University of Oregon
Erb Memorial Union
Eugene, Oregon

Craft Center – Package 1
Project Manual
Permit / Construction
Divisions 00-33

20 December 2013

SERA Project Number: 11045

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NOTICE OF EXTENDED CERTIFICATION PROVISION: The Contract will allow the Owner to certify billings and estimate within 20 days after the billings and estimates are received from the original contractor.

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Notice of Alternate Billing Cycle: The Contract will allow the Owner to require the submission of billings or estimates in billing cycles other than 30-day cycles. Billing or statements shall be submitted monthly ending on the last day of the month.

Notice of Extended Certification Provision: The Contract will allow the Owner to certify billings and estimate within 20 days after the billings and estimates are received from the original contractor.

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PART 1 GENERAL

1.01 EXISTING CONDITIONS

   1. Original copy is available for inspection at Owner’s offices during normal business hours.
   2. This report identifies properties of below grade conditions and offers recommendations for the design of foundations, prepared primarily for the use of Architect.
   3. The recommendations described shall not be construed as a requirement of this Contract, unless specifically referenced in the Contract Documents.
   4. This report, by its nature, cannot reveal all conditions that exist on the site. Should subsurface conditions be found to vary substantially from this report, changes in the design and construction of foundations will be made, with resulting credits or expenditures to the Contract Price accruing to Owner.

   1. Original copy is available for inspection at Owner’s offices during normal business hours.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Summary of the Work.
B. Work by Owner.
C. Owner's occupancy.
D. Contractor's use of site and general limitations.
E. Definitions used throughout the Specification and Drawings.
F. Specification formats and conventions.

1.02 PROJECT
A. Project Name: Erb Memorial Union, Craft Center.
B. Owner's Name: University of Oregon.
C. The Project consists of the demolition, alteration and new construction of the Erb Memorial Union Craft Center.

1.03 CONTRACT DESCRIPTION
A. Contract Type: A single prime contract based on a Stipulated Price as described in the Agreement.
B. Permit fee with the City of Eugene will be paid for by The University of Oregon.

1.04 DESCRIPTION OF ALTERATIONS WORK
A. Scope of demolition and removal work is shown on drawings and specified in Section 02 41 00.

1.05 WORK BY OWNER
A. Items noted OFOI will be furnished and installed by Owner before Substantial Completion. Some items include:
   1. Furnishings.
   2. Small equipment.
   3. Artwork.
B. Owner will supply the following for installation by Contractor:
   1. Room numbering; See Appendix – Room Numbering Guide
   2. Specification of and providing of door hardware; OFCI.
   3. Exterior trash cans. Custom UO design and order, OFOI.
   4. Exterior benches; OFCI.
   5. Toilet dispenser accessories; OFCI.
   6. Exterior light poles, globes, lamps, and junction box; OFCI.
   7. Interior signage on small to medium projects only; OFOI.
   8. Exterior building marker signage; OFOI.
   9. Wall clocks; OFCI.
   10. Waste receptacles for all spaces; OFOI.
   11. Ash posts or smoking stations. OFOI; Custom UO fabrication.
   12. Walk off mats; OFOI.
C. Third party entities hired by the Owner may include, but are not limited to, the following:
   1. Cost estimator.
   2. Site survey.
   3. Certified arborist services.
   4. Special inspections and testing services (See Section 01 40 00).
   5. Water and air balancing and testing services.
   6. Commissioning services.
   7. Energy analyst.
8. Geotechnical consultant.
9. Hazardous materials testing and monitoring.
10. Asbestos removal.

1.06 OWNER OCCUPANCY
A. Owner intends to occupy the Project upon Substantial Completion.
B. Cooperate with Owner to minimize conflict and to facilitate Owner’s operations.
C. Schedule the Work to accommodate Owner occupancy.

1.07 CONTRACTOR USE OF SITE AND PREMISES
A. Construction Operations: Limited to areas noted on Drawings.
B. No Smoking Policy: Smoking is prohibited in Project Site.
C. Provide access to and from site as required by law and by Owner:
   1. Emergency Building Exits During Construction: Keep all exits required by code open during construction period; provide temporary exit signs if exit routes are temporarily altered.
   2. Do not obstruct roadways, sidewalks, or other public ways without permit.
   3. Unless written approval is obtained, construction must not obstruct private or public streets, driveways, pedestrian walkways, ADA routes, fire lanes, egress of occupied buildings, etc.
   4. Coordinate construction detour routes for bikes, pedestrians, vehicles, etc. with FS Exterior Supervisor, PP, PM, and as needed DPS.
D. No disposal or recycling on university property outside construction area(s) unless approved by PM.
E. No burying of any demolition or construction materials on site.
F. No stockpiling of waste on-site beyond the period necessary for sorting and accumulation of practical quantities for transport off-site.
G. Description of Work times may be limited beyond requirements set by city codes.
H. In the event the Contractor encounters material that is believed to be hazardous, asbestos containing, coated with lead base paint, and/or oily debris the Contractor shall immediately stop Work in the affected area and report the condition to the PM. At no time shall such material be Disturbed, handled or disposed of by the Contractor. The Contractor will cooperate and work with the PM, EH&S, any Consultants, and abatement Contractors engaged by the Owner.
I. Protection of existing conditions:
   1. Provide necessary measures required to fully protect existing conditions.
   2. Restore permanent facilities used during construction to their specified and/or original condition.
J. When required, provide scaffolding erected by a certified erector following OSHA guidelines.
K. Reference Section 00 31 00 – Available Project Information, for information on known Asbestos containing materials and locations to be provided protection to prevent disturbance.

1.08 DELEGATED DESIGN REQUIREMENTS
A. General requirements for Delegated Design components are specified in Section 01 33 16.
B. Specific design requirements are specified in Sections of Division 02 through 50.
C. Delegated design may sometimes also be referred to as “Design-Build.” Both terms may be used interchangeably and have the same meaning.

1.09 DEFINITIONS
A. Basic Contract definitions are included in the Conditions of the Contract.

2. Basic contract definitions that are not defined in the General Conditions shall have the same meaning as defined in AIA Document A201 – 1997.

B. "AHJ": Authority Having Jurisdiction as defined in AIA Document A201.

C. "Approved": When used to convey Architect's action on Contractor's submittals, applications, and requests, "approved" is limited to Architect's duties and responsibilities as stated in the Conditions of the Contract.

D. "Delegated Design": Professional design service or certification specifically required of the Contractor in the Specifications. Such work is subject to provisions of AIA Document A201 § 3.12.10. The terms "Delegated Design," and "Design-Build," mean the same thing and are used interchangeably.

E. "Directed": A command or instruction by Architect. Other terms including "requested," "authorized," "selected," "approved," "required," and "permitted" have the same meaning as "directed."

F. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."

G. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.

H. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.

I. "Install": Operations at Project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations, complete and ready for the intended use.

J. "Provide": Furnish and install, complete and ready for the intended use.

K. "Project Site": Space available for performing construction activities. The extent of Project site is shown in Drawings and may or may not be identical with the description of the land on which Project is to be built.

L. "Work": Project material "furnished" and "installed" complete and ready for the intended use.

1.10 SPECIFICATION FORMATS AND CONVENTIONS

A. Specification Format: The Specifications are organized into Divisions and Sections using the CSI/CSC’s MasterFormat 50-Division numbering system.

B. Sections in Division 01 govern the execution of the Work of all Sections in the Specifications and Drawings.

C. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:

1. Abbreviated Language: Language used in the Specifications and other Contract Documents is abbreviated. Words and meanings shall be interpreted as appropriate. Words implied, but not stated, shall be inferred as the sense requires. Singular words shall be interpreted as plural, and plural words shall be interpreted as singular where applicable as the context of the Contract Documents indicates.

2. Imperative mood and streamlined language are generally used in the Specifications. Requirements expressed in the imperative mood are to be performed by Contractor. Occasionally, the indicative or subjunctive mood may be used in the Section Text for
clarity to describe responsibilities that must be fulfilled indirectly by Contractor or by others when so noted.

3. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.

PART 2 PRODUCTS - NOT USED
PART 3 EXECUTION - NOT USED

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Procedures for preparation and submittal of applications for progress payments.
B. Contract modification procedures.
C. Additional architectural service for extraordinary contract administration.
D. Procedures for preparation and submittal of application for final payment.

1.02 DEFINITIONS
A. Architectural Bulletin (AB): Architect's form issued by Architect indicating "Architect's Supplemental Instruction" or "Proposal Request" or "Construction Change Directive" or as a signature cover to Contractor initiated proposal.
   1. AB Form is enclosed at end of Section.
C. Proposal Request (PR): A formal request from Architect to Contractor for change in Contract Sum and Time required to perform a proposed change in Work. Proposal Request is not a directive to perform the proposed change.
D. "Construction Change Directive" and "Change Order" have meanings defined in AIA Document A201.
E. Additional Contract Administration Services: Architectural service to enforce Contract Documents resulting from Contractor's failure to comply with requirements or Contractor's request for accelerated procedures.

1.03 SCHEDULE OF VALUES
A. Electronic media printout including equivalent information will be considered in lieu of standard form specified; submit sample to Architect for approval.
B. Forms filled out by hand will not be accepted.
C. Submit a printed schedule on AIA Form G703 - Application and Certificate for Payment Continuation Sheet. Contractor's standard form or electronic media printout will be considered.
D. Submit Schedule of Values in duplicate within 15 days after date of Owner-Contractor Agreement.
E. Format: Utilize the Table of Contents of this Project Manual. Identify each line item with number and title of the specification Section. Identify site mobilization.
F. Include separately from each line item, a direct proportional amount of Contractor's overhead and profit.
G. Revise schedule to list approved Change Orders, with each Application For Payment.
H. See 1.4 Applications for Progress Payments for additional requirements.

1.04 APPLICATIONS FOR PROGRESS PAYMENTS
A. Payment Period: Submit at intervals stipulated in the Agreement.
B. Electronic media printout including equivalent information will be considered in lieu of standard form specified; submit sample to Architect for approval.
C. Forms filled out by hand will not be accepted.
D. Present required information in typewritten form.
E. Form: AIA G702 Application and Certificate for Payment and AIA G703 - Continuation Sheet including continuation sheets when required.
F. Procedures for preparation and submittal of applications for progress payments in addition to those stated in the General Conditions and General Requirements also include:
1. One half of one percent from each payment application will be allocated and held until released upon approval of the final Operation and Maintenance Manual submittal. The Contractor shall submit a draft Operation and Maintenance Manual to the Architect upon 75 percent project completion.
2. One half of one percent from each payment application will be allocated and held until released upon approval of the final Record Document submittal.
3. One half of one percent from each payment application will be allocated and held until released upon approval of the final Commissioning submittal.
4. The above items, where applicable, will be listed as separate line items on the Contractor's schedule of values.

G. Changes in the work shall be initiated using the SERA Architectural Bulletin (AB) Form.
H. Additional contract administration services is an additional architectural service and will be billed to the Owner who will then back-charge the Contractor.
I. Execute certification by notarized signature of authorized officer.
J. Use data from approved Schedule of Values. Provide dollar value in each column for each line item for portion of work performed and for stored Products.
K. List each authorized Change Order as a separate line item, listing Change Order number and dollar amount as for an original item of Work.
L. Submit three copies of each Application for Payment.
M. Include the following with the application:
   1. Construction progress schedule, revised and current as specified in Section 01 30 00.
   2. Current construction photographs specified in Section 01 30 00.
   3. Project Record Documents as specified in Section 01 78 00, for review by Owner which will be returned to the Contractor.
   4. Preliminary Closeout Documents when specified in Section 01 78 00.
   5. Affidavits attesting to off-site stored products.
   6. Contractor payment requests must be accompanied by all wage certificates for the billing period.
N. Materials stored off site and included in the schedule of values for monthly payment application are to be stored in a bonded and secure facility. Copies of bill of sale for materials and certificate of insurance for material with Owner named as an insured are to be included with the payment application.
O. When Architect requires substantiating information, submit data justifying dollar amounts in question. Provide one copy of data with cover letter for each copy of submittal. Show application number and date, and line item by number and description.

1.05 MODIFICATION PROCEDURES
A. For minor changes not involving an adjustment to the Contract Price or Contract Time, Architect will issue instructions directly to Contractor.
B. Architect will advise of minor changes in the Work not involving an adjustment to Contract Sum or Contract Time as authorized by the Conditions of the Contract by issuing supplemental instructions on Architectural Bulletin Form.
C. Construction Change Directive: Architect may issue an AB, signed by Owner, instructing Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.
   1. The document will describe the required changes and will designate method of determining any change in Contract Sum or Contract Time.
   2. Promptly execute the change.
D. Proposal Request: Architect may issue an AB which includes a detailed description of a proposed change with supplementary or revised Drawings and Specifications, a change in
Contract Time for executing the change and the period of time during which the requested price will be considered valid. Contractor shall prepare and submit a fixed price quotation within 15 days.

E. Contractor may propose a change by submitting a request for change to Architect, describing the proposed change and its full effect on the Work, with a statement describing the reason for the change, and the effect on the Contract Sum and Contract Time with full documentation. Document any requested substitutions in accordance with Section 01 60 00. Contractor proposal will be processed in one of the following methods:
1. Architect may reject Contractor proposal or may return it for modification.
2. Architect may attach Contractor proposal to SERA AB, complete the AB appropriately, and distribute it for signatures.
3. Architect may accept Contractor's form that has place for signatures, sign it and distribute to Owner for signature.

F. Computation of Change in Contract Amount: As specified in the Agreement and Conditions of the Contract.
1. For pre-determined unit prices and quantities, the amount shall be based on the fixed unit prices.

G. Substantiation and Computation of Costs: Provide complete itemized cost information with substantiating backup for each item for evaluation as follows:
1. Quantities of products, labor, and equipment.
2. Taxes, insurance, and bonds.
3. Overhead and profit on products and labor only. Overhead and profit is limited as follows:
   a. Entity performing work: 5%
   b. Upper tier contractor: 5%
5. Credit for deletions from Contract, similarly documented.
6. For Time and Material work, submit itemized account and supporting data after completion of change, within time limits indicated in the Conditions of the Contract.

H. Execution of Change Orders: Architect will issue Change Orders for signatures of parties as provided in the Conditions of the Contract.

I. After execution of Change Order, promptly revise Schedule of Values and Application for Payment forms to record each authorized Change Order as a separate line item and adjust the Contract Sum.

J. Promptly enter changes in Project Record Documents.

1.06 EXTRAORDINARY CONTRACT ADMINISTRATION SERVICE

A. Owner-Architect Agreement identifies certain additional services for which Architect may receive additional compensation. Some of these services may result out of actions or non-actions by Contractor; these include, but are not limited to:
1. Design services for modification resulting from substitution proposed by Contractor.
2. Review of submittals after the first re-submittal.
3. Review or response to unnecessary or frivolous RFI.
4. Second notification and review of non-compliant work.
5. Design services to correct or incorporate non-compliant work.
6. Design or engineering specified as Contractor's responsibility; for example, for design-build component or for performance-specified work.
7. Performing administrative work specified as Contractor's responsibility when Contractor refuses to perform after notification.
8. Performing administrative work specified as Contractor's responsibility when requested to expedite the Work.
9. Providing extra construction administration services after the specified date of Substantial Completion or the specified date of Final Completion when delay is not caused by Owner.
10. Re-inspection for Substantial Completion or Final Completion.

B. Architect will issue Notice for Extraordinary Contract Administration Services to Owner and a copy to Contractor. Thereafter, Architect will record time and expense for each occurrence, or in the case of recurring occurrences, each type of occurrence.
   1. Architect will, at their discretion, invoice Owner monthly for additional services.
   2. Architect's fee schedule for additional services is included in Owner-Architect Agreement, and is available to Contractor upon request.

C. Owner reserves the right to charge the cost of Architect’s extraordinary contract administration service plus 10% administration cost to Contractor in an AB.

1.07 APPLICATION FOR FINAL PAYMENT
A. Prepare Application for Final Payment as specified for progress payments, identifying total adjusted Contract Sum, previous payments, and sum remaining due.

B. Application for Final Payment will not be considered until the following have been accomplished:
   1. All closeout procedures specified in Section 01 70 00. Prior to any final payment(s) all required as-built and O&M documentation as listed in Section 01 70 00 must be received by Owner.
   2. Affidavit that payrolls and bills have been satisfied.
   3. Consent of Surety to make Final Payment.
   4. Certificate evidencing that Builder's Risk insurance required after Substantial Completion will remain in force, and a written statement that Contractor knows of no reason that insurance will not be renewed for the required period until Final Payment.
   5. Prior to any final payment(s) all keys checked out to Contractor(s) and/or Consultant(s) must be returned to DPS and a receipt of return provided to PM by DPS.

END OF SECTION
The following instruction is hereby issued:

**ARCHITECT’S SUPPLEMENTAL INSTRUCTION**  (complete PART A only)

The Work shall be carried out in accordance with the following supplemental instructions issued in accordance with the Contract Documents without change in Contract Sum or Contract Time. Proceeding with the Work in accordance with these instructions indicates the Contractor’s acknowledgement that there will be no change in the Contract Sum or Contract Time.

**PROPOSAL REQUEST**  (complete PART A only)

Please submit an itemized quotation for changes to the Contract Sum and/or Contract Time incidental to the proposed modifications of the Contract Documents described below. DO NOT PROCEED WITH WORK UNTIL RECEIVING FURTHER WRITTEN INSTRUCTION This is not a change order, a construction change directive or a direction to proceed with the work described herein.

**CONSTRUCTION CHANGE DIRECTIVE**  (complete PARTS A & B)

You are hereby directed to make the following change(s) in this Contract. Track the costs of changes to the Contract as described in proposed adjustments (Part B) below.

**PART A: DESCRIPTION OF WORK**

X.1  **DISPOSITION**  
(Description – describe work scope in this space – text to be Title Case and not bold. Column to left, i.e. “disposition” to denote type of change using on the following works (or iterations), “ADD”, “DELETE”, “CLARIFY”, or “CHANGE”. Disposition text to be ALL CAPS and bold.)

**ATTACHMENTS**

Issued by:  SERA Architects, Inc.

**PART B: PROPOSED ADJUSTMENTS**

1. The proposed basis of adjustment to the Contract Sum or Guaranteed Maximum Price is:

   Unit Price of $ per

   Lump Sum (increase) (decrease) of $ 

   As provided in Subparagraph 7.3.3 of AIA Document A201 1997 Edition

   As follows:

2. The Contract Time is proposed to:

   Remain unchanged

   Be adjusted with an (increase) (decrease) of days
PART 1 GENERAL
1.01 SECTION INCLUDES
   A. Schedule of Alternates
   B. Procedures for Alternates.

1.02 DEFINITIONS
   A. Alternate: An amount proposed by Bidders and stated on the Bid Form for certain work defined in the Bidding Requirements that may be added to or deducted from the Base Bid amount if Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.
      1. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate alternate into the Work. No other adjustments are made to the Contract Sum.
   B. Deferred Alternate: An Alternate that may be accepted by Owner after execution of Agreement.
      1. Deferred Time Limit: Unless stated otherwise in Bidding Requirements or Contracting Requirements or description of a specific Alternate, Alternates may be accepted up to 60 days after Bids are due.

1.03 PROCEDURE
   A. Coordination: Modify or adjust affected adjacent work as necessary to completely integrate work of 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 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.

1.04 ACCEPTANCE OF ALTERNATES
   A. Alternates quoted on Bid Forms will be reviewed and accepted or rejected or deferred at Owner's option. Accepted alternates will be identified in the Owner-Contractor Agreement or an amendment there to.
   B. Coordinate related work and modify surrounding work to integrate the Work of each alternate.

1.05 SCHEDULE OF ALTERNATES
   A. Alternate No. 1 - Casework:
      1. Alternate Description: Provide casework as shown in pricing set.
      2. Base Bid relative to Alternate: Reduce casework as shown in pricing set by $31,750 (30%).
   B. Alternate No. 2 - Reception Desk:
      1. Alternate Description: Provide reception desk as shown in pricing set.
      2. Base Bid relative to Alternate: Reception desk to be furnished and installed by UO.
   C. Alternate No. 3 - Green Wall:
      1. Alternate Description: Provide 3 bays of green wall of CIP concrete as shown in CPC presentation
      2. Base Bid relative to Alternate: Provide 2 bays of standard fencing in lieu of green wall.
   D. Alternate No. 4 - Sliding Door:
      1. Alternate Description: Provide sliding doors as shown in pricing set.
2. Base Bid relative to Alternate: Provide Cased opening between the painting and screen printing studios.

E. Alternate No. 5 - Roller Shades:
   1. Alternate Description: Provide window coverings as shown in pricing set.
   2. Base Bid relative to Alternate: All window coverings are provided and installed by UO.

F. Alternate No. 6 - Wood Ceiling:
   1. Alternate Description: Provide wood ceiling as shown in pricing set.
   2. Base Bid relative to Alternate: No wood ceiling in craft center.

G. Alternate No. 7 - Allowance for equipment install by CM/GC:
   1. Alternate Description: Provide $20,000 allowance for GMGC to assist craft center staff.
   2. Base Bid relative to Alternate: All craft center equipment installed by UO.

H. Alternate No. 8 - Enlargement of wood shop door opening:
   1. Alternate Description: Provide structural alterations as needed to extend the opening an additional 6'-0" to the north.
   2. Base Bid relative to Alternate:

I. Alternate No. 9 - Craft Center Cover:
   1. Alternate Description: Provide
   2. Base Bid relative to Alternate:

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

ALTERNATE NO. 3 - GREEN WALL:

4.01 ALTERNATE DESCRIPTION: PROVIDE

4.02 BASE BID RELATIVE TO ALTERNATE:

END OF SECTION
PART 1 - GENERAL

1.01 SUMMARY
   A. Section includes procedure for coordinating and submitting Request for Interpretation.

1.02 DEFINITIONS
   A. RFI: Request from Contractor to Architect seeking interpretation or clarification of the Contract Documents.

1.03 RFI PROCEDURE
   A. Review Contract Documents and Project Site in a thorough and timely manner so Architect will have sufficient time to respond to RFI prior to execution of subject construction.
      1. Claim for additional Time or Cost when RFI is answered within time limit specified in this Section will be rejected.
   B. Immediately on discovery of the need for interpretation of the Contract Documents, and if not possible to request interpretation at Project meeting, prepare and submit an RFI in the form specified.
      1. RFIs shall originate with Contractor. RFIs submitted by entities other than Contractor will be returned with no response.
      2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.
   C. When possible, request interpretation at next Progress Meeting. Record Architect’s response in meeting minutes.
      1. When response is not given during meeting, submit RFI in approved format.

1.04 SUBMITTALS
   A. RFI Form: Electronic form furnished by Architect, numbered and signed by Contractor.
      1. Number each page of attachments with RFI number in lower right corner.
      2. Attachments shall be electronic files in Adobe Acrobat PDF format.
      3. Alternative RFI Form: Subject to Architect’s approval, Contractor software-generated form modified to match Architect’s form. Numbering and attachments as specified in this Section.
   B. RFI Content: Include detailed, legible description of item needing interpretation and the following:
      1. Project name and number.
      2. Date.
      3. Name of Contractor.
      5. RFI number, numbered sequentially. Add revision numbers as decimal and digit.
      6. RFI subject title, less than five words
      7. Initiator of question
      8. Specification Section number and title and related paragraphs, as appropriate.
      9. Drawing number and detail references, as appropriate.
      10. Field dimensions and conditions, as appropriate.
      11. Contractor's suggested solution(s). If Contractor's solution(s) impact the Contract Time or the Contract Sum, Contractor shall state anticipated impact in the RFI.
      12. Contractor's signature.
      13. Attachments: Include drawings, descriptions, measurements, photos, Product Data, Shop Drawings, and other information necessary to fully describe items needing interpretation.
         a. Supplementary drawings prepared by Contractor shall include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments.
      14. Single discipline per RFI: Architectural, Civil, Structural, Mechanical or Electrical
15. Space for reply on same page, if possible.

C. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log weekly. Use CSI Log Form 13.2B or approved form. Include the following:
   1. Project name.
   2. Name and address of Contractor.
   3. Name and address of Architect.
   4. RFI number including RFIs that were dropped and not submitted.
   5. RFI description.
   6. Date the RFI was submitted.
   7. Date Architect's response was received.
   8. Identification of related Minor Change in the Work, Instrument of Change, Construction Change Directive, or Proposal Request, as appropriate.

