade and cross-section specified are met.

B. Site Rough Grading: Unless otherwise shown on the plans, slope grades to direct water away from buildings and to prevent ponding. Rough subgrades shall not vary to required elevations in accordance with the following tolerances in any 10 feet from the specified grade and cross-section:
   1. Turf or Unpaved Areas: ±1 inch.
   2. Sidewalks, driveways, curb/gutter, walkways: ±1 inch.

C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/4-inch when tested with a 10-foot straightedge. Under no circumstances shall overfill reduce minimum foundation thickness.

3.14  BASE COURSE UNDER SLABS, FOOTINGS, PAVEMENTS, SIDEWALKS AND CURB/GUTTER

A. Place base course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place base course under pavements sidewalks and curbs/gutters as follows:
   1. Shape base course to required grades, lines and cross sections shown on the drawings.
   2. Place base course in loose lifts that do not exceed 12 inches in compacted thickness in layers of equal thickness, with no compacted layer less than 3 inches thick.
   3. Compact base course within 2% of optimum moisture content to not less than 100 percent of maximum dry unit weight according to ASTM D 698.
   4. Finished base course shall be no higher than the specified grade and cross section and no less than ¼-inch below specified grade and cross section. Variations within the above specified tolerance shall be compensating so that the average grade and cross-section specified are met.

3.15  FIELD QUALITY CONTROL

A. Testing Agency: SRP will engage a qualified geotechnical engineering testing agency to perform tests and inspections.

B. Inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.
C. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Engineer.

D. When subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

E. When any structural excavation is complete, notify SRP for an inspection. No materials shall be placed in the excavation prior to an inspection.

3.16 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.  
   1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.17 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION
SECTION 321216 - ASPHALT PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cold milling of existing hot-mix asphalt pavement.
2. Hot-mix asphalt patching.
3. Hot-mix asphalt paving.
4. Hot-mix asphalt paving overlay.
5. Pavement-marking paint.

B. Related Sections:

1. Division 31 Section "Earth Moving" for aggregate subbase and base courses and for aggregate pavement shoulders.
2. Division 32 Section "Concrete Paving Joint Sealants" for joint sealants and fillers at paving terminations.

1.2 REFERENCES

A. Maricopa Association of Government publication Uniform Standard Specifications for Public Works Construction (MAG Specs)

1. Part 300 – Streets and Related Work; Sections 301 through 360
2. Part 400 – Right-of-Way and Traffic Control; all Sections
3. Part 700 – Materials; Sections 701 through 719

B. Where there is a conflict between the MAG Spec and this document, the requirements of this document shall take precedence over the MAG Spec.

1.3 SUBMITTALS

A. Product Data: Provide the A/E with submittals 10 working days in advance of the first use of the product. For each type of product indicated include technical data and test results.

1. Job-Mix Designs: For each job mix proposed for the Work.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by ADOT.
B. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of MAG Specs for asphalt paving work regardless of County where installed.

1. Measurement and payment provisions and submittals included in standard specifications do not apply to this Section.

C. Pre-installation Conference: Conduct conference at the Project Trailer or at the Project Site.

1.5 PROJECT CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:

1. Tack Coat: Minimum surface temperature of 60 deg F.
2. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at time of placement.
3. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.

B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature 55 deg F, and not exceeding 95 deg F.

PART 2 - PRODUCTS

2.1 AGGREGATES

A. Coarse Aggregate: In compliance with Part 700–Materials of the MAG Specs.


2.2 ASPHALT MATERIALS

A. Asphalt Binder: In compliance with Part 700–Materials of the MAG Specs.


2.3 AUXILIARY MATERIALS

A. Herbicide: Commercial chemical for weed control, registered by the EPA. Provide in granular, liquid, or wettable powder form.
B. Pavement-Marking Paint: MPI #32 Alkyd Traffic Marking Paint.

C. Wheel Stops: Precast, air-entrained concrete, in accordance with MAG Standard Detail #150.

D. Wheel Stops: Solid, integrally colored, 96 percent recycled HDPE or commingled postconsumer and postindustrial recycled plastic; UV stabilized; 4 inches high by 6 inches wide by 72 inches long. Provide chamfered corners, drainage slots on underside, and holes for anchoring to substrate.

   1. Dowels: Galvanized steel, 3/4-inch diameter, 10-inch minimum length.
   2. Adhesive: As recommended by wheel-stop manufacturer for application to asphalt pavement.

2.4 MIXES

A. Hot-Mix Asphalt: In accordance with MAG Spec 710-Asphalt Concrete.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

B. Proceed with paving only after unsatisfactory conditions have been corrected.

3.2 COLD MILLING

A. Clean existing pavement surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.

   1. Mill to a depth of 2 inches.

3.3 PATCHING

A. Hot-Mix Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

B. Portland Cement Concrete Pavement: Remove cracked pavement. Excavate rectangular or trapezoidal patches, extending into adjacent sound pavement, unless
otherwise indicated. Cut excavation faces vertically. Recompact existing unbound-aggregate base course.

C. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving at a rate of 0.05 to 0.15 gal./sq. yd.
   1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
   2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

D. Patching: Fill excavated pavements with hot-mix asphalt base mix for full thickness of patch and, while still hot, compact flush with adjacent surface.

3.4 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

B. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.

C. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd.
   1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
   2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.5 HOT-MIX ASPHALT PLACING

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.
   1. Spread mix at minimum temperature of 250 deg F.
   2. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.
3.6 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.

1. Clean contact surfaces and apply tack coat to joints.
2. Construct transverse and longitudinal joints in accordance with MAG Spec 321.

3.7 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 deg F.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the acceptance densities found in MAG Spec 321 by laboratory testing.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

G. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.8 ASPHALT CURBS

A. Construct hot-mix asphalt curbs over compacted pavement surfaces. Apply a light tack coat unless pavement surface is still tacky and free from dust. Spread mix at minimum temperature of 250 deg F.

1. Asphalt Mix: Same as pavement surface-course mix.

B. Place hot-mix asphalt to curb cross section indicated or, if not indicated, to local standard shapes, by machine or by hand in wood or metal forms. Tamp hand-placed
materials and screed to smooth finish. Remove forms after hot-mix asphalt has cooled.

3.9 INSTALLATION TOLERANCES

A. Pavement Thickness: Compact each course to produce the thickness indicated with the tolerances in accordance with MAG Spec 321.

B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 12-foot straightedge applied transversely or longitudinally to paved areas:

1. Base Course: 1/4 inch.
2. Surface Course: 1/4 inch.
3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

3.10 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.

B. Allow paving to age for 7 days before starting pavement marking.

C. Sweep and clean surface to eliminate loose material and dust.

D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

1. Broadcast glass beads uniformly into wet pavement markings at a rate of 6 lb/gal.

3.11 WHEEL STOPS

A. Install wheel stops in bed of adhesive as recommended by manufacturer.

B. Securely attach wheel stops to pavement in accordance with MAG Specs.

3.12 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Replace and compact hot-mix asphalt where core tests were taken.

C. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.
3.13 DISPOSAL

A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.

END OF SECTION