1.05 ARCHITECT'S ACTION

A. Architect will review each RFI, determine action required, and return it. Allow 14 days for Architect's response for each RFI; and additional 7 days for consultant review. RFIs received after 1:00 p.m. will be considered as received the following working day.
   1. Failure to allow specified response time will not be cause for an extension of Contract Time or additional cost.
   2. Architect's goal will be to return RFI as quickly as possible. However, quick response is not guaranteed.
   3. The following RFIs are defined as frivolous and will be returned without action:
      a. Requests for approval of submittals.
      b. Requests for approval of substitutions.
      c. Requests for information already indicated in the Contract Documents.
      d. Requests for information derived from activities assigned to Contractor in the Contract Documents.
      e. Requests for approval of adjustments in the Contract Time or the Contract Sum.
      f. Requests for interpretation of Architect's actions on submittals.
      g. Incomplete RFIs or RFIs with numerous errors.
      h. Questions relating to construction means, methods, techniques, sequences, procedures or safety precautions. (These are Contractor's responsibility exclusively.)
      i. Questions relating to construction schedule, coordination between trades, or division of work among subcontractors. (These are also Contractor's responsibility exclusively.)
   4. Architect's action may include a request for additional information, in which case Architect's time for response will start again.
   5. 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 Proposal according to Contract Modification Procedures.
      a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect in writing within 10 days of receipt of the RFI response.
      b. Do not proceed with this work until Change Order is executed.

B. On receipt of Architect's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Architect within 5 days if Contractor disagrees with response.

C. Frivolous RFI: Architect may claim compensation for cost of Architect's time and materials as a result of unnecessary or frivolous RFIs. Compensation will be assessed to Contractor in accordance with Section 01 20 00 - Price and Payment Procedures.

1.06 QUALITY ASSURANCE

A. Contractor shall strive to keep the number of RFIs to a minimum.
1. Prior to submitting RFI, carefully study Contract Documents to assure that requested information is not already available. RFIs that request information available in the Contract Documents will be considered frivolous.

B. RFI is not a substitute for Shop Drawing. When multiple RFIs are submitted for related work, Architect may require a Shop Drawing.

C. RFI submitted by Fax is not acceptable.

END OF SECTION
Request for Interpretation

Project Name: Request for Interpretation No.:
Owner: Date Issued:
Attention: Time:
Owner Contract Contractor:
No. (if any):
The Work shall be carried out in accordance with the following supplemental instructions issued in accordance with the Contract Documents without change in Contract Sum or Contract Time. Proceeding with the Work in accordance with these instructions indicates your acknowledgement that there will be no change in the Contract Sum or Contract Time.

Description:
Specification Section: Paragraph: Article:
Drawing Title: Sheet #: Reference:

Request:

Requested By: Initiating Sub. (if app.):
Title: Request Reply By:

Architect/Consultant Response:
Accepted: Accepted as Noted: Not Accepted:
Response:

BY: Date:

Attachments:
☑ Owner ☐ Consultant ☐ Contractor ☐ Other
☑ Architect ☐ Consultant ☐ Field ☐ Other

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PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Project coordination.
   B. Communication with Architect.
   C. Coordination Drawings.
   D. Pre-construction meeting.
   E. Progress meetings.
   F. Pre-installation meetings.

1.02 SUBMITTAL PROCEDURES
   A. Specified in Section 01 33 00 - Submittal Procedures

1.03 SUBMITTALS
   A. Construction Submittal Requirements:
      1. PM shall receive a minimum of one stamped original of all submittals at the time of Consultant approval.
      2. PM will provide the A/E and GC with a list of submittal items that require concurrent FS Maintenance & PM review and approval prior to official submittal acceptance. This list consists of, but is not limited to the following items:
         a. Variable Frequency Drives, VFD
         b. AHU and motor-mounts
         c. Transformers
         d. Building controls
         e. Soils
         f. Light Fixtures
         g. Backflow devices
         h. Fire Alarm systems
         i. Fire sprinkler components
   B. Pre-Construction Meeting Submittals: Bonds, insurance, schedule of values, project personnel directory, subcontractor and supplier list, and other lists; specified in other Sections.
   C. Key Personnel Names: Within 15 days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including home and office telephone numbers. Provide names, addresses, and telephone numbers of individuals assigned as standbys in the absence of individuals assigned to Project.
      1. Post copies of list in Project meeting room, in temporary field office, and by each temporary telephone. Keep list current at all times.
   D. Minutes of meetings required in this Section.
   E. Coordinated Ceiling Drawings: Submit within 60 days of Notice to Proceed. Submit 1 set of color plots or color copies on white bond paper. Transmit CADD files.
      1. Architect will review, stamp and return one copy with comments within 14 days after receipt. Procedure requirements for Shop Drawings in Section 01 33 00 apply.
      2. Architect's review is for compliance with design intent and does not relieve Contractor of coordination and performance requirements.
3. Copy reviewed drawings and distribute to appropriate entities.

1.04 PROJECT COORDINATION

A. Coordinate construction operations specified in different Sections to ensure efficient and orderly installation of each part of the Work. Coordinate portions of work that depend on each other for proper installation, connection, and operation.

B. In the event of an inconsistency in the Drawings or between the Drawings and the Specifications, unless otherwise ordered in writing by the Architect, the Contractor shall provide the greater quantity and/or better quality of work.

C. Coordination Drawings: Prepare Coordination Drawings if limited space availability necessitates maximum utilization of space for efficient installation of different components or if coordination is required for installation of products and materials fabricated by separate entities.

1. Content: Project-specific information, drawn accurately to scale. Do not base Coordination Drawings on reproductions of the Contract Documents or 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 required installation sequences.
   c. Indicate dimensions shown on the Contract Drawings and make specific note of dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Architect for resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

2. Sheet Size: At least 8-1/2 by 11 inches but no larger than Project Drawings.

3. Media: CADD electronic "dwg" files unless other media is approved by Architect.

1.05 DIGITAL COMMUNICATION

A. Communication to Architect: High speed internet based digital, except Submittals specified in Section 01 33 00.
   1. Telephone communication is acceptable for initial or simple issues.
   2. Follow up telephone communication in writing.

B. Construction Office Equipment:
   1. High speed internet connection equipment and service.
      a. Email Attachment Capacity: Not less than 10 megabytes.
   2. Computer with internet connection and project management software:
      c. Project scheduling software.
   3. Scanner, not less than 150 dpi.
   4. Copy machine not less than 400 dpi with capability for 11 x17 and color.
   5. Telephone with conference call capability
   6. Digital camera, 3.5 megapixel minimum.

C. Correspondence:
   1. correspondence by FAX is not acceptable unless specifically approved.
   2. Any information that is disseminated shall retain the original scale and aspect from the original as published by Architect.

1.06 COORDINATED CEILING DRAWINGS

A. Content and View: Two views, concealed conditions and visually exposed conditions, shown as reflected plans. Indicate actual size of components at scale sufficient to show no interference and adequate space for installation and maintenance of each component.
   1. Concealed Conditions View: Including, but not limited to: mechanical systems (plumbing, ductwork, HVAC Equipment, piping, controls, fire protection systems, etc.); electrical
systems (wiring, raceway, conduit, cable trays, controls, fire and life safety systems, lighting, alarm devices, etc.); structural elements (beams, girders, etc); acoustical systems, ceiling equipment supports.

2. Exposed Conditions View: Including, but not limited to: mechanical; electrical; structural elements as noted above; acoustical systems; lights – pendants, surface and recessed; exit signage; directional signage; conduit; grilles; diffusers; damper actuators; sprinkler heads/type, speaker locations, access panels with sizes indicated, smoke detectors and alarm devices, and any other item or element that will be seen when looking at the ceiling.

B. Coordinate space requirements, supports, and installation of mechanical and electrical Work indicated diagrammatically on Drawings. Follow routing shown for pipes, ducts, and conduit, as closely as practicable; place runs parallel with lines of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.

C. Congested Areas: Provide more detailed plan and either vertical sections or 3-dimensional CADD model.

D. Media: CADD plans, sections, and models for color plotting; ".dwg" file format.

E. Show the following in different colors for each system: structure, HVAC, plumbing, piping, electrical, fire protection, other work.

F. Distribute Coordinated Ceiling Drawings among affected entities for review. Resolve conflicts and incorporate corrections into drawings prior to submitting to Architect.

1. Work that is not included in Coordinated Ceiling Drawings shall be coordinated and installed without conflicts or defects, and without change in Time or Cost.

1.07 PRECONSTRUCTION MEETING

A. Owner/Architect will schedule meeting after Notice to proceed.

B. Meeting location shall be either on site at FS or conducted by the Lead Consultant with PM.

C. Attendance Required: Owner, Owner’s project manager, Architect and Contractor.

D. Agenda items at a minimum and/or applicable include the following; List is subject to addition as needed:

1. Execution of Owner-Contractor Agreement.
2. Submission of executed bonds and insurance certificates.
4. Submission of complete list of Subcontractors, with contact information, list of products, schedule of values, submittal schedule, and construction progress schedule with any critical path work sequencing and long lead time materials.
6. Procedures and processing of field decisions, submittals, substitutions, RFIs, requests for applications for payments, proposal request, Change Orders, and Contract closeout procedures.
7. Construction site access: pick-up, delivery, and parking; temporary facilities and controls, security, safety, and restrictions.
8. Scheduling activities of Testing Agent.
10. Anticipated building service or system interruptions, and impact to building operations/occupants.
11. Owner occupancy, schedule, and activities requiring accommodation and/or coordination.
12. Use of site, campus premises, and existing buildings.
13. Office, work, and storage areas.
14. All shut-off locations.
15. Define plan to reduce impact to building users regarding application of finishes, paints, adhesives, etc.
16. Utility mete removals or connections.
17. Facilities EH&S items include but are not limited to the following:
   a. List of emergency contacts, and contact information.
   b. Process for accessing emergency assistance.
   c. Process for spills and clean-up.
   d. EH&S expectations regarding maintaining safe conditions for UO employees, students, visitors, construction workers, etc. including odors, egress, avoidance of fire alarms, etc.
   e. If applicable, EH&S expectations regarding compliance with erosion control permits.

E. Contractor shall record minutes and distribute copies within four (4) days after meeting to participants, with one original copy to Architect, Owner and those affected by decisions made.

1.08 CONSTRUCTION PROGRESS MEETING REQUIREMENTS

A. Schedule and administer meetings throughout progress of the Work at maximum weekly intervals.
   1. Architect may elect to attend by telephone conference call.

B. Attendance Required: Job superintendent, major subcontractors and suppliers, Owner, or Owner’s representative, Architect/Engineer, as appropriate to agenda topics for each meeting. Architect shall attend in person or via conference call at Architect’s discretion.

C. Meeting location shall be on site and conducted by the GC or CM.

D. Meeting minutes shall be by the GC or CM and distributed to attendees and to individuals requesting courtesy copies.
   1. Courtesy copies shall be provided to N&TS.

E. Agenda items at a minimum and/or applicable include the following; List is subject to addition as needed:
   1. Review minutes of previous meetings.
   2. Review of Work progress overall construction schedule progress and status.
   3. Field observations, problems, and decisions.
   4. Identification of problems impeding planned progress.
   5. Review of submittals schedule and status, RFI’s and status, and proposal requests/change orders and status.
   6. Review of off-site fabrication and delivery schedules.
   7. Maintenance of construction progress schedule with 3 week detailed schedule of coming weeks’ activities and needed shutdowns.
   8. Corrective measures to regain projected schedules.
   9. Planned progress during succeeding work period with 3 week detailed schedule of coming weeks’ activities and needed shutdowns.
   10. Coordination of projected progress.
   11. Maintenance of quality and work standards.
   12. Effect of proposed changes on progress schedule and coordination.
   13. Owner schedule and activities requiring accommodation and/or coordination.
   14. Site access & utilization and any changes due to construction or delivery activities.
   15. Work hours and notification of evening or weekend events needing notification to campus.
   17. Pending changes.
   18. Payment request status.
   19. Other business relating to Work.
F. Contractor shall record minutes and distribute copies within four (4) days after meeting to participants, with one (1) original copy to Architect, Owner, and those affected by decisions made.

1.09 PRE-INSTALLATION MEETING

A. When required in individual specification sections, convene pre-installation meeting at Project site prior to commencing work of specific section.

B. Work undertaken or completed without convening a pre-installation meeting shall be subject to removal, inspection, testing, observation, etc at the Architect’s discretion without additional compensation to Contractor in time or money. Work required as a result of removal, inspection, testing, observation, etc., even though determined to be satisfactory, shall be provided without additional compensation to the contractor in time or money.

C. Require attendance of parties directly affecting, or affected by, Work of specific section including the Architect, Owner, Design Engineer, manufacturer (representative and technical support) and key personnel of the installation team.

D. Notify Architect seven (7) days in advance of meeting date.

E. Prepare agenda and preside at meeting:
   1. Review conditions of installation, preparation and installation procedures.
   2. Review coordination with related work.

F. Record minutes and distribute copies within four (4) days after meeting to participants, with one original copy to Architect, Owner, and those affected by decisions made.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Preliminary schedule.
B. Construction progress schedule, with network analysis diagrams and reports.
C. Short interval schedule.

1.02 REFERENCES

A. AGC (CPSM) - Construction Planning and Scheduling Manual; Associated General Contractors of America; 2004.

1.03 SUBMITTALS

A. Within 10 days after date of Agreement, submit Preliminary Schedule defining planned operations for the first 60 days of Work, with a general outline for remainder of Work.
   1. List Owner and other scheduled or projected building user activities and milestones coordinated within the construction activities schedule.
   2. List Owner Furnished Contractor Installed (OFCI) and Owner Furnished Owner Installed (OFI) items, delivery dates, and completion dates.
   3. Required shutdowns must be requested by the Contractor to PM a minimum of two (2) weeks in advance.
   4. Notify PM for distribution of advanced notice to campus a minimum of forty eight (48) hours prior to start of disruptive work, including but not limited to vibration, noise, or odors that may occur within occupied buildings or neighboring buildings.
   5. List commissioning activities and milestones.
B. If preliminary schedule requires revision after review, submit revised schedule within 10 days.
C. Within 20 days after review of preliminary schedule, submit draft of proposed Baseline Schedule for review.
   1. Include written certification that major contractors have reviewed and accepted proposed schedule.
   2. Include narrative report that identifies critical, near-critical and major activities in sufficient detail that explains their significance.
D. Within 10 days after joint review, submit Baseline Schedule.
E. Submit updated schedule with each Application for Payment.
F. Short Interval Schedule: Submit copies to attendees at each Progress Meeting.

1.04 QUALITY ASSURANCE

A. Scheduler: Contractor’s personnel or specialist Consultant specializing in CPM scheduling with 5 years minimum experience in scheduling construction work of a complexity comparable to this Project, and having use of computer facilities capable of delivering a detailed graphic printout within 48 hours of request.

1.05 SCHEDULE FORMAT

A. Listings: In chronological order according to the start date for each activity. Identify each activity with the applicable specification section number.
B. Diagram Sheet Size (overall schedule): Maximum 22 x 17 inches or width required.
D. Scale and Spacing: To allow for notations and revisions.
PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 PRELIMINARY SCHEDULE
A. Prepare preliminary schedule in the form of a horizontal bar chart.

3.02 BASELINE SCHEDULE
A. Baseline (Construction Progress) Schedule is a continuation of the Preliminary Schedule that shows the entire, complete construction activity. Actual progress of the Work will be measured against the Baseline Schedule.
B. Revisions to the accepted Baseline Schedule are subject to review and approval.

3.03 CONTENT
A. Show complete sequence of construction by activity, with dates for beginning and completion of each element of construction.
   1. Include Pre-Installation Meetings.
B. Identify each item by specification section number.
C. Show accumulated percentage of completion of each item, and total percentage of Work completed, as of the first day of each month.
D. Provide separate schedule of submittal dates for shop drawings, product data, and samples, owner-furnished products, Products identified under Allowances, and dates reviewed submittals will be required from Architect. Indicate decision dates for selection of finishes.
   1. Refer to Section 01 33 00 for more requirements.
E. Indicate delivery dates for owner-furnished products.
F. Provide legend for symbols and abbreviations used.

3.04 NETWORK ANALYSIS
A. Prepare network analysis diagrams and supporting mathematical analyses using the Critical Path Method.
B. Illustrate order and interdependence of activities and sequence of work; how start of a given activity depends on completion of preceding activities, and how completion of the activity may restrain start of subsequent activities.
C. Mathematical Analysis: Tabulate each activity of detailed network diagrams, using calendar dates, and identify for each activity:
   1. Preceding and following event numbers.
   2. Activity description.
   3. Estimated duration of activity, in maximum 15 day intervals.
   4. Earliest start date.
   5. Earliest finish date.
   6. Actual start date.
   7. Actual finish date.
   8. Latest start date.
   9. Latest finish date.
   10. Total and free float; float time shall accrue to Owner and to Owner’s benefit.
   11. Monetary value of activity, keyed to Schedule of Values.
   12. Percentage of activity completed.
D. Analysis Program: Capable of accepting revised completion dates, and recomputation of all dates and float.
E. Required Reports: List activities in sorts or groups:
   1. By preceding work item or event number from lowest to highest.
2. By amount of float, then in order of early start.
3. Listing of activities on the critical path.

3.05 REVIEW AND EVALUATION OF SCHEDULE
   A. Participate in joint review and evaluation of schedule with Architect at each submittal.
   B. Evaluate project status to determine work behind schedule and work ahead of schedule.
   C. After review, revise as necessary as result of review, and resubmit within 10 days.

3.06 UPDATING SCHEDULE
   A. Maintain schedules to record actual start and finish dates of completed activities.
   B. Indicate progress of each activity to date of revision, with projected completion date of each activity.
   C. Annotate diagrams to graphically depict current status of Work.
   D. Identify activities modified since previous submittal, major changes in Work, and other identifiable changes.
   E. Indicate changes required to maintain Date of Substantial Completion.
   F. Submit reports required to support recommended changes.
   G. Provide narrative report to define problem areas, anticipated delays, and impact on the schedule. Report corrective action taken or proposed and its effect including the effects of changes on schedules of separate contractors.

3.07 RECOVERY SCHEDULE
   A. Prepare and submit Recovery Schedule and Narrative Report that demonstrates how lost time will be recovered when one of the following occurs:
      1. Project falls behind schedule more than 14 days.
      2. Project falls behind schedule more than 10% of remaining duration to Substantial Completion.
   B. Submit Recovery Schedule within 7 days of falling behind schedule.
   C. Recovery Schedule is subject to review and approval.

3.08 DISTRIBUTION OF SCHEDULE
   A. Distribute copies of updated schedules to Contractor's project site file, to Subcontractors, suppliers, Architect, Owner, and other concerned parties.
   B. Instruct recipients to promptly report, in writing, problems anticipated by projections shown in schedules.

3.09 SHORT INTERVAL SCHEDULE
   A. Description: Three week schedule of current and near-future construction activity.
      1. Duration: 3 weeks
      2. Time Increment: Day
      3. Bar chart with separate bar for each trade that is active at Site, sequentially organized, beginning with continuing activities.
      4. Indicate crew size for each activity.
      5. If activity differs from Baseline Schedule, compare Baseline to proposed activity as adjacent bars.
      1. Hand drafted or computer generated schedule at Contractor's option.
   C. Update schedule weekly.

END OF SECTION
PART 1 GENERAL

1.01  SECTION INCLUDES

A. Submittal control report and submittal procedure.
B. Proposed products list.
C. Product data.
D. Sustainable building data.
E. Shop drawings.
F. Samples.
G. Design data.
H. Test reports.
I. Certificates.
J. Manufacturer's instructions.
K. Manufacturer's field reports.
L. Construction photographs.

1.02  SUBMITTAL CONTROL REPORT

A. Prepare and maintain a separate material delivery log to monitor submittals required by the contract documents. Show:
   1. Work item number corresponding to the specification section and construction schedule.
   2. Contractor, subcontractor, sub-subcontractor or supplier responsible for each work item.
   3. Narrative description of the work item.
   4. Number of days required for preparation of the submittal.
   5. Date submittal due.
   6. Number of days allowed for approval.
   7. Date approval due.
   8. Number of days required to fabricate and deliver item to the Contractor.
   9. Date of delivery.
  10. Date item required to be installed, corresponding to the construction schedule.

B. Distribution:
   1. Distribution copies of reviewed schedule to: Architect, Owner’s Representative.
   2. Instruct recipients to report any inability to comply and provide detailed explanation with suggested remedies.

1.03  SUBMITTAL PROCEDURE

A. Construction Submittal Requirements:
   1. PM shall receive a minimum of one stamped original of all submittals at the time of Consultant approval.
   2. PM will provide the A/E and GC with a list of submittal items that require concurrent FS Maintenance & PM review and approval prior to official submittal acceptance. This list consists of, but is not limited to the following items:
      a. Variable Frequency Drives, VFD
      b. AHU and motor-mounts
      c. Transformers
      d. Building controls
      e. Soils
      f. Light Fixtures
SUBMITTAL PROCEDURES

B. Organize and submit complete information into separate submittals for each Specification Section listed in Table of Contents, except as follows:
   1. 1 consolidated Division submittal for Sections in the following Divisions:
      a. Division 21, 22, and 23.
      b. Division 26, 27 and 28.
      c. Division 31, 32, and 33, except 1 separate consolidated submittal for Landscaping is acceptable.
   2. Doors, door frames and door hardware: 1 consolidated submittal.
   3. Exterior curtainwall, storefront and entrance systems: 1 consolidated submittal.
   4. Exceptions must be approved by Architect.

C. Number submittals sequentially, followed by specification Section number.
   1. Revisions: Add “R-1” to submittal number; example “034-08 51 13 R-1”.

D. Transmittal or Cover Sheet: Package each submittal individually and appropriately for transmittal and handling. Transmit each submittal using a transmittal form. Architect will discard submittals received from sources other than Contractor.
   1. Transmittal Form: Use CSI Form 12.1A.
   2. Incomplete transmittal form will be returned.

E. Contractor's Review: Apply Contractor's stamp, signed or initialed certifying that review, approval, verification of products required, field dimensions, adjacent construction Work, and coordination of information is in accordance with requirements of the Work and Contract Documents.
   1. Review submittals prior to submission and provide stamp of approval signed or initialed by Contractor.
      a. Contractor’s review indicates that Contractor has thoroughly reviewed the submittal and certifies that it is complete, correct, in compliance with the Contract Documents, and suitable for the Project.
      b. Review represents that field measurements and field conditions have been considered and that the work submitted will perform as intended.
      c. Review of Shop Drawing represents that required coordination with other work has been performed and is indicated in Shop Drawing.
   2. Architect will not review submittals that do not include Contractor's signed review stamp, do not include required field conditions, or are not accurate.
   3. Include written description and graphic demarcation of deviations from requirements of Contract Documents.
   4. All work done prior to approval of submittals shall be at the Contractor’s risk.

F. Clearly indicate all options, colors, accessories, data, etc, provided for this Project.

G. Identify variations from Contract Documents. Identify product limitations which may be detrimental to successful performance of completed Work.

H. Allow space on submittals for Contractor and Architect review stamps.

I. Schedule submittals to expedite Project. Deliver submittals to Architect at SERA Architects Inc. Coordinate submission of related items.
   1. Deliver one additional copy each to Owner

J. For each submittal, allow 14 days excluding delivery time from and to Contractor.
   1. Allow additional 7 days for any one of the following submittals:
      a. Major building components or consolidated submittals.
      b. Review by Architect’s consultant.
1.04 PRODUCT DATA
A. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
   1. Provide product data whether specified or not specified in Section.
   2. If information that must be specially prepared for submittal because standard printed data are not suitable for use, submit as Shop Drawings, not as Product Data.
   3. Mark each copy of each submittal to show which products and options are applicable.
B. Include the following information, as applicable:
   1. Manufacturer's written recommendations.
   2. Manufacturer's product specifications.
   3. Manufacturer's installation instructions.
   5. Manufacturer's catalog cuts.
   6. Wiring diagrams showing factory-installed wiring.
   7. Printed performance curves.
   8. Operational range diagrams.
   10. Standard product operation and maintenance manuals.
   11. Compliance with specified referenced standards.
   12. Testing by recognized testing agency.
   13. Application of testing agency labels and seals.
   14. Notation of coordination requirements.
C. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information specific to this Project.
D. Indicate product utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.
E. Submit one electronic copy in PDF format.
F. Architect will return a reviewed electronic copy in PDF format.

1.05 SUSTAINABLE BUILDING DATA
A. Submit information applicable to Sustainable Building Requirements and Environmental Responsibility.
   1. Recycled content as applicable: Percent post consumer and percent post industrial, on Manufacturer's letterhead or published data certified by SCS.
   2. Rapidly renewable materials as applicable: List percent of materials whose source is replaced or renewed within a 10 year period.
   3. Local materials as applicable: List material amount, cost, source of manufacture and distance to site in miles, on Manufacturer's letterhead.
   4. Locally harvested or extracted as applicable: List material amount, cost, source and distance to site in miles, on Manufacturer's letterhead.
   5. Levels of Volatile Organic Compounds (VOC).

1.06 SHOP DRAWINGS
A. Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on standard printed data or reproductions of the Contract Documents, unless submittal of Architect's CAD Drawings is permitted.
SUBMITTAL PROCEDURES

1. Provide Shop Drawings for work indicated in Sections and when needed to execute the Work.

B. Electronic copy of Architect's CADD drawings (floor plans, site plan and ceiling plans, only) will not be provided.

C. Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
   1. Dimensions.
   2. Three dimensional axonometric views of flashings, pans and sheet metal details.
   3. Identification of products.
   4. Fabrication and installation drawings.
   5. Roughing-in and setting diagrams.
   6. Wiring diagrams showing field-installed wiring, including power, signal, and control wiring.
   7. Manufacturing instructions.
   8. Templates and patterns.
  10. Design calculations.
  11. Compliance with specified standards.
  12. Notation of coordination requirements.
  13. Notation of dimensions established by field measurement.
  14. Relationship to adjoining construction clearly indicated.
  15. Seal and signature of professional engineer if specified.

D. Indicate special utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

E. Submit copies or transparencies as follows:
   1. 8.5 by 11 inch or 11 by 17 inch size: Submit 4 copies on bond paper.
   2. Larger than 11 by 17 inches: Submit 4 copies on bond paper.
   3. Submit 1 additional copy for Architect's consultant's review.

1.07 SAMPLES

A. Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.

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

C. Identification: Attach label on unexposed side of Samples that includes the following:
   1. Generic description of Sample.
   2. Product name and name of manufacturer.
   3. Sample source.
   4. Number and title of appropriate Specification Section.

D. 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.
   1. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
   2. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.

E. Samples for Initial Selection: Submit 2 manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.
SUBMITTAL PROCEDURES

F. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.

1. Submit three sets of Samples. Architect will retain one Sample set; remainder will be returned.
2. Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
3. If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.

G. Finishes, products and/or materials noted as custom, hand worked, etc shall be submitted to Architect for review and approval prior to fabrication/installation. Allow for minor revisions to sample in terms of finish, fabrication, installation and/or sequencing.

H. Field Samples: Large size samples and assembled samples that shall be submitted at the Project Site are specified in individual Sections.

1.08 DESIGN DATA

A. Prepare written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.

B. Submit for Architect's information.

   1. Architect’s review is limited to assessing conformance with design concept expressed in Contract Documents.

C. Refer to Section 01 33 16 - Delegated Design Procedures.

1.09 TEST REPORTS

A. Submit for Architect’s knowledge.

B. Submit test reports for information for limited purpose of assessing conformance with information given and design concept expressed in Contract Documents.

1.10 CERTIFICATES

A. When specified in individual specification sections, submit certification by manufacturer, installation/application subcontractor, or Contractor to Architect, in quantities specified for Product Data.

B. Indicate material or product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.

C. Certificates may be recent or previous test results on material or Product, but must be acceptable to Architect.

1.11 QUALIFICATION DATA

A. When specified in individual specification sections or requested by Architect, submit qualifications for manufacturer, installer, or subcontractor.

B. Data may include previous experience, list of previous similar projects, references, proof of training, and approval by manufacturer or warrantor.
1.12 SAMPLE WARRANTY
   A. When warranty is specified in a Section, submit sample of specified warranty with initial product submittal.
   B. Final warranty submittal is specified in Section 01 78 00 - Closeout Submittals.

1.13 MANUFACTURER'S INSTRUCTIONS
   A. When specified in individual specification sections, submit printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, to Architect for delivery to Owner in quantities specified for Product Data.
   B. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.

1.14 MANUFACTURER'S FIELD REPORTS
   A. Submit reports for Architect's benefit as contract administrator or for Owner.
   B. Submit report in duplicate within 30 days of observation to Architect for information.
   C. Submit for information for limited purpose of assessing conformance with information given and design concept expressed in Contract Documents.

1.15 CONSTRUCTION PHOTOGRAPHS
   A. Photographic Documentation Requirements by Contractor:
      1. This requirement may be waived at Owner discretion.
      2. Monthly, an 8”x10” printed photograph. On the front of the photograph identify the project name, location where photograph was taken, and month/date/year.
      3. At project start before demolition, a photo record of the project site, surrounding and adjacent structures and conditions.
      4. At final completion, final color photo documentation; date stamped on the back of the photo.
      5. With closeout documentation submittal a complete digital set of all construction photographs shall be included.
   A. Provide photographs of site and construction throughout progress of Work.
   B. Each month submit photographs with Application for Payment.
   C. Photographs: Digital camera, 3.5 mega pixel minimum.
   D. Take one (1) site photograph from same direction indicating relative progress of the Work.
   E. Deliver digital copies to Owner on approved media (CD, DVD) with project record documents. Catalog and index files in chronological sequence; include word processor table of contents.

END OF SECTION
Electronic Media Agreement

THIS AGREEMENT is entered into effective [insert date] by and between [insert party’s company name] (“Recipient”) and SERA Architects, Inc. (“SERA”) with respect to the [insert project name] (“Project”) located at [insert location].

The Recipient has requested that SERA provide to the Recipient certain drawings, specifications or other documents for the Project in electronic form ("Electronic Form Documents"). SERA agrees to do so, subject to the terms and conditions of this Agreement.

The Recipient recognizes that the Electronic Form Documents may be revised by others without the knowledge or consent of SERA and, when plotted, may result in variances or corrupt other files of the user.

The Recipient agrees not to use the Electronic Form Documents for any purpose or project other than the Project.

The Recipient acknowledges that the Electronic Form Documents are the property of SERA or its consultants and are subject to the copyrights and other reserved rights of those parties. The Electronic Form Documents may be write-protected by SERA such that no data can be manipulated by the Recipient or third parties. SERA may provide to the Recipient only a working copy of Electronic Form Documents which have all indices of SERA, its consultants, and their respective ownership, professional names, and involvement in the Project removed from the electronic display.

Any use of or changes to the Electronic Form Documents shall be at the sole risk of the user, and without liability, risk or legal exposure to SERA or its consultants. The Recipient and any other person or entity using the Electronic Form Documents agrees to release and, to the fullest extent permitted by law, indemnify, hold harmless and defend SERA, its consultants, and their respective partners, shareholders, agents and employees from and against any and all claims, demands, losses, expenses, damages, penalties and liabilities of any kind, including without limitation attorneys’ and expert witnesses’ fees, arising out of or relating in any way to any such use of or changes to the Electronic Form Documents.

Under no circumstances shall SERA’s transfer of the Electronic Form Documents to the Recipient be deemed a sale by SERA or its consultants. SERA and its consultants make no warranties, either expressed or implied, with respect to the Electronic Form Documents, including but not limited to warranties of merchantability or of fitness for any particular purpose.

The Recipient agrees, as a condition of providing the Electronic Form Documents to any contractor, design professional or other person or entity, to require such third party to agree in writing to the terms and conditions of this Agreement.

By electronically accessing the Electronic Form Documents, the Recipient accepts and is bound to the terms and conditions of this Agreement.

RECIPIENT: SERA:
Company: ___________________________ SERA Architects, Inc.
Signature: ___________________________ Signature: ___________________________
Printed Name: ___________________________ Printed Name: ___________________________
Title: ___________________________ Title: Principal
Date: ___________________________ Date: ___________________________
PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:
   2. Permitting for Delegated Design portion of Work.
   3. Delegated Design submittals.

B. Coordinate and assume full responsibility for design, engineering, submittals, fabrication, transportation, and installation of this work.

C. Delegated Design portions include the following:
   1. Temporary shoring and supports for excavation, concrete, walls and other construction.
   2. Section 03 30 00 - Concrete mix design.
   3. Section 05 31 00 - Steel Decking; for small openings in decking.
   4. Section 05 40 10 - Furring Assemblies.
   5. Section 05 50 00 - Metal Fabrications, for fabricated railings.
   6. Section 07 42 13 - Metal Wall Panels; for furring system and panel attachment to structure.
   7. Section 07 62 00 - Sheet Metal Flashing and Trim;
   8. Section 07 81 00 - Applied Fireproofing.
   9. Section 07 81 23 - Intumescent Mastic Fireproofing
   10. Section 07 84 00 - Firestopping
   11. Section 08 44 13 - Glazed Aluminum Curtain Walls.
   12. Section 08 80 00 - Glazing, for glass strength.
   13. Section 09 21 16 - Gypsum Board Assemblies; For non-structural metal-framed interior partitions, gypsum board ceiling suspension systems and perimeter requirements, and seismic bracing.
   14. Section 09 51 00 - Acoustical Ceilings, for ceiling suspension systems.
   15. Division 21 - Fire suppression system.
   16. Divisions 21, 22 and 23 - seismic restraint of systems.
   17. Divisions 26, 27 and 28 - seismic restraint of systems.
   18. Division 28 - Fire detection and alarms.
      a. Salvage strobes during demolition and reinstall to indicated locations in new area layout.
   19. Section 32 80 00 - Irrigation Systems.
   20. See structural notes for other delegated design items.

D. Delegated Design Contiguous Utility Component:
   1. Subterranean Utility Tunnel: Provide extension of existing utility tunnel to new/renovation Work, as a complete and working extension, complying with any and all local, state, and national codes, as well as University of Oregon Campus Construction Standards, Factory Mutual Global insurance requirements, and as a minimum, the following elements:
      a. Continuous cast-in-place concrete tunnel extending profile of existing interfacing tunnel from termination of existing tunnel to interface with new/renovation Work.
      b. Campus construction standard compliant waterproofing system.
      c. Campus construction standard compliant sub-drainage system and connections to storm sewer.
      d. Campus construction standard compliant rated enclosure at building entry location.
      e. Campus construction standard compliant fire protection and fire alarm as required.
      f. Campus construction standard compliant ingress/egress guardrails and ships ladder.
      g. Campus construction standard compliant lighting system.
      h. Shoring.
      i. Backfill.
j. Temporary building ingress/egress.

1.02 DEFINITIONS
A. Delegated Design: Professional design service or certification specifically required of the Contractor in the Specifications.
B. AHJ: Authorities Having Jurisdiction, defined in Section 01 10 00 and AIA Document A201.

1.03 PERFORMANCE REQUIREMENTS
A. Comply with Regulations.
B. Provide complete, operational systems that perform their intended use.
C. Engineer Delegated Design portions for gravity, lateral and seismic loads.
   1. Load criteria is indicated in Structural Drawings. If not indicated, request criteria.
   2. Indicate reactions to structure.
   3. Provide services of a qualified professional engineer licensed in the Project jurisdiction.
D. Calculate and complete energy forms required by AHJ.
E. Execute the design intent as indicated in Project Drawings and Specifications.
F. Obtain Permits and inspections and pay fees required by AHJ.

1.04 OWNER'S RESPONSIBILITIES
A. The Owner will not pay for progress delays, additional Work, additional products, restocking, or re-working required by Contractor's failure to coordinate Delegated Design work with other Project work.

1.05 SUBMITTALS
A. Preliminary Design: Submit to Architect drawings and product data that describe Contractor's design prior to performing engineering calculations and Shop Drawings.
   1. Architect will evaluate proposed design and comment on conformance with intent of Contract Documents.
   2. Preliminary review is for aesthetic and general function concerns and will not constitute approval of engineering.
   3. Purpose of this submittal is to avoid engineering and detailing an unacceptable proposal.
B. Permit Review: Submit Delegated Design documents to AHJ for review and approval.
   1. When AHJ requires review by Architect or Architect's consultant, allow 10 days for Architect's review. Submit documents to Architect and pick-up documents when review is complete. Make corrections noted by Architect.
   2. Obtain permits prior to executing work component.
   3. Comply with AHJ requirements.
   4. Execute corrections to Delegated Design work required by AHJ at no cost to Owner and prior to Substantial Completion.
      a. Notify Architect of changes required by AHJ as soon as they are known.
   5. Include design criteria, design assumptions, structural calculations, fabrication and construction details, required clearances, and interface requirements.
      a. Delegated Design drawings are in addition to Shop Drawings.
   6. Affix Design Professional's seal for State License on Submittals.
C. Engineer's qualifications.
D. Product Data, Shop Drawings and Samples: Comply with requirements in Section 01 33 00 for each product of Delegated Design portion of work. Product submittals are in addition to submittals for permit and design data.

1.06 QUALITY ASSURANCE
A. Documentation: Comply with the following:
DELEGATED DESIGN PROCEDURES

2. Minimum text size: 1/8 inch
3. Legible when microfilmed
4. Other requirements of AHJ

B. Design requirements specific to Delegated Design portions are indicated in Drawings and in Sections that specify the component.

C. Engineer’s Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated.

D. Pre-Submittal Meeting: Contractor shall meet with Architect, Consultant, and Delegated Designer to discuss requirements of work-portion, submittals, scheduling and sequencing.

1.07 SCHEDULING

A. Schedule design process and submittals required for Delegated Design portions to fit within Construction Schedule.

B. Allow adequate time for AHJ review. Contact AHJ for time estimate and coordination of schedule.

C. If Architect’s approval of Shop Drawings is required prior to application for permit, schedule and sequence Shop Drawing review prior to review of permit submittal. Allow time specified in Section 01 33 00.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. References and standards.
B. Quality assurance submittals.
C. Mock-up.
D. Control of installation.
E. Tolerances.
F. Testing and inspection services.
G. Manufacturers' field services.

1.02 REFERENCE STANDARDS


1.03 DEFINITIONS

A. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.
B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Services do not include contract enforcement activities performed by Architect.
C. Mock-Up: Full-size, physical assemblies that are constructed on-site. Mock-ups are used to verify selections made under sample submittals, to demonstrate aesthetic effects and, where indicated, qualities of materials and execution, and to review construction, coordination, testing, or operation; they are not Samples.
   1. Approved mock-ups establish the standard by which the Work will be judged.
D. Laboratory Mock-up: Full-size, physical assemblies that are constructed at testing facility to verify performance characteristics.
E. Preconstruction Testing: Tests and inspections that are performed specifically for the Project before products and materials are incorporated into the Work to verify performance or compliance with specified criteria.
F. Product Testing: Tests and inspections that are performed by an NRTL, an NVLAP, or a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with industry standards.
G. Source Quality-Control Testing: Tests and inspections that are performed at the source, i.e., plant, mill, factory, or shop.
H. Field Quality-Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.
QUALITY REQUIREMENTS

I. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.

J. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.
   1. Using a term such as "carpentry" does not imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as "carpenter." It also does not imply that requirements specified apply exclusively to tradespeople of the corresponding generic name.

K. Experienced: When used with an entity, "experienced" means having successfully completed a minimum of 10 previous projects similar in size and scope to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

1.04 INDUSTRY STANDARDS

A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.

B. Publication Dates: Comply with standards in effect as of date of Contract Documents, unless otherwise indicated.

C. Copies of Standards: Each entity engaged in construction on the Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.
   1. When copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.
   2. When copies of standards are needed for any reason, obtain copies directly from publication source.

D. Abbreviations and Acronyms for Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the standards and regulations in the following list.
   1. ADAAG or ADAAmericans with Disabilities Act
   2. CFRCode of Federal Regulations
   3. DODDepartment of Defense Military Specifications and Standards
   4. FSFederal Specification
   5. MILSPECMilitary Specification and Standards
   6. UFASUniform Federal Accessibility Standards

E. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities indicated in Gale Research's "Encyclopedia of Associations" or in Columbia Books' "National Trade & Professional Associations of the U.S."

1.05 CONFLICTING REQUIREMENTS

A. General: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer uncertainties and requirements that are different, but apparently equal, 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. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as
appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.

1.06 SUBMITTALS

A. Reports: Prepare and submit certified written reports that include the following:
   1. Date of issue.
   2. Project title and number.
   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 temperature and weather conditions at time of sample taking and 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.
   14. Distribution: Contractor, Architect, Engineer of Record, Authority Having Jurisdiction, Owner (verify), and Construction Manager (when appropriate).

B. Deficiencies Report: Attach a separate list of deficiencies identified in previous reports that have not been corrected and successfully retested.
   1. Submit a final report certifying the status of all deficiencies, signed and stamped. Submit report directly to Authority having jurisdiction (when required) and copy to others.

C. Permits, Licenses, and Certificates: For Owner’s records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

D. Testing Agency Qualifications:
   1. Prior to start of Work, submit agency name, address, and telephone number, and names of full time registered Engineer and responsible officer.

1.07 REFERENCES AND STANDARDS

A. For products and workmanship specified by reference to a document or documents not included in the Project Manual, also referred to as reference standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.

B. Conform to reference standard of date of issue current on date of Contract Documents, except where a specific date is established by applicable code.

C. Obtain copies of applicable reference code(s) enforced by authorities having jurisdiction.

D. Obtain copies of standards and where required by product specification sections.

E. Maintain copies of standards and codes at project site during submittals, planning, and progress of the specific work, until Substantial Completion.

F. Should specified reference standards conflict with Contract Documents, request clarification from Architect before proceeding.

G. Neither the contractual relationships, duties, or responsibilities of the parties in Contract nor those of Architect shall be altered from the Contract Documents by mention or inference otherwise in any reference document.
1.08 TESTING AND INSPECTION AGENCIES

A. Owner will employ and pay for services of an independent testing agency to perform specified testing and inspection.
   1. Owner's testing agent will perform "special inspections" required by Regulations.

B. Contractor shall employ and pay for services of an independent testing agency to perform other testing and inspection specified as Contractor's responsibility or required by Contractor for quality control.

C. Employment of agency in no way relieves Contractor of obligation to perform Work in accordance with requirements of Contract Documents.

D. Contractor Employed Agency:
   2. Inspection agency: Comply with requirements of ASTM D3740 and ASTM E329.
   3. Laboratory: Authorized to operate in the State in which the Project is located.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 CONTROL OF INSTALLATION

A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce Work of specified quality.

B. Comply with manufacturers' instructions, including each step in sequence.

C. Should manufacturers' instructions conflict with Contract Documents, request clarification from Architect before proceeding.

D. Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

E. Have Work performed by persons qualified to produce required and specified quality.

F. Verify that field measurements are as indicated on shop drawings or as instructed by the manufacturer.

G. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, and disfigurement.
   1. Design anchorage and attachments to resist seismic forces when required by Regulations.

3.02 MOCK-UP

A. Before installing portions of the Work requiring mockups, build mock-up for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:
   1. Build mock-up in location and of size indicated or, if not indicated, as directed by Architect.
   2. Notify Architect seven days in advance of dates and times when mock-up will be constructed.
   3. Demonstrate the proposed range of aesthetic effects and workmanship.
   4. Obtain Architect's approval of mock-up before starting work, fabrication, or construction.
      a. Allow seven days for initial review and each re-review of mock-up.
   5. Maintain mock-up during construction in an undisturbed condition as a standard for judging the completed Work.

B. Tests will be performed under provisions identified in this section and identified in the respective product specification sections.
C. Assemble and erect specified items with specified attachment and anchorage devices, flashings, seals, and finishes.

D. Accepted mock-up shall be a comparison standard for the remaining Work.

E. Where mock-up has been accepted by Architect and is specified in product specification sections to be removed, remove mock-up and clear area when directed to do so.
   1. Deconstruct and recycle mock-up that is not incorporated in Work.

3.03 TOLERANCES
A. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.

B. Comply with manufacturers' tolerances. Should manufacturers' tolerances conflict with Contract Documents, request clarification from Architect before proceeding.

C. Adjust products to appropriate dimensions; position before securing products in place.

3.04 TESTING AND INSPECTION
A. Testing Agency Duties:
   2. Perform specified sampling and testing of products in accordance with specified standards.
   3. Ascertain compliance of materials and mixes with requirements of Contract Documents.
   4. Promptly notify Architect and Contractor of observed irregularities or non-conformance of Work or products.
   5. Perform additional tests and inspections required by Architect.
   6. Submit reports of all tests/inspections specified.

B. Limits on Testing/Inspection Agency Authority:
   1. Agency may not release, revoke, alter, or enlarge on requirements of Contract Documents.
   2. Agency may not approve or accept any portion of the Work.
   3. Agency may not assume any duties of Contractor.
   4. Agency has no authority to stop the Work.

C. Contractor Responsibilities:
   1. Deliver to agency at designated location, adequate samples of materials proposed to be used that require testing, along with proposed mix designs.
   2. Cooperate with laboratory personnel, and provide access to the Work and to manufacturers' facilities.
   3. Provide incidental labor and facilities:
      a. To provide access to Work to be tested/inspected.
      b. To obtain and handle samples at the site or at source of Products to be tested/inspected.
      c. To facilitate tests/inspections.
      d. To provide storage and curing of test samples.
   4. Notify Architect and laboratory 24 hours prior to expected time for operations requiring testing/inspection services.
   5. Employ services of an independent qualified testing laboratory and pay for additional samples, tests, and inspections required by Contractor beyond specified requirements.
   6. Arrange with Owner's agency and pay for additional samples, tests, and inspections required by Contractor beyond specified requirements.

D. Re-testing required because of non-conformance to specified requirements shall be performed by the same agency on instructions by Architect.
E. Re-testing required because of non-conformance to specified requirements shall be paid for by Contractor.

F. Re-testing required because of non-conformance to specified requirements shall be performed by the same agency on instructions by Architect. Payment for re-testing will be charged to the Contractor by deducting testing charges from the Contract Price.

3.05 MANUFACTURERS’ FIELD SERVICES

A. When specified in individual specification sections, require material or product suppliers or manufacturers to provide qualified staff personnel to observe site conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment, test, adjust and balance of equipment as applicable, and to initiate instructions when necessary.

B. Submit qualifications of observer to Architect 30 days in advance of required observations.
   1. Observer subject to approval of Architect.

C. Report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers’ written instructions.

3.06 DEFECT ASSESSMENT

A. Replace Work or portions of the Work not conforming to specified requirements.

B. If, in the opinion of Architect, it is not practical to remove and replace Work, Architect will direct an appropriate remedy or adjust payment.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Measuring moisture vapor emission of concrete floors.
   1. Calcium Chloride (CaCl2) Test.
   2. In-situ Relative Humidity Test.
B. Measuring alkalinity (pH) of concrete floors.

1.02 RELATED SECTIONS
A. Section 01 30 00 - Administrative Requirements for submittal procedures.
B. Section 01 40 00 - Quality Requirements for quality assurance, laboratory responsibilities and laboratory reports.
C. Section 01 50 00 - Temporary Facilities and Controls: Temporary heating, cooling and ventilating.
D. Section 03 01 33.01 - Rehabilitating Moist/Alkaline Concrete Floors;
E. Section 03 30 00 - Cast-In-Place Concrete; for substrate to be tested.

1.03 REFERENCES
A. ASTM F 1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.

1.04 PERFORMANCE REQUIREMENTS
A. Provide suitable concrete floor substrate for application of finish floor systems that will meet finish floor manufacturer’s installation requirements.
B. Moisture vapor emission testing:
   1. Moisture dome testing (calcium chloride test):
      a. Moisture vapor test results to achieve three pounds per 1,000 square feet of concrete floor surface per 24 hours, or as allowed by flooring (or adhesive) manufacturer, when tested in conformance with ASTM F 1859.
   2. In-situ relative humidity test:
      a. In-situ relative humidity test results to achieve relative humidity reading of no greater than 75 percent or as allowed by flooring (or adhesive) manufacturer, when tested in conformance with ASTM F 2170.
C. Concrete slab surface pH testing:
   1. Alkalinity testing with probe or pH testing paper to achieve an alkalinity pH no more than 7 and no greater than 9 or as allowed by flooring (or adhesive) manufacturer when tested in conformance with ASTM F 710.

1.05 SUBMITTALS
A. Product Data: Submit manufacturer’s product data for all testing materials proposed for Work of this Section.
B. Letter of Verification of Environmental Conditions as below.
C. Test Reports: Submit moisture vapor emission and alkalinity test reports in accordance with requirements of Section 01 30 00.

1.06 ENVIRONMENTAL CONDITIONS
A. Prior to testing for moisture vapor emissions rate, space shall be enclosed, fully weather-tight, wet work shall be complete and normally dry, work above ceilings finished. The test site shall be at the same temperature and humidity expected during normal use.
B. Building Temperature: Minimum 65 degrees F. Maximum 85 degrees F.
C. Interior Relative Humidity: Minimum 40 percent. Maximum 60 percent.
D. Maintain specified environmental conditions not less than 72 hours prior to conducting tests
   and throughout duration of the tests.

1.07 QUALITY CONTROL
A. Testing shall be conducted not less than 120 days after date of last pour of concrete slab to be
   tested.
B. Quantity of Tests Required:
   1. Not less than 3 test are required for the first 1,000 square feet plus one test per each
      additional 1,000 square feet or fraction thereof.

PART 2 PRODUCTS
2.01 MOISTURE VAPOR EMISSION TESTING
A. Moisture Dome Testing: Conform to requirements of ASTM F 1869.
   1. Anhydrous Calcium Chloride (CaCl2) Test Kits: Kits shall contain a plastic spherical dome
      with a factory installed silicone gasket, weight ring, airtight foil bag of calcium chloride
      (approximately 30 grams), and a plastic dish with snap-top lid and label.
      a. This test requires use of a gram-weight scale with a gradation of 1/10th (0.1) gram.
   B. In-situ Relative Humidity Testing is required to be performed by an independent testing
      laboratory using relative humidity moisture meter kits and sensors conforming to requirements
      of ASTM F 2170.

2.02 CONCRETE SLAB SURFACE PH TESTING
A. pH Tester with a surface probe.
B. pH Test Kits: Kits shall contain pH paper, pH pencil and pH color chart for comparison.

PART 3 EXECUTION
3.01 PREPARATION
A. General:
   1. Prior to testing, verify that environmental conditions have been met.
   2. Heating ventilating and air conditioning system is operating or temporary heat, cooling and
      ventilating system is operating.
   3. Lay Out Test Area: Measure the space to be tested. Layout the test sites in a rectangular,
      quasi rectangular or a cross-diagonal grid. Come in 5 feet from any exterior wall and place
      test kits at even intervals. Complete the grid. Record the location of each test site on a
      Record Drawing.
B. Moisture Dome Testing:
   1. Surface Preparation:
      a. For each test area, expose a surface area of 20 inches square.
      b. Grind or sand the concrete surface. Test area shall be clean and free of all foreign
         substances; including curing compounds, sealers, paint, oil, resins, parting
         compounds, floor leveling compounds, dirt, etc.
   2. After surface preparation is complete and prior to testing, allow space to remain
      undisturbed for 24 hours.
C. In-situ Relative Humidity Test:
   1. Drill 5/8 inch diameter test site holes to a depth equal to 40 percent of the slab's thickness
      for slabs on grade and 20 percent for elevated slabs.
3.02 TESTING

A. Using a vacuum, remove any dust or dirt from concrete surface where moisture dome test kit is to be placed or in the case of an insitu relative humidity test clean debris from hole then insert plastic sleeve and cap sleeve. Do not use solvents or water to clean the concrete.

B. Moisture Dome Testing: Perform in accordance with requirements of ASTM F 1869.
   1. Install moisture vapor emission test kits according to manufacturer's published instructions.
   2. Test results are sensitive to testing procedures. Take care to follow manufacturer's instructions.
   3. Allow test kits to remain in place undisturbed for 60 to 72 hours.

C. In-situ Relative Humidity Test: Perform testing in accordance with requirements of ASTM F 2170.
   1. Allow probe sensor at each test site 72 hours equilibration time prior to reading relative humidity levels.
   2. After equilibration, take a probe into the sleeve and obtain relative humidity level readings from the bottom of the hole.
   3. Testing density is required to equal 3 tests in the first 1,000 square feet, with one additional test per each additional 1,000 square feet of concrete slab surface.
   4. Once satisfactory relative humidity testing results are achieved, patch testing site holes prior to application of finish flooring.

D. Alkalinity Testing Using pH Tester:
   1. Conduct test adjacent each location of test for moisture vapor emission.
   2. With the concrete already clean, pour approximately 2 tablespoons of distilled water onto surface of concrete.
   3. Allow distilled water to stand for approximately 3 minutes. While waiting, lightly stir water to help it absorb any of the salts.
   4. Place tip of surface probe into the distilled water solution to obtain results.

E. Record data and results and submit in accordance with Section 01 30 00.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Temporary utilities.
   B. Temporary telecommunications services.
   C. Temporary sanitary facilities.
   D. Temporary Controls: Barriers, enclosures, and fencing.
   E. Security requirements.
   F. Vehicular access and parking.
   G. Waste removal facilities and services.
   H. Project identification sign.
   I. Field offices.

1.02 TEMPORARY AND CONSTRUCTION UTILITIES
   A. Provide and pay for all electrical power, lighting, water, heating and cooling, and ventilation required for construction purposes.
   B. Existing facilities may not be used.
   C. New permanent facilities may be used.
   D. Use trigger-operated nozzles for water hoses, to avoid waste of water.
   E. All shut-off locations are to be documented for emergency purposes prior to pre-construction meeting.
   G. Documentation of locations is to be distributed to PM, Facilities Zone Supervisor, DPS, EH&S, and any others determined by individual projects.

1.03 TELECOMMUNICATIONS SERVICES
   A. Provide, maintain, and pay for telecommunications services to field office at time of project mobilization.

1.04 TEMPORARY SANITARY FACILITIES
   A. Provide and maintain required facilities and enclosures. Provide at time of project mobilization.
   B. Maintain daily in clean and sanitary condition.

1.05 BARRIERS
   A. Provide barriers to prevent unauthorized entry to construction areas, to prevent access to areas that could be hazardous to workers or the public, to allow for owner's use of site and to protect existing facilities and adjacent properties from damage from construction operations and demolition.
   B. Provide barricades and covered walkways required by governing authorities for public rights-of-way and for public access to existing building.
   C. Protect non-owned vehicular traffic, stored materials, site, and structures from damage.

1.06 FENCING
   A. Provide 6 foot high fence around construction site; equip with vehicular and pedestrian gates with locks.

1.07 EXTERIOR ENCLOSURES
   A. Provide temporary insulated weather tight closure of exterior openings to accommodate acceptable working conditions and protection for Products, to allow for temporary heating and maintenance of required ambient temperatures identified in individual specification sections,
and to prevent entry of unauthorized persons. Provide access doors with self-closing hardware and locks.

1.08 INTERIOR ENCLOSURES
A. Provide temporary partitions and ceilings as indicated to separate work areas from Owner-occupied areas, to prevent penetration of dust and moisture into Owner-occupied areas, and to prevent damage to existing materials and equipment.
B. Construction: Framing and reinforced polyethylene sheet materials with closed joints and sealed edges at intersections with existing surfaces.

1.09 SECURITY AND ACCESS TO CONSTRUCTION SITES
A. Provide security and facilities to protect Work, existing facilities, and Owner's operations from unauthorized entry, vandalism, or theft.
B. DPS and PM are to be consulted to determine strategies to be implemented.
C. UO Fire Marshal and EH&S consultation regarding egress routes from the project site and adjacent buildings to be provided and maintained at all times.
D. ADA routes must be provided and maintained at all times from the site & adjacent buildings.
E. Parking within site fencing is controlled and managed by the GC.
F. If the project does not have site fencing then parking is restricted by issued parking permits through DPS in designated locations only. Parking permits are requested of DPS by the PM.

1.10 VEHICULAR ACCESS AND PARKING
A. Coordinate access and haul routes with governing authorities and Owner.
B. Provide and maintain access to fire hydrants, free of obstructions.
C. Provide means of removing mud from vehicle wheels before entering streets.
D. Provide temporary parking areas to accommodate construction personnel. When site space is not adequate, provide additional off-site parking.

1.11 WASTE REMOVAL
A. Provide waste removal facilities and services as required to maintain the site in clean and orderly condition.
B. Provide containers with lids. Remove trash from site periodically.
C. If materials to be recycled or re-used on the project must be stored on-site, provide suitable non-combustible containers; locate containers holding flammable material outside the structure unless otherwise approved by the authorities having jurisdiction.
D. Open free-fall chutes are not permitted. Terminate closed chutes into appropriate containers with lids.

1.12 PROJECT IDENTIFICATION
A. Provide project identification sign of design and construction indicated on Drawings.
B. Erect on site at location indicated.
C. No other signs are allowed without Owner permission except those required by law.
D. Only two types of signs fixed to construction fencing are allowed:
   1. One sign to identify the project, project purpose, project rendering and design team.
   2. One sign to list the general and sub-contractors.
1.13 FIELD OFFICES
   A. Office: Weather-tight, with lighting, electrical outlets, heating, cooling equipment, and equipped with sturdy furniture, drawing rack and drawing display table.
   B. Provide space for Project meetings, with table and chairs to accommodate 6 persons.
   C. Locate offices a minimum distance of 30 feet from existing and new structures.

PART 2 PRODUCTS - NOT USED
PART 3 EXECUTION - NOT USED

END OF SECTION
PART 1 - GENERAL

1.01 SECTION INCLUDES
A. General protection and pruning of existing trees and plants that are affected by execution of the Work, whether temporary or permanent construction.

1.02 DEFINITIONS
A. Caliper: Diameter of a trunk measured by a diameter tape at 6 inches above the ground for trees up to, and including, 4-inch size; and 12 inches above the ground for trees larger than 4-inch size.
B. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction, and indicated on Drawings.
C. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.03 SUBMITTALS
A. Product Data: For each type of product indicated:
   1. Organic Mulch.
   2. Protection-Zone Fencing.
   3. Protection-Zone Signage.
B. Tree Pruning Schedule: Written schedule detailing scope and extent of pruning of trees to remain that interfere with or are affected by construction:
   1. Species and size of tree.
   2. Location on site plan. Include unique identifier for each.
   3. Reason for pruning.
   4. Description of pruning to be performed.
   5. Description of maintenance following pruning.
C. Qualification Data: For qualified arborist and tree service firm.
D. Certification: From arborist, certifying that trees indicated to remain have been protected during construction according to recognized standards and that trees were promptly and properly treated and repaired when damaged.
E. Maintenance Recommendations: From arborist, for care and protection of trees affected by construction during and after completing the Work.
F. Existing Conditions: Documentation of existing trees and plantings indicated to remain, which establishes preconstruction conditions that might be misconstrued as damage caused by construction activities.
   1. Use sufficiently detailed photographs or videotape.
   2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.

1.04 QUALITY ASSURANCE
A. Arborist Qualifications: Certified Arborist as certified by International Society of Arborists (ISA).
B. Tree Service Firm Qualifications: An experienced tree service firm that has successfully completed temporary tree and plant protection work similar to that required for this Project and that will assign an experienced, qualified arborist to Project site during execution of the Work.
C. Preinstallation Conference: Conduct conference at location to be determined by Owner's Representative Pre-installation conference shall be arranged 4 weeks prior to beginning of construction.
   1. Review methods and procedures related to temporary tree and plant protection and soil protection including, but not limited to, the following:
      a. Construction schedule. Verify availability of materials, personnel, and equipment needed to make progress and avoid delays.
1.05 PROJECT CONDITIONS

A. The following practices are prohibited within protection zones:
   1. Storage of construction materials, debris, or excavated material.
   2. Foot traffic.
   3. Erection of sheds or structures.
   4. Impoundment of water.
   5. Excavation or other digging unless otherwise indicated.

B. Do not direct vehicle or equipment exhaust toward protection zones.

C. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones and organic mulch.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Organic Mulch: Free from deleterious materials and suitable as a top dressing for trees and shrubs, and soil protection areas consisting of one of the following:
   1. Type: Ground or shredded bark.
   2. Size Range: 2 inches maximum, 1/2 inch minimum.

B. Protection-Zone Fencing: Fencing anchored into a fixed position and meeting the following requirements.
   1. Chain-Link Protection-Zone Fencing: Galvanized-steel fencing fabricated from minimum 2-inch opening, 0.148-inch- diameter wire chain-link fabric; with pipe posts, minimum 2-3/8-inch- OD line posts, and 2-7/8-inch- OD corner and pull posts; with 1-5/8-inch- OD top rails; with 0.177-inch- diameter top tension wire and 0.177-inch- diameter bottom tension wire; with tie wires, hog ring ties, and other accessories for a complete fence system.
      a. Height: 6 feet.

C. Protection-Zone Signage: Shop-fabricated, rigid plastic or metal sheet with attachment holes prepunched and reinforced; legibly printed with nonfading lettering and as follows:
   1. Size and Text: As shown on Drawings.
   2. Lettering: 3-inch high minimum, black characters on white background.

D. Matting: 1/2" thick polyethylene
   1. Available manufacturers or approved equal:
      a. Altturnamat

E. Geotextile Fabric:
   1. Filter fabric shall be pervious synthetic polymer, non-woven, from continuous filaments.
      Fabric shall be EX 250 manufactured by Exxon Chemical Company, or approved equal.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Erosion and Sedimentation Control: Examine the site to verify that temporary erosion- and sedimentation-control measures are in place. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.
3.02 PREPARATION

A. Locate and clearly identify trees, shrubs, and other vegetation to remain or to be relocated. Tie a 1-inch blue-vinyl tape around each tree trunk at 54 inches above the ground.

B. Protect tree root systems from damage caused by runoff or spillage of noxious materials while mixing, placing, or storing construction materials. Protect root systems from ponding, eroding, or excessive wetting caused by dewatering operations.

C. Tree-Protection Zones: Mulch areas inside tree-protection zones and other areas indicated.
   1. Apply 4-inch average thickness of organic mulch. Do not place mulch within 24 inches of tree trunks.
   2. Prior to any demolition, outline materials and procedures to be used in protecting Zones of Protection. These are to include scheduling of mulching and maintenance, procedures for obtaining variances, relative timing for removal of protective fencing and procedures for protecting Zones of Protection after fencing is removed. FS Exterior Supervisor must be notified and consulted before removal of protection fencing occurs.

3.03 TREE- AND PLANT-PROTECTION ZONES

A. Protection-Zone Fencing: Install protection-zone fencing along edges of indicated protection zones before materials or equipment are brought on the site and construction operations begin in a manner that will prevent people from easily entering protected area except by entrance gates. Construct fencing so as not to obstruct safe passage or visibility at vehicle intersections where fencing is located adjacent to pedestrian walkways or in close proximity to street intersections, drives, or other vehicular circulation.
   1. Chain-Link Fencing: Install to comply with ASTM F 567 and with manufacturer's written instructions.
   2. Posts: Set or drive posts into ground one-third the total height of the fence without concrete footings. Where a post is located on existing paving or concrete to remain, provide appropriate means of post support acceptable to Architect.
   3. Access Gates: Install where indicated; adjust to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Protection-Zone Signage: Install protection-zone signage in visibly prominent locations in a manner approved by Landscape Architect and FS Exterior Supervisor. Install one sign spaced approximately every 35 feet on protection-zone fencing, but no fewer than four signs with each facing a different direction.
   1. Protection-Zone Signage shall have a posted notice listing prohibited activities that must have prior authorization. These notices shall remain in place until a combined authorization is granted by the Landscape Architect, Arborist, and FS Exterior Supervisor.
   2. Protection-Zone Signage prohibited activities to be listed and posted on signage:
      a. Removal or moving of protective fencing.
      b. Parking and driving of vehicles
      c. Storing of equipment.
      d. Excavations.
      e. Flooding and cleanup of equipment, tools, etc.
      f. Operation of equipment.
      g. Staging of materials.
      h. Trenching.
      i. Stockpiling.
      j. Altering Drainage
   3. Submit requests to work within the Zones of Protection following procedures established by the Landscape Architect and FS Exterior Supervisor must be notified and consulted before work occurs.

NOTICE OF ALTERNATE BILLING CYCLE: The Contract allows the Owner to require the submission of billings or estimates in billing cycles other than 30-day cycles. Billings or estimates shall be submitted monthly ending on the last day of the month.

NOTICE OF EXTENDED CERTIFICATION PROVISION: The Contract will allow the Owner to certify billings and estimates within 20 days after the billings and estimates are received.

NOTICE OF EXTENDED PAYMENT PROVISION: The Contract will allow the Owner to make payment within 30 days after the date a billing or estimate is received.
C. Maintain protection zones free of weeds and trash.

D. Tree trunks are to be protected as specified by the Landscape Architect and project’s Arborist.

E. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by Landscape Architect and FS Exterior Supervisor.

F. Maintain protection zone fencing and signage in good condition as acceptable to Landscape Architect and FS Exterior Supervisor and remove when construction operations are complete and equipment has been removed from the site.
   1. Do not remove protection-zone fencing, even temporarily, to allow deliveries or equipment access through the protection zone
   2. Temporary access is permitted subject to preapproval in writing by arborist if a root buffer effective against soil compaction is constructed as directed by arborist. Maintain root buffer so long as access is permitted.
   3. Fencing may not be moved or removed without prior Arborist, Landscape Architect, and FS Exterior Supervisor approvals.
   4. When fencing is removed all protection requirements still apply.

G. Prevent damage to plant materials including trees, ground cover, root systems, soil, bark, foliage, branches, and limbs due to construction activities that include, but are not limited to the following:
   1. Soil contamination, erosion and compaction.
   2. Excessive wetting, ponding and construction run-off.
   3. Alteration of grade, stockpiling of soil, debris and materials.
   4. Damage to soil, roots, bark, trunk, limbs, branches and foliage.
   5. Unauthorized cutting, breaking, skinning and abrasion of roots, branches.

3.04 ROOT PRUNING

A. During any excavation, no roots larger than 1-inch in diameter will be cut without prior approvals from the Landscape Architect, Arborist and FS Exterior Supervisor.

B. Prune roots that are affected by temporary and permanent construction. Prune roots as follows:
   1. Cut roots manually by digging a trench and cutting exposed roots with clean, sharp pruning instruments; do not break, tear, chop, or slant the cuts. Do not use a backhoe or other equipment that abrains, rips, tears, or pulls roots.
   2. Many plant authorities do not consider it beneficial to paint cut root ends.
   3. Cut Ends: Do not paint cut root ends. Coat cut ends of roots more than 1-1/2 inches in diameter with an emulsified asphalt or other coating formulated for use on damaged plant tissues and that is acceptable to arborist.
   4. Temporarily support and protect roots from damage until they are permanently redirected and covered with soil.
   5. Backfill as soon as possible according to requirements in Division 31 Section - Earth Moving.

C. Root Pruning at Edge of Protection Zone: Prune roots 12 inches outside of the protection zone, by cleanly cutting all roots to the depth of the required excavation.

D. Root Pruning within Protection Zone: Clear and excavate by hand to the depth of the required excavation to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.

3.05 CROWN PRUNING

A. Trimming of tree canopies will not be allowed without prior FS Exterior Supervisor approval.

B. Prune branches that are affected by temporary and permanent construction. Prune branches as follows:
1. Prune trees according to recommendations from Arborist.
2. Prune trees to remain to compensate for root loss caused by damaging or cutting root system. Provide subsequent maintenance during Contract period as recommended by arborist.
   a. Type of Pruning: Cleaning and Thinning.
   b. Cut branches with sharp pruning instruments; do not break or chop.
   c. Do not apply pruning paint to wounds.

C. Chip removed branches and dispose of off-site.

3.06 FIELD QUALITY CONTROL
   A. Inspections: Engage a qualified arborist to direct plant-protection measures in the vicinity of trees, shrubs, and other vegetation indicated to remain and to prepare inspection reports.

3.07 REPAIR AND REPLACEMENT
   A. General: Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by Architect.
      1. Submit details of proposed root cutting and tree and shrub repairs.
      2. Have arborist perform the root cutting, branch pruning, and damage repair of trees and shrubs.
      3. Treat damaged trunks, limbs, and roots according to arborist's written instructions.
      4. Perform repairs within 24 hours.
      5. Replace vegetation that cannot be repaired and restored to full-growth status, as determined by Architect.

B. Trees: Remove and replace trees indicated to remain that are more than 25 percent dead or in an unhealthy condition before the end of the corrections period or are damaged during construction operations that Architect determines are incapable of restoring to normal growth pattern.
      1. Provide new trees of same size and species as those being replaced for each tree that measures 6 inches or smaller in caliper size.
      2. Provide two new trees of 4-inch caliper size for each tree being replaced that measures more than 6 inches in caliper size.
         a. Species: Match existing.
         b. Plant and maintain new trees as specified in Division 32 Section "Plants."

C. Damages to any trees that are to remain and protected:
   1. Tree values will be assessed by the Landscape Architect and FS Exterior Supervisor in one of two ways:
      a. Establish value per ISA standards and posted to the tree at start of construction. Compensation of any and all harm, damage, destruction, etc. to the tree will be assessed based on the tree value. OR
      b. Five Hundred dollar ($500.00) fine per tree, per incident, for violation of these requirements.
   2. Damages may be waived only by Landscape Architect and FS Exterior Supervisor if the tree is replaced with the like species and size and has a full one year unconditional guarantee.

3.08 TREE REMOVAL
   A. Tree Removal: See Section 31 10 00.

3.09 DISPOSAL OF SURPLUS AND WASTE MATERIALS
   A. Disposal: Remove excess excavated material, displaced trees, trash and debris, and legally dispose of them off Owner's property; see Section 01 74 19
      1. Separate recyclable materials produced during work of this section from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. General product requirements.
   B. Re-use of existing products.
   C. Transportation, handling, storage and protection.
   D. Product option requirements.
   E. Substitution limitations and procedures.
   F. Procedures for Owner-supplied products.
   G. Maintenance materials, including extra materials, spare parts, tools, and software.

1.02 DEFINITIONS
   A. Products: Items purchased for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
   B. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature, that is current as of date of the Contract Documents.
   C. New Products: Items that have not previously been incorporated into another project or facility, except that products consisting of recycled-content materials are allowed, unless explicitly stated otherwise. Products salvaged or reused from other projects are not considered new products.
   D. Comparable Product: Product that is demonstrated and approved through submittal process, or where indicated as a product substitution, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
   E. Substitutions: Contractor proposed changes in products, materials, equipment, or methods of construction different from those required by the Contract Documents.
   F. VOC: Volatile organic compound, carbon compounds that participate in atmospheric photochemical reactions and vaporize at normal room temperature. Measure as grams per liter, less water.
   G. Bidding/ Negotiating Period: The period within the project schedule where the Contractor receives bids or pricing from subcontracts or prepares their own bid to establish a contract value with the Owner.
   H. Award of Contract: The formal acceptance of the terms of the negotiation by the Contractor.
   I. Notice to Proceed: A document that establishes the date work is authorized to commence. It may also include the number of calendar days or date of substantial completion.

1.03 SUBMITTALS
   A. Submittal procedure for Product Data, Shop Drawings, Samples, and Certificates is specified in Section 01 33 00 - Submittal Procedure.
   B. Proposed Products List: Submit list of major products proposed for use, with name of manufacturer, trade name, and model number of each product.
      1. Submit within 15 days after date of Notice to Proceed.
      2. For products specified only by reference standards, list applicable reference standards.
   C. Indicate utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.
   D. Request for Substitution: Submit approved form with supporting information to CM/GC. Comply with "Substitution Procedures" Article in this Section.
1. Requests During Bidding/ Negotiating period: CSI Form 1.5C or current CSI Northwest Region Form.
2. Requests after Bidding/ Negotiating period: CSI Form 13.1A.
3. Submit original request forms in quantity required distribution. Original must be signed by person authorized to certify the substitution request form. Architect may request proof of authorization.

E.

1.04 QUALITY ASSURANCE
A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, product selected shall be compatible with products previously selected, even if previously selected products were also options.

1.05 DELIVERY, STORAGE, AND HANDLING
A. Construction deliveries shall be made at the project jobsite to the attention of the Contractor; not FS receiving.
B. Products and materials shall be protected from damage, weather, vandalism, etc. prior to installation. Replacement and replacement cost will be the responsibility of the Contractor.

1.06 PRODUCT WARRANTIES
A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
1. Manufacturer's Warranty: Preprinted written warranty published by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
2. Special Warranty: Written warranty required by or incorporated into the Contract Documents, either to extend time limit provided by manufacturer's warranty or to provide more rights for Owner.
B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution. Submit a draft for approval before final execution.
1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
2. Specified Form: When specified forms are included with the Specifications, prepare a written document using appropriate form properly executed.
3. Refer to Divisions 2 through 16 Sections for specific content requirements and particular requirements for submitting special warranties.

PART 2 PRODUCTS

2.01 EXISTING PRODUCTS
A. Do not use materials and equipment removed from existing premises unless specifically required or permitted by the Contract Documents.
B. Existing materials and equipment indicated to be removed, but not to be re-used, relocated, reinstalled, delivered to the Owner, or otherwise indicated as to remain the property of the Owner, become the property of the Contractor; remove from site.
C. Reused Products: Reused products include materials and equipment salvaged and refurbished as specified.
1. Protect, repair and prepare for installation items indicated as "reinstall" or "salvage for reinstallation".
2. Replace items that are damaged beyond repair during demolition or construction.

2.02 NEW PRODUCTS
A. Provide new products unless specifically required or permitted by the Contract Documents.
B. Provide commercial grade products as a minimum; residential grade products are unacceptable.

B. Do not use products having any of the following characteristics:
   1. Made using or containing CFC's or HCFC's.
   2. Made of wood from newly cut old growth timber.

C. Where all other criteria are met, Contractor shall give preference to products that:
   1. Are extracted, harvested, and/or manufactured within 500 miles of the project.
   2. Are made with rapidly renewable material.
   3. Contain more recycled material.
   4. Use sustainably harvested wood over non-sustainably harvested wood.
   5. Do not contain urea formaldehyde.
   6. Contain fewer VOCs.
   7. Are Green Label Plus carpet, cushion or adhesive.
   8. Have longer documented life span under normal use.
   9. Result in less construction waste.

D. Products with Rapidly Renewable Material Content:
   1. Definition: Materials made from plants that are typically harvested within 10 years or less after planting.
   2. Overall Project Requirement: Provide materials amounting to a minimum of 2.5 percent of the total value of all materials and products used on the project.
   3. Specific Product Categories: Provide renewable material content as specified elsewhere.
   4. Calculations: Where information about renewable material content is required to be submitted and an item is not made completely of rapidly renewable material, calculate content by dividing the renewable material content by weight by the total weight of the item.
   5. Submittals: State unit cost, renewable material content percentage, quantity installed, total material cost, and total renewable material value; attach evidence of contents from either manufacturer or an independent agency.

E. Products with Recycled Content:
   1. Overall Project Requirement: Provide products with recycled content such that the sum of post-consumer recycled content plus one-half of the post-industrial recycled content constitutes at least 10 percent of the total value of all products installed, except mechanical and electrical components.
   2. Specific Product Categories: Provide recycled content as specified elsewhere.
   3. Calculations: Where information about recycled content is required to be submitted:
      a. Determine percentage of post-consumer and post-industrial content separately, using the guidelines contained in 16 CFR 260.7(e).
      b. Previously used, reused, refurbished, and salvaged products are not considered recycled.
      c. Wood fabricated from timber abandoned in transit to original mill is considered reused, not recycled.
      d. Determine percentage of recycled content of any item by dividing the weight of recycled content in the item by the total weight of all material in the item.
      e. Determine value of recycled content of each item separately, by multiplying the content percentage by the value of the item.
   4. Submittals: State unit cost, post-consumer and post-industrial content percentages, quantity installed, total material cost, and total recycled content value; attach evidence of contents from either manufacturer or an independent agency.

F. Certified Wood - Sustainably Harvested Wood:
   1. Definition: Wood-based materials include but are not limited to structural framing, dimension lumber, flooring, wood doors, finishes, and furnishings that are permanently...
installed in the project. Wood and wood-based products not permanently installed in the project are not included in the definition.

2. Overall Project Requirement: Provide a minimum of 50 percent of all wood-based materials made of sustainably harvested wood.

3. Specific Wood-Based Fabrications: Fabricate of sustainably harvested wood when so specified elsewhere.

4. Certification: Provide wood certified or labeled by an organization accredited by one of the following:

5. Submittals: State unit cost of each wood-based item, quantity installed, quantity certified as sustainably harvested, total wood-based material cost, and total sustainably harvested value; provide letter of certification signed by supplier of each item, indicating compliance with the specified requirements and identifying the certifying organization.
   a. Provide chain-of-custody documentation:
   b. Include the certifying organization's certification numbers for each certified product, itemized on a line-item basis.
   c. Attach copies of invoices bearing the certifying organization's certification numbers.

G. Urea-Formaldehyde Prohibition:
   1. Overall Project Requirement: Provide composite wood and agrifiber products having no added urea-formaldehyde resins. Laminating adhesives used to fabricate both on-site and shop-applied composite wood and agrifiber assemblies shall not contain urea formaldehyde resin.
      a. Require each installer to certify compliance and submit product data showing product content.

2. Specific Product Categories: Comply with limitations specified elsewhere.

H. Adhesives and Sealants: Provide only products having lower volatile organic compound (VOC) content than required by South Coast Air Quality Management District Rule No.1168, and Green Seal Standard for Commercial Adhesives GS-36.
   1. Specific Product Categories: VOC in grams/Liter shall not exceed:
      a. Indoor Carpet Adhesive: 50.
      b. Carpet Pad Adhesive: 50.
      c. Wood Flooring Adhesive:100.
      d. Rubber Flooring Adhesive:60.
      e. Subfloor Adhesive:50.
      g. VCT and Asphalt Adhesive:50.
      h. Gypsum Board Adhesive:50.
      i. Resilient Base Adhesive:50.
      j. Multipurpose Construction Adhesive: 70.
      k. Structural Glazing Adhesive:100.
   2. Specialty Applications: VOC in grams/Liter shall not exceed:
      a. PVC Welding:510.
      b. CPVC Welding:490.
      c. ABS Welding:325.
      e. Adhesive Primer for Plastic:550.
      f. Contact Adhesive:80.
      g. Special Purpose Contact Adhesive:250.
      h. Structural Wood Member Adhesive:140
      j. Top and Trim Adhesive:250.
3. Substrate Specific Applications: VOC in grams/Liter shall not exceed:
   a. Metal to Metal: 30.
   d. Wood: 30.
   e. Fiberglass: 80.

4. Sealants: VOC in grams/Liter shall not exceed:
   b. Roof: 300.
   e. Other: 250.

5. Primers for Sealants: VOC in grams/Liter shall not exceed:
   c. Other: 750.

6. Aerosol Adhesives: Percent VOC by weight shall not exceed:
   a. General Purpose Mist Spray: 65%.
   b. General Purpose Web Spray: 55%.
   c. Special Purpose (all types): 70%.

I. Interior Paints and Coatings: Provide only products having lower volatile organic compound (VOC) content than required by Green Seal Standards GS-11 and GC-03, SCAQMB Rule 1113, in grams/Liter as follows:
1. VOC in grams/Liter shall not exceed the following for each product:
   b. Flat opaque products: 50.
   c. Anti-corrosive paint: 250.
   d. Floor coating: 100.
   e. Clear varnish: 350.
   g. Sealer: 250.
   h. Other sealers: 200.
   i. Stains: 250.
   j. Lacquer: Not allowed.
2. Comply with other requirements of GS-11 (component limitations, scrubbability, hiding power, washability).

J. Carpet, Carpet Tile, Carpet Cushion and Adhesives: Provide only products having lower volatile organic compound (VOC) content than required by Carpet and Rug Institute Green Label Plus Testing Program Limits, Emission Factor Limit in mg/sq.. m. x hour as follows:
1. Total Carpet or Carpet Tile VOC: 0.50
   a. 4-Phenylcyclohexene: 0.05
   b. Formaldehyde: 0.05
   c. Styrene: 0.40
   d. Green Label Plus testing for Acetaldehyde, Benzene, Caprolactam, 2-Ethylhexanoic Acid, Formaldehyde, 1-Methyl-2-Pyrroldinone, Naphthalene, Nonanal, Octanal, 4-Phenylcyclohexene, Styrene, Toluene, and Vinyl Acetate.
2. Total Adhesive VOC: 10.00
   a. Formaldehyde: 0.05
   b. 2-Ethyl-1-Hexanol: 3.00
3. Total Cushion VOC: 1.00
   a. 4-Phenylcyclohexene: 0.05
b. Formaldehyde: 0.05
c. BHT (butylated hydroxytoluene): 0.30

K. Provide interchangeable components of the same manufacture for components being replaced.

L. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Size terminal lugs to NFPA 70, include lugs for terminal box.

M. Cord and Plug: Provide minimum 6 foot cord and plug including grounding connector for connection to electric wiring system. Cord of longer length is specified in individual specification sections.

2.03 PRODUCT OPTIONS

A. Products Specified by Reference Standards or by Description Only: Use any product meeting those standards or description.

B. Products Specified by Naming One or More Manufacturers: Use a product of one of the manufacturers named and meeting specifications, no options or substitutions allowed.

C. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions: Submit a request for substitution for any manufacturer not named.

D. Basis-of-Design Product: Where Specifications name a product and include a list of manufacturers, provide the specified product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named.

E. Visual Matching Specification: Where Specifications require matching an established Sample, select a product that complies with requirements and matches Architect's sample. Architect's decision will be final on whether a proposed product matches.
   1. If no product available within specified category matches and complies with other specified requirements, comply with provisions in "Product Substitutions" Article for proposal of product.

F. Visual Selection Specification: Selection of products for color, pattern, density, or texture will be by Architect from Manufacturer's full range, unless indicated otherwise.
   1. Standard Range: Where Specifications include the phrase "standard range of colors, patterns, textures" or similar phrase, Architect will select color, pattern, density, or texture from manufacturer's product line that does not include premium items.
   2. Full Range: Where Specifications include the phrase "full range of colors, patterns, textures" or similar phrase, Architect will select color, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

2.04 MAINTENANCE MATERIALS

A. Furnish maintenance/overstock/extra materials, spare parts, tools, and software of types and in quantities specified in individual specification sections.

B. Specific construction overstock requirements are stated in each section as applicable.

C. Overstock goods shall be from the same manufacturer, lot and/or run as the material installed.

D. Provide complete written inventory of overstock goods in Excel format indicating product type, model number, installed location(s), name of supplier, quantity supplied, and storage location. Inventory shall be confirmed prior to issuance of Substantial Completion.

E. Deliver to Project site; obtain receipt prior to final payment.

NOTICE OF ALTERNATE BILLING CYCLE: The Contract allows the Owner to require the submission of billings or estimates in billing cycles other than 30-day cycles. Billings or estimates shall be submitted monthly ending on the last day of the month.

NOTICE OF EXTENDED CERTIFICATION PROVISION: The Contract will allow the Owner to certify billings and estimates within 20 days after the billings and estimates are received from the original contractor.

NOTICE OF EXTENDED PAYMENT PROVISION: The Contract will allow the Owner to make payment within 30 days after the date a billing or estimate is received.
PART 3 EXECUTION

3.01 SUBSTITUTION PROCEDURES

A. Instructions to Bidders specify time restrictions for submitting requests for substitutions during the bidding period. Comply with requirements specified in this section.

B. Substitutions may be considered during construction when a product becomes unavailable through no fault of the Contractor.

C. Document each request with complete data substantiating compliance of proposed substitution with Contract Documents.
   1. Note any departures from the Contract Documents or changes in previously reviewed submittals which were not commented upon in the initial review of information.

D. A request for substitution constitutes a representation that the submitter:
   1. Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product.
   2. Will provide the same warranty for the substitution as for the specified product.
   3. Will coordinate installation and make changes to other Work that may be required for the Work to be complete with no additional cost to Owner.
   4. Waives claims for additional costs or time extension that may subsequently become apparent.
   5. Where “visual matching” is not possible, paragraph 2.3E.
   6. Will reimburse Owner and Architect for review or redesign services associated with re-approval by authorities.
   7. Will reimburse the Architect for changes to the building design, including engineering design, detailing and additional Construction Administration services as a result of the proposed substitution.

E. Conditions for Substitution after Bidding/ Negotiating Period: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:
   1. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Architect for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
   2. Requested substitution does not require revisions to the Contract Documents.
   3. Requested substitution is consistent with the Contract Documents and will produce indicated results including warranty, maintenance service or source replacement of parts.
   4. Requested substitution will not adversely affect Contractor's Construction Schedule or the work of other trades.
   5. Requested substitution will not require changing specifications or affect the Owner's activities.
   6. Requested substitution has received necessary approvals of authorities having jurisdiction.
   7. Requested substitution is compatible with other portions of the Work.
   8. Requested substitution has been coordinated with other portions of the Work.
   9. The Contractor agrees to reschedule activities around the required redesign time needed without changing Substantial Completion date and reimburse Architect for changes to the building design, including design, detailing and additional Construction Administration services as a result of the proposed substitution.

F. Substitutions will not be considered when they are indicated or implied on Shop Drawing or product data submittals, without separate written request, or when acceptance will require revision to the Contract Documents.
1. Submit proposed substitution 14 days prior to submittal.

G. Substitution Submittal Procedure:
1. Submit three copies of request for substitution for consideration. Limit each request to one proposed substitution.
2. Submit shop drawings, product data, and certified test results attesting to the proposed product equivalence. Burden of proof is on proposer.
4. Requests after Bidding/ Negotiating Period: Architect will notify Contractor in writing of decision to accept or reject request.

3.02 OWNER-FURNISHED PRODUCTS (CONTRACTOR INSTALLED)

A. Owner's Responsibilities:
1. Arrange for and deliver Owner reviewed shop drawings, product data, and samples, to Contractor.
2. Arrange and pay for product delivery to site.
3. On delivery, inspect products jointly with Contractor.
4. Submit claims for transportation damage and replace damaged, defective, or deficient items.
5. Arrange for manufacturers' warranties, inspections, and service.

B. Contractor's Responsibilities:
1. Review Owner reviewed shop drawings, product data, and samples.
2. Receive and unload products at site; inspect for completeness or damage jointly with Owner.
3. Handle, store, install and finish products.
4. Repair or replace items damaged after receipt.

3.03 TRANSPORTATION AND HANDLING

A. Coordinate schedule of product delivery to designated prepared areas in order to minimize site storage time and potential damage to stored materials.

B. Transport and handle products in accordance with manufacturer's instructions.

C. Transport materials in a manner to prevent contamination of product and littering of surrounding areas.

D. Promptly inspect shipments to ensure that products comply with requirements, quantities are correct, and products are undamaged.

E. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage.

F. Arrange for the return of packing materials, such as wood pallets, where economically feasible.

3.04 STORAGE AND PROTECTION

A. Designate receiving/storage areas for incoming products so that they are delivered according to installation schedule and placed convenient to work area in order to minimize waste due to excessive materials handling and misapplication.

B. Store and protect products in accordance with manufacturers' instructions.

C. Store with seals and labels intact and legible.

D. Store sensitive products in weather tight, climate controlled, enclosures in an environment favorable to product.

E. For exterior storage of fabricated products, place on sloped supports above ground.

F. Provide bonded off-site storage and protection when site does not permit on-site storage or protection.
G. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.

H. Store loose granular materials on solid flat surfaces in a well-drained area. Prevent mixing with foreign matter.

I. Prevent contact with material that may cause corrosion, discoloration, or staining.

J. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.

K. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.

L. Installed products and materials shall be protected from damage, weather, vandalism, etc. prior to Final Completion. Replacement and replacement cost will be Contractor's responsibility.
SUBSTITUTION REQUEST
(After the Bidding/Negotiating Stage)

Project: ____________________________  Substitution Request Number: ______________________
From: ______________________________

To: ________________________________  Date: ________________________________
A/E Project Number: __________________

Re: ________________________________  Contract For: ____________________________

Specification Title: ___________________  Description: ______________________________________
Section: ________________  Page: __________  Article/Paragraph: ____________________________

Proposed Substitution: ________________________________________________________________

Manufacturer: ________________________  Address: ___________________________  Phone: __________
Trade Name: _________________________  Model No.: _________________________________
Installer: ____________________________  Address: _____________________________  Phone: __________

History: □ New product □ 1-4 years old □ 5-10 years old □ More than 10 years old
Differences between proposed substitution and specified product: ____________________________

□ Point-by-point comparative data attached — REQUIRED BY A/E

Reason for not providing specified item: __________________________________________________

Similar Installation:

Project: ____________________________  Architect: _______________________________
Address: ___________________________  Owner: _________________________________
Date Installed: ______________________

Proposed substitution affects other parts of Work: □ No □ Yes; explain ________________________

Savings to Owner for accepting substitution: ____________________________ ($ _______).

Proposed substitution changes Contract Time: □ No □ Yes [Add] [Deduct] ___________ days.

Supporting Data Attached: □ Drawings □ Product Data □ Samples □ Tests □ Reports □ ____________
SUBSTITUTION REQUEST
(After the Bidding/Negotiating Stage - Continued)

The Undersigned certifies:
• Proposed substitution has been fully investigated and determined to be equal or superior in all respects to specified product.
• Same warranty will be furnished for proposed substitution as for specified product.
• Same maintenance service and source of replacement parts, as applicable, is available.
• Proposed substitution will have no adverse effect on other trades and will not affect or delay progress schedule.
• Cost data as stated above is complete. Claims for additional costs related to accepted substitution which may subsequently become apparent are to be waived.
• Proposed substitution does not affect dimensions and functional clearances.
• Payment will be made for changes to building design, including A/E design, detailing, and construction costs caused by the substitution.
• Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.

Submitted by: ____________________________

Signed by: ____________________________

Firm: ____________________________

Address: ____________________________

Telephone: ____________________________

Attachments: ____________________________

A/E’s REVIEW AND ACTION
□ Substitution approved – Make submittals in accordance with Specifications Section 01 60 00 Product Requirements.
□ Substitution approved as noted – Make submittals in accordance with Specification Section 01 60 00 Product Requirements.
□ Substitution rejected – Use specified materials.
□ Substitution Request received too late – Use specified materials.

Signed by: ____________________________ Date: ____________________________

Additional Comments: □ Contractor □ Subcontractor □ Supplier □ Manufacturer □ A/E □ ________________

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PART 1 GENERAL

1.01 SECTION INCLUDES
A. Examination, preparation, and general installation procedures.
B. Cutting and patching.
C. Laying out the work.
D. Cleaning and protection.
E. Starting of systems and equipment.
F. Demonstration and instruction of Owner personnel.
G. Closeout procedures, except payment procedures.

1.02 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Cutting and Patching: If not shown in Documents, submit an RFI in advance of cutting or alteration that affects:
   1. Structural integrity of any element of Project.
   2. Integrity of weather exposed or moisture resistant element.
   3. Efficiency, maintenance, or safety of any operational element.
   5. Work of Owner or separate Contractor.
C. Substantial Completion Documents: Statement that Project is substantially complete and list of incomplete items (Punch List).
   1. 1 copy.
   2. Other items listed under Substantial Completion in Part 3.
D. Project Record Documents: Accurately record actual locations of capped and active utilities.

1.03 QUALIFICATIONS
A. For survey work, employ a land surveyor registered in the State in which the Project is located and acceptable to Architect. Submit evidence of Surveyor’s Errors and Omissions insurance coverage in the form of an Insurance Certificate to be kept on file in Contractor's office.

1.04 PROJECT CONDITIONS
A. Protect site from puddling or running water. Provide water barriers as required to protect site from soil erosion.
B. Ventilate enclosed areas to assist cure of materials, to dissipate humidity, and to prevent accumulation of dust, fumes, vapors, or gases.
C. Dust Control: Execute work by methods to minimize raising dust from construction operations. Provide positive means to prevent air-borne dust from dispersing into atmosphere and over adjacent property, as required by Authority Having Jurisdiction (AHJ).
D. Noise Control: Provide methods, means, and facilities to minimize noise produced by construction operations, as required by Authority Having Jurisdiction (AHJ).
E. Pest and Rodent Control: Provide methods, means, and facilities to prevent pests and insects from damaging the work.
F. Rodent Control: Provide methods, means, and facilities to prevent rodents from accessing or invading premises.
G. Pollution Control: Provide methods, means, and facilities to prevent contamination of soil, water, and atmosphere from discharge of noxious, toxic substances, and pollutants produced by construction operations. Comply with federal, state, and local regulations.
1.05 COORDINATION

A. Coordinate scheduling, submittals, and work of the various sections of the Project Manual to ensure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later.

B. Notify affected utility companies and comply with their requirements.

C. Verify that utility requirements and characteristics of new operating equipment are compatible with building utilities. Coordinate work of various sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.

D. Coordinate space requirements, supports, and installation of mechanical and electrical work that are indicated diagrammatically on Drawings. Follow routing shown for pipes, ducts, and conduit, as closely as practicable; place runs parallel with lines of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.

E. In finished areas except as otherwise indicated, conceal pipes, ducts, and wiring within the construction. Coordinate locations of fixtures and outlets with finish elements.

F. Coordinate completion and clean-up of work of separate sections.

G. After Owner occupancy of premises, coordinate access to site for correction of defective work and work not in accordance with Contract Documents, to minimize disruption of Owner's activities.

PART 2 PRODUCTS

2.01 PATCHING MATERIALS

A. New Materials: As specified in product sections; match existing products and work for patching and extending work.

B. Type and Quality of Existing Products: Determine by inspecting and testing products where necessary, referring to existing work as a standard.

C. Product Substitution: For any proposed change in materials, submit request for substitution described in Section 01 60 00.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that existing site conditions and substrate surfaces are acceptable for subsequent work. Start of work means acceptance of existing conditions.

B. Verify that existing substrate is capable of structural support or attachment of new work being applied or attached.

C. Examine and verify specific conditions described in individual specification sections.

D. Take field measurements before confirming product orders or beginning fabrication, to minimize waste due to over-ordering or misfabrication.

E. Verify that utility services are available, of the correct characteristics, and in the correct locations.

F. Prior to Cutting: Examine existing conditions prior to commencing work, including elements subject to damage or movement during cutting and patching. After uncovering existing work, assess conditions affecting performance of work. Beginning of cutting or patching means acceptance of existing conditions.

3.02 PREPARATION

A. Clean substrate surfaces prior to applying next material or substance.

B. Seal cracks or openings of substrate prior to applying next material or substance.

C. Apply manufacturer required or recommended substrate primer, sealer, or conditioner prior to applying any new material or substance in contact or bond.
3.03 LAYING OUT THE WORK

A. Verify locations of survey control points prior to starting work.
B. Promptly notify Architect of any discrepancies discovered.
C. Protect survey control points prior to starting site work; preserve permanent reference points during construction.
D. Promptly report to Architect the loss or destruction of any reference point or relocation required because of changes in grades or other reasons.
E. Replace dislocated survey control points based on original survey control. Make no changes without prior written notice to Architect.
F. Utilize recognized engineering survey practices.
G. Establish elevations, lines and levels. Locate and lay out by instrumentation and similar appropriate means:
   1. Site improvements including pavements; stakes for grading, fill and topsoil placement; utility locations, slopes, and invert elevations.
   2. Grid or axis for structures.
   3. Building foundation, column locations, ground floor elevations.
H. Periodically verify layouts by same means.
I. Maintain a complete and accurate log of control and survey work as it progresses.

3.04 GENERAL INSTALLATION REQUIREMENTS

A. Install products as specified in individual sections, in accordance with manufacturer's instructions and recommendations, and so as to avoid waste due to necessity for replacement.
B. Make vertical elements plumb and horizontal elements level, unless otherwise indicated.
C. Install equipment and fittings plumb and level, neatly aligned with adjacent vertical and horizontal lines, unless otherwise indicated.
D. Make consistent texture on surfaces, with seamless transitions, unless otherwise indicated.
E. Make neat transitions between different surfaces, maintaining texture and appearance.

3.05 CUTTING AND PATCHING

A. Whenever possible, execute the work by methods that avoid cutting or patching.
B. Perform whatever cutting and patching is necessary to:
   1. Complete the work.
   2. Fit products together to integrate with other work.
   3. Provide openings for penetration of mechanical, electrical, and other services.
   4. Match work that has been cut to adjacent work.
   5. Repair areas adjacent to cuts to required condition.
   6. Repair new work damaged by subsequent work.
   7. Remove samples of installed work for testing when requested.
   8. Remove and replace defective and non-conforming work.
C. Execute cutting and patching including excavation and fill to complete the work, to uncover work in order to install improperly sequenced work, to remove and replace defective or non-conforming work, to remove samples of installed work for testing when requested, to provide openings in the work for penetration of mechanical and electrical work, to execute patching to complement adjacent work, and to fit products together to integrate with other work.
D. Execute work by methods that avoid damage to other work and that will provide appropriate surfaces to receive patching and finishing. In existing work, minimize damage and restore to original condition.
E. Employ original installer to perform cutting for weather exposed and moisture resistant elements, and sight exposed surfaces.

F. Cut rigid materials using masonry saw or core drill. Pneumatic tools not allowed without prior approval.
   1. Do not overcut at corners of masonry, concrete, metals and similar rigid materials.

G. Restore work with new products in accordance with requirements of Contract Documents.

H. Fit work air tight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.

I. At penetrations of fire rated walls, partitions, ceiling, or floor construction, completely seal voids with fire rated material in accordance with Section 07 84 00, to full thickness of the penetrated element.

J. Patching:
   1. Finish patched surfaces to match finish that existed prior to patching. On continuous surfaces, refinish to nearest intersection or natural break. For an assembly, refinish entire unit.
   2. Match color, texture, and appearance.
   3. Repair patched surfaces that are damaged, lifted, discolored, or showing other imperfections due to patching work. If defects are due to condition of substrate, repair substrate prior to repairing finish.

K. Refinish surfaces to match adjacent finish. For continuous surfaces, refinish to nearest intersection or natural break. For an assembly, refinish entire unit.

L. Make neat transitions. Patch work to match adjacent work in texture and appearance. Where new work abuts or aligns with existing, perform a smooth and even transition.

3.06 PROGRESS CLEANING

A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in a clean and orderly condition.

B. Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces, and other closed or remote spaces, prior to enclosing the space.

C. Broom and vacuum clean interior areas prior to start of surface finishing, and continue cleaning to eliminate dust.

D. Collect and remove waste materials, debris, and trash/rubbish from site periodically and dispose off-site; do not burn or bury.

E. Daily Cleaning Requirements:
   1. Collect waste material which may constitute a fire hazard, place in closed metal containers, and remove daily from site.
   2. After cutting and boring, contractor is required to clean the space of all debris, water and concrete.
   3. Keep the premises free from accumulation of debris.
   4. Remove all debris, equipment, surplus materials and leave the premises in a neat and orderly condition at the completion of the work day.
   5. Clean all walks, streets, etc. affected by the work.

3.07 PROTECTION OF INSTALLED WORK

A. Protect installed work from damage by construction operations.

B. Provide special protection where specified in individual specification sections.

C. Provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.

D. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.
E. Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.

F. Prohibit traffic or storage upon waterproofed or roofed surfaces. If traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.

G. Remove protective coverings when no longer needed; reuse or recycle plastic coverings if possible.

3.08 SYSTEM STARTUP

A. Coordinate schedule for start-up of various equipment and systems.

B. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, and for conditions that may cause damage.

C. Verify tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.

D. Verify that wiring and support components for equipment are complete and tested.

E. Execute start-up under supervision of applicable Contractor personnel and manufacturer’s representative in accordance with manufacturers’ instructions.

F. Submit a written report that equipment or system has been properly installed and is functioning correctly.

3.09 DEMONSTRATION AND INSTRUCTION

A. Demonstrate operation and maintenance of products to Owner’s personnel two weeks prior to date of Substantial Completion.

B. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment at scheduled time, at equipment location.

1. Training & demonstration session of overview for all trades and response groups.

2. In depth training and demonstration session for maintenance, technician, and service personnel. shall be to a maintenance technician, and/or service levels for all systems.

3. Required hours will be listed in following standards.

C. For equipment or systems requiring seasonal operation, perform demonstration for other season within six months.

D. Provide a qualified person who is knowledgeable about the Project to perform demonstration and instruction of owner personnel.

E. Utilize operation and maintenance manuals as basis for instruction. Review contents of manual with Owner’s personnel in detail to explain all aspects of operation and maintenance.

F. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.

3.10 ADJUSTING

A. Adjust operating products and equipment to ensure smooth and unhindered operation.

3.11 FINAL CLEANING

A. Execute final cleaning prior to Substantial Completion.

B. Use cleaning materials that are nonhazardous and will not damage the Work.

C. Clean interior and exterior glass, surfaces exposed to view; remove temporary labels, stains and foreign substances, polish transparent and glossy surfaces, vacuum carpeted and soft surfaces.

D. Remove all labels that are not permanent. Do not paint or otherwise cover fire test labels or nameplates on mechanical and electrical equipment.
E. Clean equipment and fixtures to a sanitary condition with cleaning materials appropriate to the surface and material being cleaned.

F. Clean filters of operating equipment.

G. Clean debris from roofs, gutters, downspouts, and drainage systems.

H. Clean site; sweep paved areas, rake clean landscaped surfaces.

I. Remove waste, surplus materials, trash/rubbish, and construction facilities from the site; dispose of in legal manner; do not burn or bury.

J. See also Divisions 31 and 32 for landscape restoration requirements.

K. Special cleaning for specific work may be noted in following sections of this document.

L. Comply with manufacturer’s instructions for cleaning of all system components, equipment, and materials installed into the project.

M. Prior to the time the Contractor requests Substantial Completion Inspection:
   1. Remove labels that are not required as permanent labels.
   2. Clean exposed hard-surfaced finishes including glass, metals, stone, concrete, painted surfaces, plastics, tile, wood, special coatings, and similar surfaces, to a dirt free condition, free of dust, stains, films, and similar noticeable distracting substances.
   4. Clean lighting fixtures and lamps of all dust and debris.
   5. Remove crates, cartons, and other flammable waste materials or trash from work areas. Building(s) shall be turned over free of concealed garbage, trash, and rodent infestation. If any of the preceding is revealed, or odors from them occur, they shall be removed by the Contractor at Contractor’s expense.
   6. Restore all surrounding property to its original condition.
   7. Elevator shafts, electric closets, pipe, and duct shafts, chases, furred spaces, and similar spaces which are generally unfurnished, shall be cleaned and left free from rubbish, loose plaster, mortar drippings, extraneous construction materials, dirt, and dust.
   8. Rubbish and debris shall be lowered by way of chutes, hoists, or lowered in receptacles. Under no circumstances shall any rubbish or waste be dropped or thrown from one level to another within or outside the building(s).
   9. No marking, soiling, or other defacing of finished surfaces. In the event that finished surfaces become defaced, all costs for cleaning and restoring such surfaces to their originally intended condition shall be the responsibility and cost of the Contractor.
   10. Remove debris from and clean tops of all equipment, AHU, lights, etc. This includes mechanical rooms.

N. Prior to Contractor request of Final Acceptance Inspection:
   1. Clean transparent materials, including mirrors and window or door glass, to a polished condition, removing substances that are noticeable as vision-obscuring materials.
   2. Turn the work over in immaculate condition inside and outside including the premises.
   3. Clean all work on the premises including walks, drives, curbs, paving, fences, grounds, and walls. Slick surfaces shall be left with a clear shine. Cleanup shall include removal of smudges, marks, stains, fingerprints, soil, dirt, paint, dust, lint, labels, discolorations, and other foreign materials.
   4. Clean all finished surfaces on interior and exterior of project including floors, walls, ceilings, windows, glass, doors, fixtures, hardware, and equipment.
   5. Clean and apply finish (including ‘Anchor’ wax) to all floors as recommended by the manufacturer.
   6. Wash exterior glass using a window-cleaning contractor specializing in such work.
7. Remove temporary buildings and structures, fences, scaffolding, surplus materials, and rubbish of every kind from the site of the work. Repair these areas to be compatible with the surrounding finished conditions.

8. Clean tops of all equipment, AHU, lights, etc. This includes mechanical rooms.

9. Construction Waste Management, see Section 01 74 19.

3.12 CLOSEOUT PROCEDURES

A. Make submittals that are required by governing or other authorities.
   1. Provide copies to Architect.

B. Notify Architect when work is considered ready for Substantial Completion.

C. Substantial Completion: Submit written statement that Contract Documents have been reviewed, work has been inspected, and that work is complete in accordance with Contract Documents and ready for Architect's review.
   1. Prepare a list of items to be completed and corrected (punch list), the value of items on the list, and reasons why the Work is not complete.
      a. Organize list of spaces in sequential order, starting with exterior areas first and proceeding from lowest floor to highest floor.
      b. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
      c. Include the following information at the top of each page: Project name; Date; Name of Architect; Name of Contractor; Page number.
   2. Advise Owner of pending insurance changeover requirements.
   3. Submit specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
   4. Obtain and submit releases permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
   5. Prepare and submit Project Record Documents, operation and maintenance manuals, Final Completion construction digital photographs, damage or settlement surveys, property surveys, and similar final record information.
   6. Deliver tools, spare parts, extra materials, and similar items to location designated by Owner. Label with manufacturer's name and model number where applicable.
   7. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
   8. Complete startup testing of systems.
   10. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
   11. Advise Owner of changeover in heat and other utilities.
   12. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
   13. Complete final cleaning requirements, including touchup painting.
   14. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.

D. Certificate of Substantial Completion: On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Architect, that must be completed or corrected before certificate will be issued.
   1. Request re-inspection when the Work identified in previous inspections as incomplete is completed or corrected.
   2. Re-inspection is Extraordinary Contract Administration Service, Section 01 20 00.
3. Results of completed inspection will form the basis of requirement for Final Completion.

E. Correct items of work listed in executed Certificates of Substantial Completion and comply with requirements for access to Owner-occupied areas.

F. Notify Architect when work is ready for Final Completion.
   1. Submit certified copy of Architect's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
   2. Submit evidence of final, continuing insurance coverage complying with insurance requirements.
   3. Submit pest-control final inspection report and warranty.
   4. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems.
   5. Submit demonstration and training videotapes.

G. Final Completion: On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will certify a final Certificate for Payment after inspection or will notify Contractor of work that must be completed or corrected before certificate will be issued.

H. Complete items of work determined by Architect's final inspection.
   1. Request re-inspection when the Work identified in previous inspections as incomplete is completed or corrected.
   2. Re-inspection is Extraordinary Contract Administration Service, Section 01 20 00.

END OF SECTION
PART 1 GENERAL

1.01 WASTE MANAGEMENT REQUIREMENTS

A. Owner requires that this project generate the least amount of trash and waste possible.

B. Salvage and Recycling Requirements: Our goal is to salvage and recycle as much non-hazardous demolition and construction waste as possible including any demolition and/or construction waste.

C. Employ processes that ensure the generation of as little waste as possible due to error, poor planning, breakage, mishandling, contamination, or other factors.

D. Minimize trash/waste disposal in landfills; reuse, salvage, or recycle as much waste as economically feasible.

E. Required Recycling, Salvage, and Reuse: The following may not be disposed of in landfills or by incineration:
   1. Aluminum and plastic beverage containers.
   2. Corrugated cardboard.
   3. Wood pallets.
   4. Clean dimensional wood: May be used as blocking or furring.
   5. Land clearing debris, including brush, branches, logs, and stumps: See Section 31 10 00 for use options.
   6. Concrete: May be crushed and used as riprap, aggregate, sub-base material, or fill.
   7. Bricks: May be used on project if whole, or crushed and used as landscape cover, sub-base material, or fill.
   8. Concrete masonry units: May be used on project if whole, or crushed and used as sub-base material or fill.
   9. Asphalt paving: May be recycled into paving for project.
   10. Metals, including packaging banding, metal studs, sheet metal, structural steel, piping, reinforcing bars, door frames, and other items made of steel, iron, galvanized steel, stainless steel, aluminum, copper, zinc, lead, brass, and bronze.
   11. Glass.
   12. Gypsum drywall and plaster.
   14. Carpet, carpet cushion, carpet tile, and carpet remnants, both new and removed: DuPont (http://flooring.dupont.com) and Interface (www.interfaceinc.com) conduct reclamation programs.
   15. Asphalt roofing shingles.
   16. Paint.
   17. Plastic sheeting.
   18. Rigid foam insulation.
   19. Windows, doors, and door hardware.
   20. Plumbing fixtures.
   21. Mechanical and electrical equipment.
   22. Fluorescent lamps (light bulbs).
   23. Acoustical ceiling tile and panels.

F. Owner requires that 95 percent, by weight, of potential landfill trash/waste is diverted by recycling or salvage.

G. Contractor shall submit periodic Waste Disposal Reports; all landfill disposal, recycling, salvage, and reuse must be reported regardless of to whom the cost or savings accrues; use the same units of measure on all reports.

H. Contractor shall develop and follow a Waste Management Plan designed to implement these requirements.
I. The following sources may be useful in developing the Waste Management Plan:
   2. State DEQ Commercial Waste Reduction Clearinghouse, at www.deq.state.or.us/wmc/cwrc.

J. Methods of trash/waste disposal that are not acceptable are:
   1. Burning on the project site.
   2. Burying on the project site.
   3. Dumping or burying on other property, public or private.
   4. Other illegal dumping or burying.
   5. Incineration, either on- or off-site.

K. Regulatory Requirements: Contractor is responsible for knowing and complying with regulatory requirements, including but not limited to Federal, state and local requirements, pertaining to legal disposal of all construction and demolition waste materials.

1.02 RELATED REQUIREMENTS

   A. Section 01 30 00 - Administrative Requirements: Additional requirements for project meetings, reports, submittal procedures, and project documentation.
   B. Section 01 50 00 - Temporary Facilities and Controls: Additional requirements related to trash/waste collection and removal facilities and services.
   C. Section 01 60 00 - Product Requirements: Waste prevention requirements related to delivery, storage, and handling.
   D. Section 01 70 00 - Execution and Closeout Requirements: Trash/waste prevention procedures related to demolition, cutting and patching, installation, protection, and cleaning.
   E. Section 31 10 00 - Site Clearing: Handling and disposal of land clearing debris.

1.03 DEFINITIONS

   A. Clean: Untreated and unpainted; not contaminated with oils, solvents, caulk, or the like.
   B. Construction and Demolition Waste: Solid wastes typically including building materials, packaging, trash, debris, and rubble resulting from construction, remodeling, repair and demolition operations.
   C. Hazardous: Exhibiting the characteristics of hazardous substances, i.e., ignitibility, corrosivity, toxicity or reactivity.
   D. Material Recovery Facility: Waste sorting facility where commingled materials are accepted and recovered for recycling or salvage.
   E. Nonhazardous: Exhibiting none of the characteristics of hazardous substances, i.e., ignitibility, corrosivity, toxicity, or reactivity.
   F. Nontoxic: Neither immediately poisonous to humans nor poisonous after a long period of exposure.
   G. Recyclable: The ability of a product or material to be recovered at the end of its life cycle and remanufactured into a new product for reuse by others.
   H. Recycle: To remove a waste material from the project site to another site for remanufacture into a new product for reuse by others.
   I. Recycling: The process of sorting, cleansing, treating and reconstituting solid waste and other discarded materials for the purpose of using the altered form. Recycling does not include burning, incinerating, or thermally destroying waste.
   J. Return: To give back reusable items or unused products to vendors for credit.
   K. Reuse: To reuse a construction waste material in some manner on the project site.
L. Salvage: To remove a waste material from the project site to another site for resale or reuse by others.

M. Sediment: Soil and other debris that has been eroded and transported by storm or well production run-off water.

N. Source Separation: The act of keeping different types of waste materials separate beginning from the first time they become waste.

O. Toxic: Poisonous to humans either immediately or after a long period of exposure.

P. Trash: Any product or material unable to be reused, returned, recycled, or salvaged.

Q. Waste: Extra material or material that has reached the end of its useful life in its intended use. Waste includes salvageable, returnable, recyclable, and reusable material.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Recycling Plan: Prior to preparation of the Waste Management Plan, submit the recycling plan to the PM and Architect for approval.

C. Submit Waste Management Plan within 10 calendar days after receipt of Notice of Award of Bid, or prior to any trash or waste removal, whichever occurs sooner; submit projection of all trash and waste that will require disposal and alternatives to landfilling.

D. Waste Management Plan: Include the following information:
   1. Analysis of the trash and waste projected to be generated during the entire project construction cycle, including types and quantities.
   2. Landfill Options: The name, address, and telephone number of the landfill(s) where trash/waste will be disposed of, the applicable landfill tipping fee(s), and the projected cost of disposing of all project trash/waste in the landfill(s).
   3. Landfill Alternatives: List all waste materials that will be diverted from landfills by reuse, salvage, or recycling.
   4. Meetings: Describe regular meetings to be held to address waste prevention, reduction, recycling, salvage, reuse, and disposal.
   5. Materials Handling Procedures: Describe the means by which materials to be diverted from landfills will be protected from contamination and prepared for acceptance by designated facilities; include separation procedures for recyclables, storage, and packaging.
   6. Transportation: Identify the destination and means of transportation of materials to be recycled; i.e. whether materials will be site-separated and self-hauled to designated centers, or whether mixed materials will be collected by a waste hauler.

E. Waste Disposal Reports: Submit at specified intervals, with details of quantities of trash and waste, means of disposal or reuse, and costs; show both totals to date and since last report.
   1. Submit updated Report with each Application for Progress Payment; failure to submit Report will delay payment.
   2. Submit Report on a form acceptable to Owner.
   3. Landfill Disposal: Include the following information:
      a. Identification of material.
      b. Amount, in tons or cubic yards, of trash/waste material from the project disposed of in landfills.
      c. State the identity of landfills, total amount of tipping fees paid to landfill, and total disposal cost.
      d. Include manifests, weight tickets, receipts, and invoices as evidence of quantity and cost.
      e. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.
4. Recycled and Salvaged Materials: Include the following information for each:
   a. Identification of material, including those retrieved by installer for use on other projects.
   b. Amount, in tons or cubic yards, date removed from the project site, and receiving party.
   c. Transportation cost, amount paid or received for the material, and the net total cost or savings of salvage or recycling each material.
   d. Include manifests, weight tickets, receipts, and invoices as evidence of quantity and cost.
   e. Certification by receiving party that materials will not be disposed of in landfills or by incineration.
   f. Waste Reduction Calculations: Before request for Substantial Completion, submit three copies of calculated end-of-Project rates for salvage, recycling, and disposal as a percentage of total waste in weight generated by the Work.
   g. Recycling and Processing Facility Records: Indicate receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices. Include documentation for back-charge fees (if any) for improperly segregated waste.

5. Material Reused on Project: Include the following information for each:
   a. Identification of material and how it was used in the project.
   b. Amount, in tons or cubic yards.
   c. Include weight tickets as evidence of quantity.

6. Other Disposal Methods: Include information similar to that described above, as appropriate to disposal method.

F. LEED Credit MR 2: Plan and documentation for Construction Waste Management. Comply with Section 01 35 15.

G. Donation Record Keeping: Indicate receipt and acceptance of salvageable waste donated to individuals and organizations. Indicate whether or not the organization is tax exempt.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 WASTE MANAGEMENT PROCEDURES

   A. See Section 01 30 00 for additional requirements for project meetings, reports, submittal procedures, and project documentation.

   B. See Section 01 60 00 for waste prevention requirements related to delivery, storage, and handling.

3.02 WASTE MANAGEMENT PLAN IMPLEMENTATION

   A. Manager: Designate an on-site person or persons responsible for instructing workers and overseeing and documenting results of the Waste Management Plan.

   B. Communication: Distribute copies of the Waste Management Plan to job site foreman, each subcontractor, Owner, and Architect.

   C. Instruction: Provide on-site instruction of appropriate separation, handling, and recycling, salvage, reuse, and return methods to be used by all parties at the appropriate stages of the project.

   D. Meetings: Discuss trash/waste management goals and issues at project meetings.
      1. Pre-bid meeting.
      2. Pre-construction meeting.
      3. Regular job-site meetings.

   E. Facilities: Provide specific facilities for separation and storage of materials for recycling, salvage, reuse, return, and trash disposal, for use by all contractors and installers.
1. As a minimum, provide:
   a. Separate area for storage of materials to be reused on-site, such as wood cut-offs for blocking.
   b. Separate dumpsters for each category of recyclable.
   c. Recycling bins at worker lunch area.
2. Label containers and areas with durable, weather-resistant signs. Use clear simple language. Use multiple languages spoken at Project Site.
3. Provide containers as required.
4. Provide adequate space for pick-up and delivery and convenience to subcontractors.
5. Keep recycling and trash/waste bin areas neat and clean and clearly marked in order to avoid contamination of materials.
6. Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
   a. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged, recycled, reused, donated, and sold.
   b. Comply with project requirements for controlling dust and dirt, environmental protection, and noise control.
F. Alternative to Site Separation: Material Recovery Facility that provides specified documentation is acceptable in lieu of source-separated recycling facilities.
G. Hazardous Wastes: Separate, store, and dispose of hazardous wastes according to applicable regulations.
H. Recycling: Separate, store, protect, and handle at the site identified recyclable waste products in order to prevent contamination of materials and to maximize recyclability of identified materials. Arrange for timely pickups from the site or deliveries to recycling facility in order to prevent contamination of recyclable materials.
I. Reuse of Materials On-Site: Set aside, sort, and protect separated products in preparation for reuse.
J. Salvage: Set aside, sort, and protect products to be salvaged for reuse off-site.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Project Record Documents.
B. Operation and Maintenance Manuals.

1.02 RELATED REQUIREMENTS

A. Section 01 30 00 - Administrative Requirements: Submittals procedures, shop drawings, product data, and samples.
B. Individual Product Sections: Specific requirements for operation and maintenance data.
C. Individual Product Sections: Warranties required for specific products or Work.

1.03 SUBMITTALS

A. Project Record Documents: Submit documents to Architect with claim for final Application for Payment.
B. Operation and Maintenance Data:
   1. Submit one copy of preliminary manual before 75% of Work is complete. Include table of contents, outline contents of each section, and at least one typical finish section complete, and one equipment section complete. Architect will review preliminary and return one copy with comments.
      a. Applications for payment equal to and greater than 75% will not be certified until preliminary manual is submitted.
   2. For equipment, or component parts of equipment put into service during construction and operated by Owner, submit completed documents within ten days after acceptance.
   3. Submit 1 copy of completed documents 15 days prior to Substantial Completion. This copy will be reviewed and returned, with Architect comments. Revise content of all document sets as required prior to final submission.
   4. Submit two sets of revised final documents in final form within 10 days after request for final payment or request for final inspection, whichever is first.
C. Warranties and Bonds:
   1. For equipment or component parts of equipment put into service during construction with Owner's permission, submit documents within 10 days after acceptance.
   2. Make other submittals within 10 days after Date of Substantial Completion, prior to final Application for Payment.
   3. Items of Work for which acceptance is delayed beyond Date of Substantial Completion, submit within 10 days after acceptance, listing the date of acceptance as the beginning of the warranty period.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 PROJECT RECORD DOCUMENTS

A. Maintain on site one set of the following record documents; record actual revisions to the Work:
   1. Drawings.
   2. Specifications.
   3. Addenda.
   4. Change Orders and other modifications to the Contract.
   5. Reviewed shop drawings, product data, and samples.
B. Ensure entries are complete and accurate, enabling future reference by Owner.
C. Store record documents separate from documents used for construction.
D. Record information concurrent with construction progress.
   1. Review current information with Architect prior to each Application for Payment. This is a condition for payment. See Section 01200

E. Specifications: Legibly mark and record at each product section description of actual products installed, including the following:
   1. Changes made by Addenda and modifications.

F. Record Drawings and Shop Drawings: Legibly mark each item to record actual construction including:
   1. Measured depths of foundations in relation to finish first floor datum.
   2. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
   3. Field changes of dimension and detail.
   4. Details not on original Contract drawings.

G. Commissioning Closeout Documentation: Provide commissioning closeout documentation and/or verification not included in the O&M manuals or as-built documentation.
   1. This information is intended to be a consolidation of documentation and verification for the project commissioning and closeout process.
   2. Include documentation of training of FS personnel regarding operation of particular systems. Such documentation shall include identification of parties receiving training and date(s) of training.

H. General Contractor As-Built document requirements / deliverables at project closeout: With all the following listed items, give particular attention to concealed products and portions of the work that are not clearly identified in the original submittal or cannot otherwise be readily discerned at a later date by direct observation.
   1. Original permit set of documents with sign off of inspections. Contractor should make copies of these sign offs for their records.
   2. 1 complete full-size, reproducible drawing sets on bond paper.
   3. 1 complete set of as-built specifications.
   4. 1 complete reproducible CD of as-built drawings and specifications in ‘pdf’ file format.
   5. 1 complete full-size reproducible drawing & specification set of Contractor’s red-lines on bond paper.
   6. Complete digital set of all construction photographs by Contractor.

3.02 OPERATION AND MAINTENANCE DATA - GENERAL

A. For Each Product or System: List names, addresses and telephone numbers of Subcontractors and suppliers, including local source of supplies and replacement parts.

B. Product Data: Mark each sheet to clearly identify specific products and component parts, and data applicable to installation. Delete inapplicable information.

C. Drawings: Supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams. Do not use Project Record Documents as maintenance drawings.

D. Typed Text: As required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions.

3.03 OPERATION AND MAINTENANCE DATA FOR MATERIALS AND FINISHES

A. For Each Product, Applied Material, and Finish:
   1. Product data, with catalog number, size, composition, and color and texture designations.
   2. Information for re-ordering custom manufactured products.

B. Instructions for Care and Maintenance: Manufacturer's recommendations for cleaning agents and methods, precautions against detrimental cleaning agents and methods, and recommended schedule for cleaning and maintenance.
3.04 OPERATION AND MAINTENANCE DATA FOR EQUIPMENT AND SYSTEMS

A. For Each Item of Equipment and Each System:
   1. Description of unit or system, and component parts.
   2. Identify function, normal operating characteristics, and limiting conditions.
   3. Include performance curves, with engineering data and tests.
   4. Complete nomenclature and model number of replaceable parts.

B. Operating Procedures: Include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions. Include summer, winter, and any special operating instructions.

C. Maintenance Requirements: Include routine procedures and guide for preventative maintenance and trouble shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.

D. Provide servicing and lubrication schedule, and list of lubricants required.

E. Include manufacturer's printed operation and maintenance instructions.

F. Include sequence of operation by controls manufacturer.

G. Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.

H. Additional Requirements: As specified in individual product specification sections.

3.05 ASSEMBLING OPERATION AND MAINTENANCE MANUALS

A. Prepare instructions and data by personnel experienced in maintenance and operation of described products.

B. Prepare data in the form of an instructional manual.

C. Binders: Commercial quality, 8-1/2 by 11 inch three D side ring binders with durable plastic covers; 2 inch maximum ring size. When multiple binders are used, correlate data into related consistent groupings.
   1. Multiple Volumes: Divide O & M information logically following CSI MasterFormat when more than one binder is necessary.
   2. Subtitle binders by Volume Number and CSI sub group title or CSI division title as appropriate.

D. Cover: Identify each binder with printed title OPERATION AND MAINTENANCE INSTRUCTIONS; identify title of Project; identify Subtitle appropriate for subject matter of contents, Month and Year of Substantial Completion.

E. Table of Contents: Project name on each page; list products and systems included in Volume, indexed by CSI Section number.

F. Information Page: Project name; names, addresses, and telephone numbers of Architect, Consultants, and Contractor with name of responsible parties; date of substantial completion.

G. Index of Products: Table that can be sorted by word processor or spreadsheet; printed and digital formats; include product information under the following column headings:
   1. Product Name
   2. Manufacturer
   3. Model number
   4. O&M Volume Number
   5. Section Number

H. Arrange content by systems under Section numbers and sequence of Table of Contents of this Project Manual.

I. Provide tabbed dividers for each separate product or system, with Specification Section number and product name.
CLOSEOUT SUBMITTALS

1. Product Summary: On divider page or a separate first page indicate Specification Section number and title, product or system name, manufacturer, model, major components, supplier and installer information.

J. Text: Manufacturer's printed or typewritten information on 20 pound paper.

K. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.

L. Elevator Operation and Maintenance Manual: Submit an additional copy of information for elevator in a separate manual, formatted similar to primary manual. This Manual will be kept in Elevator Machine Room.
   1. When Project includes more than one Elevator Machine Room, provide separate manuals with information for elevators served by that machine room.

M. Operation and Maintenance Manuals:
   1. 2 complete physical hard copies of ALL listed items.
   2. 1 complete reproducible CD of ALL listed items in ‘pdf’ file format.
   3. ALL part numbers of manufacturers and suppliers.
   4. Total quantities installed under the contract.
   5. Manufacturer and supplier names and addresses.
   6. Complete manufacturer’s serial number(s) or other identity symbol(s).
   7. Parts lists that clearly identify every part in the item of equipment with the proper manufacturer’s name, part nomenclature and number, local source, and list price.
   8. Draw-downs of all finish paint used.
   9. Recommended Spare Parts:
      a. Furnish a list of recommended spare parts for each equipment item that will be needed to support that item of equipment for a 12-month period.
      b. The quantities of spare parts recommended shall be based upon the quantity of like equipment items installed under the contract.
      c. Storage shelf life of part, in months, if the part has a limited life.
      d. Recommended quantity of part(s) to inventory and support the installed quantity of equipment in which the part appears for a period of 12 months.
      e. Name, address, and phone number of the nearest supplier for the part.
   10. Normal Operating Instructions: Provide sufficient information that will permit a journeyman mechanic to adjust, startup, operate, and shutdown the equipment. Special startup precautions and other action items required before the equipment is put into service must be noted.
   11. Emergency Operating Procedures: Detail description of the sequence of action to be taken in the event of a malfunction, either to permit a short period of continued operation or an emergency shutdown to prevent further damage to the unit and to the system.
   12. Preventative Maintenance: Detail information to cover routine and special inspection requirements, including field adjustments, inspections for wear, adjustment changes, packing wear, lubrication points, frequency and specific lubrication type required, cleaning of the unit, type of solvent to use, and other measures applicable.
   13. Calibration: Detailed data on what to calibrate, how to calibrate, when to calibrate, and procedures to enable checking the equipment for reliability; provide indications and data for test equipment, special tools and the location of test points.
   n. Scale and Corrosion Control: Detailed information for prevention and removal of scale and corrosion.
   14. Trouble Shooting Procedures: Detailed information and procedures for detecting and isolating malfunctions; provide detailed information concerning probable causes and applicable remedies.
   15. Removal and Installation Instructions: Detailed information concerning the logical sequence of steps required to remove and install the item including instructions for the use of special tools and equipment.
16. Disassembly and Assembly Instructions: Detailed illustrations and text to show the logical procedure and provide the instructions necessary to disassemble and assemble the unit properly. The text shall include all checks and special precautions and list the use of special tools and equipment required to perform the assembly or disassembly.

17. Repair Instructions: Detailed repair procedures to bring the equipment up to the required operating standard including instruction for examining equipment and parts for needed repairs and adjustments, and tests or inspections required to determine whether old parts may be reused or must be replaced.

18. System Drawings: Detailed drawings, where applicable, that clearly show wiring diagrams, control diagrams, system schematics, pneumatic and fluid flow diagrams, etc., which pertain to the unit function. Drawings are required to show modifications to another manufacturer’s standard unit which is incorporated into the assembly or packaged unit.
   a. The Contractor shall provide diagrammatic drawings for each installed system, which shall show the placement of the system in relation to the building, and the physical location of each item or equipment installed within the system. Each installed item of equipment shown on the drawing will be identified by the equipment item model and/or serial/part number.

19. Special Tools and Test Equipment: Furnish a detailed list of the special tools and test equipment needed to perform repair and maintenance for each equipment item. The list shall contain the special tool and test equipment part number, size, quantity, price, manufacturer’s name and address, and local supplier’s name and address.

20. Warranties and Guarantees: Within each tabbed section of the O&M, include an executed copy of the specified warranty/guarantee covering the particular system, equipment item, or material.
   a. This is to include both the manufacturer’s warranty and the installing contractor’s guarantee for workmanship and system operation. This copy of the particular warranty/guarantee is in addition to the original signed copies that are to be bound together separately.
   b. Provide a separate binder containing all original project warranties and guarantees.

21. Field records on excavations, foundations, underground construction, wells, and similar work; if not already included in as-built drawings / documentation.

22. Accurate survey showing locations and elevations of underground lines, including invert elevations of drainage piping; if not already included in as-built drawings / documentation.

23. Surveys establishing lines and levels of buildings; if not already included in as-built drawings / documentation.

24. Load and/or performance testing.

25. Final inspection and deficiency corrections.

26. Prior to date of substantial completion the Architect and PM shall determine which (if any) samples or mock-ups are to be transmitted to the PM for record purposes.

27. With all the above listed items, give particular attention to concealed products and portions of the work that are not clearly identified in the original submittal or cannot otherwise be readily discerned at a later date by direct observation.

3.06 WARRANTIES AND BONDS MANUAL

A. Obtain warranties and bonds, executed in duplicate by responsible Subcontractors, suppliers, and manufacturers, within 10 days after completion of the applicable item of work. Except for items put into use with Owner’s permission, leave date of beginning of time of warranty until the Date of Substantial completion is determined.

1. Always provide, at a minimum, the responsible Subcontractor’s, supplier’s and manufacturer’s standard product warranty unless noted otherwise in the individual specification sections.

2. All listed manufacturers and all listed installers through the act of submitting a bid are confirming obligatory responsibility for providing an equal quantity and equal quality...
warranty to the design basis warranties listed, unless individual specification sections note otherwise.

3. Minimum warranty for all material and workmanship, building envelope and penetration components excluded per above noted ORS, for a minimum of 1-year after date of substantial completion OR for the extended period of time determined by manufacturer’s guarantee.

4. Extended warranties may be required for specific items as noted in the following document.

5. Correct immediately any failure caused by poor material or workmanship during warranty period; within 72 hours of notice.

6. If the PM or FS personnel are required to proceed with repairs, the responsible party of the warranty will be billed for costs and damages when failing to comply.

B. Verify that documents are in proper form, contain full information, and are notarized.

C. Co-execute submittals when required.

D. Retain warranties and bonds until time specified for submittal.

E. Manual: Bind in commercial quality 8-1/2 by 11 inch three D side ring binders with durable plastic covers.

F. Cover: Identify each binder with typed or printed title WARRANTIES AND BONDS, with title of Project; name, address and telephone number of Contractor and equipment supplier; and name of responsible company principal.

1. Do not include "And Bonds" when Project does not include bonds.

G. Table of Contents: Neatly typed, in the sequence of the Table of Contents of the Project Manual, with each item identified with the number and title of the specification section in which specified, and the name of product or work item.

H. Separate each warranty or bond with index tab sheets keyed to the Table of Contents listing. Provide full information, using separate typed sheets as necessary. List Subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal.

3.07 MAINTENANCE MATERIALS

A. Closeout delivery of any and all closeout and/or overstock items to the PM requires formal transmittals for project records; including O&M manuals, extra materials, custom finish knives, etc.

b. See Section 01 60 00 for additional requirements.

END OF SECTION
PART 1 GENERAL

1.01 SUMMARY

A. Commissioning is intended to achieve the following specific objectives; this section specifies the Contractor's responsibilities for commissioning:

1. Verify that the work is installed in accordance with the Contract Documents and the manufacturer’s recommendations and instructions, and that it receives adequate operational checkout prior to startup: Startup reports and Prefunctional Checklists executed by Contractor are utilized to achieve this.

2. Verify and document that functional performance is in accordance with the Contract Documents: Functional Tests executed by Contractor and witnessed by the Commissioning Authority are utilized to achieve this.

3. Verify that operation and maintenance manuals submitted to Owner are complete: Detailed operation and maintenance (O&M) data submittals by Contractor are utilized to achieve this.

4. Verify that the Owner’s operating personnel are adequately trained: Formal training conducted by Contractor is utilized to achieve this.

B. The Commissioning Authority directs and coordinates all commissioning activities; this section describes some but not all of the Commissioning Authority’s responsibilities.

C. The Commissioning Authority is employed by Owner.

1.02 SCOPE OF COMMISSIONING

A. The following are to be commissioned:

B. Plumbing Systems:

C. HVAC System:

D. Special Ventilation:

E. Electrical Systems:

F. Electronic Safety and Security:

G. Communications:

H. Other equipment and systems explicitly identified elsewhere in Contract Documents as requiring commissioning.

1.03 RELATED REQUIREMENTS

A. Section 01 78 00 - Closeout Submittals: Scope and procedures for operation and maintenance manuals and project record documents.

1.04 REFERENCE STANDARDS

1.05 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures; except:

1. Make all submittals specified in this section, and elsewhere where indicated for commissioning purposes, directly to the Commissioning Authority, unless they require review by Architect; in that case, submit to Architect first.

2. Submit one copy to the Commissioning Authority, not to be returned.

3. Make commissioning submittals on time schedule specified by Commissioning Authority.

4. Submittals indicated as "Draft" are intended for the use of the Commissioning Authority in preparation of Prefunctional Checklists or Functional Test requirements; submit in editable electronic format, Microsoft Word 2003 preferred.

5. As soon as possible after submittals made to Architect are approved, submit copy of approved submittal to the Commissioning Authority.
B. Manufacturers' Instructions: Submit copies of all manufacturer-provided instructions that are shipped with the equipment as soon as the equipment is delivered.

C. Product Data: If submittals to Architect do not include the following, submit copies as soon as possible:
   1. Manufacturer's product data, cut sheets, and shop drawings.
   2. Manufacturer's installation instructions.
   3. Startup, operating, and troubleshooting procedures.
   4. Fan and pump curves.
   5. Factory test reports.
   6. Warranty information, including details of Owner's responsibilities in regard to keeping warranties in force.

D. Startup Plans and Reports.

E. Completed Prefunctional Checklists.

PART 2 PRODUCTS

2.01 TEST EQUIPMENT

A. Provide all standard testing equipment required to perform startup and initial checkout and required Functional Testing; unless otherwise noted such testing equipment will NOT become the property of Owner.

B. Calibration Tolerances: Provide testing equipment of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified. If not otherwise noted, the following minimum requirements apply:
   1. Temperature Sensors and Digital Thermometers: Certified calibration within past year to accuracy of 0.5 degree F and resolution of plus/minus 0.1 degree F.
   2. Pressure Sensors: Accuracy of plus/minus 2.0 percent of the value range being measured (not full range of meter), calibrated within the last year.
   3. Calibration: According to the manufacturer's recommended intervals and when dropped or damaged; affix calibration tags or keep certificates readily available for inspection.

C. Equipment-Specific Tools: Where special testing equipment, tools and instruments are specific to a piece of equipment, are only available from the vendor, and are required in order to accomplish startup or Functional Testing, provide such equipment, tools, and instruments as part of the work at no extra cost to Owner; such equipment, tools, and instruments are to become the property of Owner.

D. Dataloggers: Independent equipment and software for monitoring flows, currents, status, pressures, etc. of equipment.
   1. Dataloggers required to for Functional Tests will be provided by the Commissioning Authority and will not become the property of Owner.

PART 3 EXECUTION

3.01 COMMISSIONING PLAN

A. Commissioning Authority has prepared the Commissioning Plan.
   1. Attend meetings called by the Commissioning Authority for purposes of completing the commissioning plan.
   2. Require attendance and participation of relevant subcontractors, installers, suppliers, and manufacturer representatives.

B. Contractor is responsible for compliance with the Commissioning Plan.

C. Commissioning Plan: The commissioning schedule, procedures, and coordination requirements for all parties in the commissioning process.

D. Commissioning Schedule:
GENERAL COMMISSIONING REQUIREMENTS

1. Submit anticipated dates of startup of each item of equipment and system to Commissioning Authority within 60 days after award of Contract.
2. Re-submit anticipated startup dates monthly, but not less than 4 weeks prior to startup.
3. Prefunctional Checklists and Functional Tests are to be performed in sequence from components, to subsystems, to systems.
4. Provide sufficient notice to Commissioning Authority for delivery of relevant Checklists and Functional Test procedures, to avoid delay.

3.02 STARTUP PLANS AND REPORTS

A. Startup Plans: For each item of equipment and system for which the manufacturer provides a startup plan, submit the plan not less than 8 weeks prior to startup.

B. Startup Reports: For each item of equipment and system for which the manufacturer provides a startup checklist (or startup plan or field checkout sheet), document compliance by submitting the completed startup checklist prior to startup, signed and dated by responsible entity.

C. Submit directly to the Commissioning Authority.

3.03 PREFUNCTIONAL CHECKLISTS

A. A Prefunctional Checklist is required to be filled out for each item of equipment or other assembly specified to be commissioned.
   1. No sampling of identical or near-identical items is allowed.
   2. These checklists do not replace manufacturers’ recommended startup checklists, regardless of apparent redundancy.
   3. Prefunctional Checklist forms will not be complete until after award of the contract; the following types of information will be gathered via the completed Checklist forms:
      a. Certification by installing contractor that the unit is properly installed, started up, and operating and ready for Functional Testing.
      b. Confirmation of receipt of each shop drawing and commissioning submittal specified, itemized by unit.
      c. Manufacturer, model number, and relevant capacity information; list information "as specified," "as submitted," and "as installed."
      d. Serial number of installed unit.
      e. List of inspections to be conducted to document proper installation prior to startup and Functional Testing; these will be primarily static inspections and procedures; for equipment and systems may include normal manufacturer’s start-up checklist items and minor testing.
      f. Sensor and actuator calibration information.

B. Contractor is responsible for filling out Prefunctional Checklists, after completion of installation and before startup; witnessing by the Commissioning Authority is not required unless otherwise specified.
   1. Each line item without deficiency is to be witnessed, initialed, and dated by the actual witness; checklists are not complete until all line items are initialed and dated complete without deficiencies.
   2. Checklists with incomplete items may be submitted for approval provided the Contractor attests that incomplete items do not preclude the performance of safe and reliable Functional Testing; re-submission of the Checklist is required upon completion of remaining items.
   3. Individual Checklists may contain line items that are the responsibility of more than one installer; Contractor shall assign responsibility to appropriate installers or subcontractors, with identification recorded on the form.
   4. If any Checklist line item is not relevant, record reasons on the form.
   5. Contractor may independently perform startup inspections and/or tests, at his option.
6. Regardless of these reporting requirements, Contractor is responsible for correct startup and operation.
7. Submit completed Checklists to Commissioning Authority within two days of completion.

C. Commissioning Authority is responsible for furnishing the Prefunctional Checklists to Contractor.
   1. Initial Drafts: Contractor is responsible for initial draft of Prefunctional Checklist where so indicated in the Contract Documents.
   2. Provide all additional information requested by Commissioning Authority to aid in preparation of checklists, such as shop drawing submittals, manufacturers’ startup checklists, and O&M data.
   3. Commissioning Authority may add any relevant items deemed necessary regardless of whether they are explicitly mentioned in the Contract Documents or not.
   4. When asked to review the proposed Checklists, do so in a timely manner.

D. Commissioning Authority Witnessing: Required for:
   1. Each piece of primary equipment, unless sampling of multiple similar units is allowed by the commissioning plan.
   2. A sampling of non-primary equipment, as allowed by the commissioning plan.

E. Deficiencies: Correct deficiencies and re-inspect or re-test, as applicable, at no extra cost to Owner.
   1. If difficulty in correction would delay progress, report deficiency to the Commissioning Authority immediately.

3.04 FUNCTIONAL TESTS

A. A Functional Test is required for each item of equipment, system, or other assembly specified to be commissioned, unless sampling of multiple identical or near-identical units is allowed by the final test procedures.

B. Contractor is responsible for execution of required Functional Tests, after completion of Prefunctional Checklist and before closeout.

C. Commissioning Authority is responsible for witnessing and reporting results of Functional Tests, including preparation and completion of forms for that purpose.

D. Contractor is responsible for correction of deficiencies and re-testing at no extra cost to Owner; if a deficiency is not corrected and re-tested immediately, the Commissioning Authority will document the deficiency and the Contractor’s stated intentions regarding correction.
   1. Deficiencies are any condition in the installation or function of a component, piece of equipment or system that is not in compliance with the Contract Documents or does not perform properly.
   2. When the deficiency has been corrected, the Contractor completes the form certifying that the item is ready to be re-tested and returns the form to the Commissioning Authority; the Commissioning Authority will reschedule the test and the Contractor shall re-test.
   3. Identical or Near-Identical Items: If 10 percent, or three, whichever is greater, of identical or near-identical items fail to perform due to material or manufacturing defect, all items will be considered defective; provide a proposal for correction within 2 weeks after notification of defect, including provision for testing sample installations prior to replacement of all items.
   4. Contractor shall bear the cost of Owner and Commissioning Authority personnel time witnessing re-testing.
   5. Contractor shall bear the cost of Owner and Commissioning Authority personnel time witnessing re-testing if the test failed due to failure to execute the relevant Prefunctional Checklist correctly; if the test failed for reasons that would not have been identified in the Prefunctional Checklist process, Contractor shall bear the cost of the second and subsequent re-tests.
E. Functional Test Procedures:
1. Some test procedures are included in the Contract Documents; where Functional Test procedures are not included in the Contract Documents, test procedures will be determined by the Commissioning Authority with input by and coordination with Contractor.
2. Examples of Functional Testing:
   a. Test the dynamic function and operation of equipment and systems (rather than just components) using manual (direct observation) or monitoring methods under full operation (e.g., the chiller pump is tested interactively with the chiller functions to see if the pump ramps up and down to maintain the differential pressure setpoint).
   b. Systems are tested under various modes, such as during low cooling or heating loads, high loads, component failures, unoccupied, varying outside air temperatures, fire alarm, power failure, etc.
   c. Systems are run through all the HVAC control system’s sequences of operation and components are verified to be responding as the sequence's state.
   d. Traditional air or water test and balancing (TAB) is not Functional Testing; spot checking of TAB by demonstration to the Commissioning Authority is Functional Testing.

F. Deferred Functional Tests: Some tests may need to be performed later, after substantial completion, due to partial occupancy, equipment, seasonal requirements, design or other site conditions; performance of these tests remains the Contractor’s responsibility regardless of timing.

3.05 SENSOR AND ACTUATOR CALIBRATION
A. Calibrate all field-installed temperature, relative humidity, carbon monoxide, carbon dioxide, and pressure sensors and gages, and all actuators (dampers and valves) on this piece of equipment shall be calibrated. Sensors installed in the unit at the factory with calibration certification provided need not be field calibrated.
B. Calibrate using the methods described below; alternate methods may be used, if approved by Owner beforehand. See PART 2 for test instrument requirements. Record methods used on the relevant Prefunctional Checklist or other suitable forms, documenting initial, intermediate and final results.
C. All Sensors:
   1. Verify that sensor location is appropriate and away from potential causes of erratic operation.
   2. Verify that sensors with shielded cable are grounded only at one end.
   3. For sensor pairs that are used to determine a temperature or pressure difference, for temperature make sure they are reading within 0.2 degree F of each other, and for pressure, within tolerance equal to 2 percent of the reading, of each other.
   4. Tolerances for critical applications may be tighter.
D. Sensors Without Transmitters - Standard Application:
   1. Make a reading with a calibrated test instrument within 6 inches of the site sensor.
   2. Verify that the sensor reading, via the permanent thermostat, gage or building automation system, is within the tolerances in the table below of the instrument-measured value.
   3. If not, install offset, calibrate or replace sensor.
E. Sensors With Transmitters - Standard Application:
   1. Disconnect sensor.
   2. Connect a signal generator in place of sensor.
   3. Connect ammeter in series between transmitter and building automation system control panel.
4. Using manufacturer’s resistance-temperature data, simulate minimum desired temperature.
5. Adjust transmitter potentiometer zero until 4 mA is read by the ammeter.
6. Repeat for the maximum temperature matching 20 mA to the potentiometer span or maximum and verify at the building automation system.
7. Record all values and recalibrate controller as necessary to conform with specified control ramps, reset schedules, proportional relationship, reset relationship and P/I reaction.
8. Reconnect sensor.
9. Make a reading with a calibrated test instrument within 6 inches of the site sensor.
10. Verify that the sensor reading, via the permanent thermostat, gage or building automation system, is within the tolerances in the table below of the instrument-measured value.
11. If not, replace sensor and repeat.
12. For pressure sensors, perform a similar process with a suitable signal generator.

F. Sensor Tolerances for Standard Applications: Plus/minus the following maximums:
   1. Watthour, Voltage, Amperage: 1 percent of design.
   2. Pressure, Air, Water, Gas: 3 percent of design.
   3. Air Temperatures (Outside Air, Space Air, Duct Air): 0.4 degrees F.
   4. Relative Humidity: 4 percent of design.
   5. Barometric Pressure: 0.1 inch of Hg.
   6. Barometric Pressure: 0.1 inch of Hg (.
   7. Flow Rate, Air: 10 percent of design.
   8. Flow Rate, Water: 4 percent of design.
   9. AHU Wet Bulb and Dew Point: 2.0 degrees F.

G. Critical Applications: For some applications more rigorous calibration techniques may be required for selected sensors. Describe any such methods used on an attached sheet.

H. Valve/Damper Stroke Setup and Check:
   1. For all valve/damper actuator positions checked, verify the actual position against the control system readout.
   2. Set pump/fan to normal operating mode.
   3. Command valve/damper closed; visually verify that valve/damper is closed and adjust output zero signal as required.
   4. Command valve/damper to open; verify position is full open and adjust output signal as required.
   5. Command valve/damper to a few intermediate positions.
   6. If actual valve/damper position does not reasonably correspond, replace actuator or add pilot positioner (for pneumatics).

I. Isolation Valve or System Valve Leak Check: For valves not associated with coils.
   1. With full pressure in the system, command valve closed.
   2. Use an ultra-sonic flow meter to detect flow or leakage.

3.06 TEST PROCEDURES - GENERAL

A. Provide skilled technicians to execute starting of equipment and to execute the Functional Tests. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem-solving.

B. Provide all necessary materials and system modifications required to produce the flows, pressures, temperatures, and conditions necessary to execute the test according to the specified conditions. At completion of the test, return all affected equipment and systems to their pre-test condition.

C. Sampling: Where Functional Testing of fewer than the total number of multiple identical or near-identical items is explicitly permitted, perform sampling as follows:
1. **Identical Units**: Defined as units with same application and sequence of operation; only minor size or capacity difference.

2. **Sampling is not allowed for**:
   a. Major equipment.
   b. Life-safety-critical equipment.
   c. Prefunctional Checklist execution.

3. **XX** = the percent of the group of identical equipment to be included in each sample; defined for specific type of equipment.

4. **YY** = the percent of the sample that if failed will require another sample to be tested; defined for specific type of equipment.

5. Randomly test at least XX percent of each group of identical equipment, but not less than three units. This constitutes the "first sample."

6. If YY percent of the units in the first sample fail, test another XX percent of the remaining identical units.

7. If YY percent of the units in the second sample fail, test all remaining identical units.

8. If frequent failures occur, resulting in more troubleshooting than testing, the Commissioning Authority may stop the testing and require Contractor to perform and document a checkout of the remaining units prior to continuing testing.

**D. Manual Testing**: Use hand-held instruments, immediate control system readouts, or direct observation to verify performance (contrasted to analyzing monitored data taken over time to make the "observation").

**E. Simulating Conditions**: Artificially create the necessary condition for the purpose of testing the response of a system; for example apply hot air to a space sensor using a hair dryer to see the response in a VAV box.

**F. Simulating Signals**: Disconnect the sensor and use a signal generator to send an amperage, resistance or pressure to the transducer and control system to simulate the sensor value.

**G. Over-Writing Values**: Change the sensor value known to the control system in the control system to see the response of the system; for example, change the outside air temperature value from 50 degrees F to 75 degrees F to verify economizer operation.

**H. Indirect Indicators**: Remote indicators of a response or condition, such as a reading from a control system screen reporting a damper to be 100 percent closed, are considered indirect indicators.

**I. Monitoring**: Record parameters (flow, current, status, pressure, etc.) of equipment operation using dataloggers or the trending capabilities of the relevant control systems; where monitoring of specific points is called for in Functional Test Procedures:

1. All points that are monitored by the relevant control system shall be trended by Contractor; at the Commissioning Authority’s request, Contractor shall trend up to 20 percent more points than specified at no extra charge.

2. Other points will be monitored by the Commissioning Authority using dataloggers.

3. At the option of the Commissioning Authority, some control system monitoring may be replaced with datalogger monitoring.

4. Provide hard copies of monitored data in columnar format with time down left column and at least 5 columns of point values on same page.

5. Graphical output is desirable and is required for all output if the system can produce it.

6. Monitoring may be used to augment manual testing.

### 3.07 OPERATION AND MAINTENANCE MANUALS

- **A.** See Section 01 78 00 for additional requirements.
- **B.** Add design intent documentation furnished by Architect to manuals prior to submission to Owner.
C. Submit manuals related to items that were commissioned to Commissioning Authority for review; make changes recommended by Commissioning Authority.

D. Commissioning Authority will add commissioning records to manuals after submission to Owner.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Selective demolition of built site elements.
   B. Selective demolition of built underground site utility tunnel.
   C. Selective demolition of building elements for alteration purposes.
   D. Selective removal of finishes.
   E. Abandonment and removal of existing utilities and utility structures.
   F. Salvage fire alarm strobes and equipment for re-use.

1.02 REFERENCE STANDARDS

1.03 DEFINITIONS
   A. Remove: Detach items from existing construction and legally dispose of them off-site, unless indicated to be removed and salvaged or removed and reinstalled.
   B. Salvage: Detach items from existing construction and deliver them to Owner ready for reuse.
   C. Remove and Reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.
   D. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.
      1. Protect and Existing to Remain have the same meaning regarding work in this Section.

1.04 MATERIALS OWNERSHIP
   A. Historic items, relics, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, antiques, and other items of interest or value to Owner that may be encountered during selective demolition remain Owner's property. Carefully remove and salvage each item or object in a manner to prevent damage and deliver promptly to Owner.
      1. Coordinate with Owner's historical adviser, who will establish special procedures for removal and salvage.

1.05 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Site Plan: Showing:
      1. Vegetation to be protected.
      2. Areas for temporary construction and field offices.
      3. Areas for temporary and permanent placement of removed materials.
   C. Demolition Plan: Submit demolition plan as specified by OSHA and local authorities.
      1. Indicate extent of demolition, removal sequence, bracing and shoring, and location and construction of barricades and fences.
      2. Identify demolition firm and submit qualifications.
      3. Include a summary of safety procedures.
   D. Project Record Documents: Accurately record actual locations of capped and active utilities and subsurface construction.

1.06 QUALITY ASSURANCE
   A. Demolition Firm Qualifications: Company specializing in the type of work required.
      1. Minimum of 8 years of documented experience.
1.07 PROJECT CONDITIONS

A. Minimize production of dust due to demolition operations; do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.

B. Comply with other requirements specified in Section 01 30 00, 01 57 13, and 01 70 00.

PART 2 PRODUCTS -- NOT USED

PART 3 EXECUTION

3.01 SCOPE

A. Coordination through ‘one-call’ to City of Eugene for Facility Services Cartographer locates prior to beginning any demolition.

B. Remove paving and curbs as required to accomplish new work.

C. Within area of new construction, remove foundation walls and footings to a minimum of 2 feet below finished grade.

D. Outside area of new construction, remove foundation walls and footings to a minimum of 2 feet below finished grade.

E. Saw cut and core concrete where indicated or as required to gain access to utilities, or provide utility tie-ins and new pathways and other access ways.

F. Remove other items indicated, for salvage, relocation, and recycling.

G. Fill excavations, open pits, and holes in ground areas generated as result of removals, using specified fill; compact fill as specified in Section 31 22 00.

3.02 GENERAL PROCEDURES AND PROJECT CONDITIONS

A. Comply with applicable codes and regulations for demolition operations and safety of adjacent structures and the public.
   1. Obtain required permits.
   2. Comply with applicable requirements of NFPA 241.
   3. Use of explosives is not permitted.
   4. Take precautions to prevent catastrophic or uncontrolled collapse of structures to be removed; do not allow worker or public access within range of potential collapse of unstable structures.
   5. Provide, erect, and maintain temporary barriers and security devices.
   6. Use physical barriers to prevent access to areas that could be hazardous to workers or the public.
   7. Conduct operations to minimize effects on and interference with adjacent structures and occupants.
   8. Do not close or obstruct roadways or sidewalks without permit.
   9. Conduct operations to minimize obstruction of public and private entrances and exits; do not obstruct required exits at any time; protect persons using entrances and exits from removal operations.
   10. Obtain written permission from FS when demolition equipment will will need to traverse, infringe upon or limit access to portions of the building under use.

B. Do not begin removal until receipt of notification to proceed from Owner.

C. Do not begin removal until built elements to be salvaged or relocated have been removed.

D. Do not begin removal until vegetation to be relocated has been removed and specified measures have been taken to protect vegetation to remain.

E. Protect existing structures and other elements that are not to be removed.
   1. Provide bracing and shoring.
   2. Prevent movement or settlement of adjacent structures.
3. Stop work immediately if adjacent structures appear to be in danger.

F. Minimize production of dust due to demolition operations; do not use water if that will result in ice, flooding, sedimentation of facility or public waterways or storm sewers, or other pollution.

G. If hazardous materials are discovered during removal operations, stop work and notify Architect, PM and FS/Owner; hazardous materials include regulated asbestos containing materials, lead, PCB's, and mercury.

H. Perform demolition in a manner that maximizes salvage and recycling of materials.
   1. Comply with requirements of Section 01 74 19 - Waste Management.
   2. Dismantle existing construction and separate materials.
   3. Set aside reusable, recyclable, and salvageable materials; store and deliver to collection point or point of reuse.

I. Partial Removal of Paving and Curbs: Neatly saw cut at right angle to surface.

J. Salvage: Certain wood elements are to be salvaged for re-milling and reuse as indicate.

3.03 EXISTING UTILITIES

A. Facility Services Cartographer locates shall be initiated through ‘one-call’ to City of Eugene.

B. Coordinate work with utility companies; notify before starting work and comply with their requirements; obtain required permits.

C. Protect existing utilities to remain from damage.

D. Do not disrupt public utilities without permit from authority having jurisdiction.

E. Do not close, shut off, or disrupt existing life safety systems that are in use without at least 7 days prior written notification to Owner.

F. Do not close, shut off, or disrupt existing utility branches or take-offs that are in use without at least 3 days prior written notification to Owner.

G. Locate and mark utilities to remain; mark using highly visible tags or flags, with identification of utility type; protect from damage due to subsequent construction, using substantial barricades if necessary.

H. Remove exposed piping, valves, meters, equipment, supports, and foundations of disconnected and abandoned utilities.

I. Prepare building demolition areas by disconnecting and capping utilities outside the demolition zone; identify and mark utilities to be subsequently reconnected, in same manner as other utilities to remain.

3.04 SELECTIVE DEMOLITION FOR ALTERATIONS

A. Drawings showing existing construction and utilities are based on casual field observation and existing record documents only.
   1. Verify that construction and utility tunnel and arrangements are as shown.
   2. Report discrepancies to Architect before disturbing existing installation.
   3. Beginning of demolition work constitutes acceptance of existing conditions that would be apparent upon examination prior to starting demolition.

B. Separate areas in which demolition is being conducted from other areas that are still occupied.
   1. Provide, erect, and maintain temporary dustproof partitions of construction specified in Section 01 50 00 in locations indicated on drawings.

C. Maintain weatherproof exterior building enclosure except for interruptions required for replacement or modifications; take care to prevent water and humidity damage.

D. Remove existing work as indicated and as required to accomplish new work.
   1. Remove rotted wood, corroded metals, and deteriorated masonry and concrete; replace with new construction specified.
2. Remove items indicated on drawings.

E. Services (Including but not limited to HVAC, Plumbing, Fire Protection, Electrical, and Telecommunications): Remove existing systems and equipment as indicated.
   1. Maintain existing active systems that are to remain in operation; maintain access to equipment and operational components.
   2. Where existing active systems serve occupied facilities but are to be replaced with new services, maintain existing systems in service until new systems are complete and ready for service.
   3. Verify that abandoned services serve only abandoned facilities before removal.
   4. Remove abandoned pipe, ducts, conduits, and equipment, including those above accessible ceilings; remove back to source of supply where possible, otherwise cap stub and tag with identification.

F. Protect existing work to remain.
   1. Prevent movement of structure; provide shoring and bracing if necessary.
   2. Perform cutting to accomplish removals neatly and as specified for cutting new work.
   3. Repair adjacent construction and finishes damaged during removal work.
   4. Patch as specified for patching new work.

3.05 DEBRIS AND WASTE REMOVAL

A. Remove debris, junk, and trash from site.

B. Remove from site all materials not to be reused on site; comply with requirements of Section 01 74 19 - Waste Management.

C. Leave site in clean condition, ready for subsequent work.

D. Clean up spillage and wind-blown debris from public and private lands.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. General work items include, but are not necessarily limited to:

1. Building materials sampled contain detectable concentrations of lead above and below the United States Department of Housing and Urban Development (HUD) definition of lead based paint (1.0 milligrams per square centimeter).

2. There is a potential for exposure to lead and lead dust during asbestos abatement, demolition and new construction work. The Contractor is responsible for monitoring work activities and determining when work involves hazardous materials and conditions that require conformance with specified regulatory requirements. Applicable regulations regarding exposure to lead (Oregon Administrative Rules, Oregon Occupational Safety and Health Division, Subpart D, 1926.62) apply to this project.

3. The project requires welding and cutting of existing structural steel. Due to the elevated risk for worker exposure, the contractor shall outline specific procedures for emissions control when performing these activities on existing structural steel.

1.02 CODES AND REGULATIONS

A. Due to the potential health and environmental hazards associated with the work at this site as described in this section, the work shall be performed in compliance with the applicable provisions of the Washington Industrial Safety and Health Act, and the Washington State Hazardous Waste Management Act, as well as other applicable federal, state, and local codes and regulations governing hazardous materials and hazardous waste. The Contractor is fully responsible for planning and executing all the work under this Contract in a manner that meets or exceeds the requirements of the OAR 1926.62 for protecting the health and safety of employees, the public, and for protecting the environment.

B. The following regulations of the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA), the U.S. Environmental Protection Agency (EPA) and applicable requirements of the State of Washington are pertinent to this work. Other applicable regulations not specifically identified herein also apply.

1. United States Department of Labor, Occupational and Health Administration (OSHA):

   a. 29 CFR 1910 Occupational Safety and Health Standards
   b. 29 CFR 1910.134 Respiratory Protection
   c. 29 CFR 1910.1025 Lead
   d. 29 CFR 1910.1200 Hazard Communication
   e. 29 CFR 1910 Safety and Health Regulations for Construction
   f. 29 CFR 1926.55 Gases, Vapors, Fumes, Dusts, and Mists
   g. 29 CFR 1926.57 Ventilation
   h. 29 CFR 1926.62 Lead Exposure in Construction; Interim Rule (with appendices A, B, C and subpart D)

2. United States Environmental Protection Agency:

   a. 40 CFR 148 Hazardous Waste Injection Restrictions
   c. 40 CFR 261 Identification and Listing of Hazardous Waste
   d. 40 CFR 262 Standards Applicable to Generators of Hazardous Waste
   e. 40 CFR 263 Standards Applicable to Transporters of Hazardous Waste
   f. 40 CFR 264 Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
   g. 40 CFR 265 Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
   h. 40 CFR 268 Land Disposal Restrictions
   i. 40 CFR 745 Lead; Requirements for Lead-based Paint Activities
LEAD CONTROL PROCEDURES

j. 49 CFR 172 Hazardous Materials Tables and Hazardous Materials Communications Regulations
k. 49 CFR 178 Specifications for Packaging


4. National Institute for Occupational Safety and Health (OSHA):
   a. NIOSH OSHA Booklet 3142 Lead in Construction

5. State Requirements: Oregon Requirements, and/or DEQ rules which govern lead paint work or hauling and disposal include but are not limited to:
   a. OAR Subpart D, 1926.62
   c. OAR Department of Human services, Public Health Division 333-069

1.03 DEFINITIONS

A. Whenever the terms below occur in this Contract Document, they will have the meanings which follow:

1. Action Level: Employee exposure, without regard to use of respirators, to an airborne concentration of lead of 30 micrograms per cubic meter of air averaged over an 8-hour period. As used in this section, “30 micrograms per cubic meter of air” refers to the action level.

2. Air Monitoring: The process of measuring the concentration of lead in a specific volume of air in a stated period of time. Air samples shall be collected and analyzed in accordance with the methods specified by the National Institute for Occupational Safety and Health (NIOSH Method 7105) and as required by OAR 1926.62.

3. Area Monitoring: Sampling of lead concentrations within the lead control area, inside the physical boundaries that are representative of the airborne lead concentrations that may reach the breathing zone of personnel potentially exposed to lead.

4. Eight-Hour Time Weighted Average (TWA): Airborne concentration of lead averaged over an 8-hour workday to which an employee is exposed.

5. Lead: Metallic lead, inorganic lead compounds, and organic lead soaps. Excluded from this definition are other organic lead compounds.

6. Lead Permissible Exposure Limit (PEL): Fifty micrograms per cubic meter of air as an 8-hour time weighted average.

7. Personal Monitoring: Sampling of lead concentrations within the breathing zone of an employee to determine the 8-hour time weighted average concentration in accordance with OAR 1926.62. Samples shall be Consultant of the employee's work tasks. Breathing zone shall be considered an area within a hemisphere, forward of the shoulders, with a radius of 6 to 9 inches and the center at the nose or mouth of an employee.

8. Industrial Hygienist: The Industrial Hygienist shall be at least one of the following:
   a. Certified by the American Board of Industrial Hygiene and have prior experience in the health and safety aspects of a lead hazard control work project.
   b. A professional engineer or certified safety professional with a minimum of three (3) years prior experience in industrial hygiene relating to lead hazard control work.

1.04 QUALITY ASSURANCE

A. The Contractor shall submit a work plan (pursuant to Paragraph 1.06 A of this Section) if work, other than heavy equipment general building demolition, will impact lead containing materials or if there is a potential for occupational exposure to lead above the action limit. The work plan will demonstrate that abatement, demolition, recycling and disposal of lead-coated and lead containing building materials will be performed in a manner consistent with pertinent federal, state, and local regulation and this specification. The work plan will be submitted to the owner for review prior to the start of any lead related work.
B. The owner or the owner’s consultant will perform periodic observation of the site work to ensure that it is being performed in a manner consistent with the contractor’s reviewed work plan and this specification.

1.05 SUBMITTALS

A. Contractors shall provide complete submittals as per Section 01 30 00 and 01 315 for review by the owner’s representative.

PART 2 PRODUCTS

2.01 EQUIPMENT AND SUPPLIES

A. Provide a list and description of equipment and supplies necessary to support the work as described in the work plan. Equipment and supplies may include but are not limited to:
   1. Chemicals to be used on-site including dust suppressants/wetting agents, fuels/lubricants, cleaning degreasing, and/or welding/cutting supplies;
   2. Enclosure equipment (for dust control);
   3. Fencing, barriers and signs;
   4. Demolition equipment;
   5. Materials and debris hauling/moving equipment;
   6. Material storage containers and supplies;
   7. Decontamination equipment and supplies;
   8. Protective clothing and respirators;
   9. Labels, manifests and other shipping documentation;
   10. Release prevention equipment;
   11. Field documentation logs/supplies; and,
   12. Protective clothing, respirators, equipment and supplies necessary to support the work.

PART 3 EXECUTION

3.01 WORK AREA PREPARATION

A. Perform the following preliminary steps to prepare the Work Areas prior to work impacting lead or lead-coated building materials:
   1. Establish a Control Area that includes a perimeter sufficient to perform the work around each building or area that contains lead or lead-coated building materials. The control area shall also consist of the pathway for transport of any lead-contaminated material to a stockpile or storage receptacle, if lead-containing debris is not immediately transported from the site. Provide and display caution signs, in clearly visible areas, at entrances indicating that hazardous material work is being conducted and that unauthorized persons should not enter. Signs shall be comply with OAR 1926.62 regulations.
   2. Emergency Procedures: Establish and post written emergency procedures within each Work Area, including emergency contact names and contact phone numbers, plans for medical emergencies, temporary loss of electrical power or water, and procedures for an emergency. Contractor is responsible for establishing and posting contingency procedures to all workers on site.
   3. Health and Safety Briefing: Conduct a health and safety briefing prior to the start of work and weekly to discuss the health and safety plan, hazardous materials, hazardous work and other related items per the specified health and safety plan. More frequent briefings should be performed as required by project activities or changes in the work.
   4. Log-in Sheet: Restrict access to work sites by maintaining a daily log of personnel entering Work Areas; including workers and other authorized personnel and their start/stop times.
   5. Decontamination Unit: Prepare the decontamination unit for use at all entrances and exits from the Work Area as described in the approved work plan.
3.02 WORK PROCEDURE

A. General Procedures: Perform all work and comply with the safety and health provisions in the site specific Health and Safety Plan. The work includes all measures necessary to adequately protect workers, authorized personnel, and the public from lead exposures during abatement and demolition activities.

B. Coordination of Work of all Trades: Coordinate the work of all trades to ensure that work is performed in accordance with the applicable regulations and that the control limits are maintained at all times both inside and outside the control area.

C. Access to Work Area: Access to work areas shall be through decontamination areas. Only the Contractor, subcontractors, authorized Owner personnel, project consultants, and regulatory personnel shall have access to the work area.

D. Means of Egress: Establish and maintain emergency and fire exits from the work area.

E. Prevent dust generation at all times to the maximum extent practicable. Provide hand wash stations at appropriate and approved locations for the duration of demolition.

F. The use of water shall be restricted to the smallest quantity necessary to minimize dust and to avoid the potential of contaminant migration through run-off or ponding. In no case shall liquids generated during building demolition come into contact with uncontaminated soils, storm drains, surfaces or conduits which may constitute a release to the environment.

G. Demolition Procedures: Perform general demolition or demolition required for hazardous material abatement in areas of lead-containing paints in accordance with approved Health & Safety Plans. Use procedures and equipment required to limit occupational and environmental exposure to lead when lead-containing paint is impacted or when building components are demolished. The procedures employed by the Contractor shall not create the potential for contaminating surrounding areas or materials with lead-containing coatings or dust. Dust generation shall be kept to a minimum. Dry scraping, dry sanding, or dry grinding on lead-containing paints or lead contaminated surfaces will not be permitted without a full enclosure.

H. All lead-coated demolition debris shall be handled, stored and disposed of as to meet applicable federal, state and local requirements.

I. Personnel and equipment decontamination shall occur whenever people or equipment leave the work site as described in the approved work plan. Decontamination waste shall be packaged, stored, labeled and disposed of according to all applicable requirements at the cost of the Contractor. All contaminated equipment, tools or materials that cannot be decontaminated shall be stored and disposed of by the Contractor in accordance with all federal, state and local regulations.

J. Grossly inadequate health, safety or environmental precautions on the part of the Contractor or the belief that the Contractor's personnel, the general public or the environment are or may be exposed to an immediate hazard, may be cause for the Owner to suspend the Contractor's site work and ask the Contractor's personnel to evacuate the hazard area. The Contractor shall not be compensated for such delays. The contractor is responsible for costs identified by the Owner as a consequence of the contractor's actions.

K. The Owner or the Owner's Consultant may inspect the Contractor's operations and work areas daily for job site cleanliness and conformance with the specifications. The Contractor shall locate any fuels, solvents or lubricants in a common area in a manner that will prevent releases to the environment. Any hazardous materials shall be appropriately labeled with the generic name of the contents and the Contractor's name.

1. Waste Sampling: Contractor will be required to collect representative samples of demolition debris for analysis as required under DEQ Regulations, to determine appropriate disposal methods. Select materials that were tested and determined to have
lead in the coating for sampling and submittal to an approved laboratory for Toxicity Characteristic Leachate Procedure (TCLP) testing.

3.03 SITE QUALITY CONTROL AND MONITORING

A. Site Inspection: While performing the work, the Contractor may be subject to on site inspection by Oregon OSHA, EPA/Ecology inspectors and/or local building or health officials. If found to be in violation of pertinent regulations, the Contractor shall cease all work immediately until the violation is resolved. Standby time required to resolve the violation shall be at the Contractor's expense. Complete sets of equipment (such as respirators and disposable clothing) that may be required for entry to the control area shall be made available at all times by the Contractor to the Owner and/or agency inspectors for inspection of the control area. Such requests will only be made during working hours.

B. Quality Assurance
   1. Restrict the spread of dust and debris from being distributed over the work area.
   2. Area air quality monitoring and personnel monitoring shall be conducted throughout the work as appropriate.
   3. Air Monitoring: Monitoring of airborne concentrations of lead shall be in accordance with OAR 1926.62, and as specified herein. Air monitoring, testing, and reporting shall be performed in accordance with an Air Monitoring Plan prepared and signed by the Contractor's Industrial Hygienist. The plan shall include personal monitoring in accordance with regulatory requirements and area monitoring outside the lead control area.
      a. Submit results of air monitoring samples within 24 hours after the air samples were taken.
      b. Notify the Owner immediately of the corrective action taken if the exposure to lead is at or in excess of the action level of 30 micrograms per cubic meter of air outside of the lead control area.
      c. If the area air monitoring results are above the action level of 30 micrograms, the Owner shall have the option of stopping all work until the work procedures and lead hazard controls are revised to the Owner's satisfaction.

3.04 CLEAN-UP, TESTING AND DISPOSAL

A. Housekeeping: Housekeeping and clean-up procedures are essential tasks for contamination control. Maintain all surfaces throughout the area free of contaminated debris to the maximum extent practical. Restrict debris from being distributed over the general area. In all possible instances workers shall clean-up their own areas. Equip personnel engaged in cleaning up scrap and demolition debris with necessary respiratory equipment and protective clothing.

B. Cleanup: Maintain surfaces of the lead control area as free of accumulation of paint chips and dust as practicable. Restrict the spread of dust and debris; keep waste from being distributed over the work area. The use of compressed air to clean up the area is strictly prohibited. At the end of each shift, clean the area of visible lead paint contamination by vacuuming with a HEPA-filtered vacuum cleaner, wet mopping the area, or cleanup by other appropriate means.

C. Testing of Demolition Debris: The Contractor will be required to collect representative sample(s) of the actual demolition debris stream for Toxicity Characteristic Leaching Procedure (TCLP) analysis as required under DEQ Regulations. The Owner's Consultant reserves the right to review sampling procedures and analytical data before disposal of demolition waste.

D. Disposal of Lead Demolition Waste: If any lead dangerous waste is identified the following requirements shall be met for the disposal of lead dangerous waste:
   1. Collect lead dangerous waste, scrap, debris, bags, containers, equipment, and lead contaminated clothing that may produce airborne concentrations of lead particles. Label the containers in accordance with 29 CFR 1910.1025.

3. The Transporter and Disposal Facility must each have an EPA identification number. The Contractor shall submit the name, address, and EPA Identification Number of the Transporter and Disposal Site to the Owner prior to the disposal of hazardous waste.

E. Disposal Documentation: Disposal documentation is required for all waste streams. At a minimum, provide a disposal receipt or manifest for all non-dangerous waste streams. For lead dangerous waste, if any is generated, submit written evidence that the hazardous waste treatment, storage, or disposal facility (TSD), or recycling facility is approved for lead dangerous waste disposal or recycling by the EPA and state or local regulatory agencies. Submit one (1) copy of the completed manifest, signed and dated by the initial transporter in accordance with 40 CFR 262. Final payment for the project shall not be made until all disposal documentation has been submitted and accepted by the Owner.

3.05 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for lead handling, waste disposal, and/or training will be made. The cost shall be considered incidental to and included in the Lump Sum price of the project.

END OF SECTION
PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This Section specifies cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes for the following:
   1. Footings.
   2. Foundation walls.
   3. Slabs-on-grade.
   4. Suspended slabs.
   5. Concrete toppings.
   7. Building walls.
   8. Acoustical isolation floating slabs.
   9. Architectural Concrete Mock-ups for the following
      a. Retaining walls.
      b. Slabs.
      c. Interior ramp.
      d. Cast concrete against existing walls.

B. This Section specifies architectural cast-in-place concrete for locations indicated, and all materials, procedures, and requirements specified in Section 03 30 00 Cast-in-Place Concrete shall fully apply to cast-in-place architectural concrete, except as otherwise specified.

1.02 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following, subject to compliance with requirements:
   1. Blended hydraulic cement.
   2. Fly ash and other pozzolans.
   3. Ground granulated blast-furnace slag.
   4. Silica fume.

1.03 SUBMITTALS

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

B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
   1. Indicate amounts of mixing water to be withheld for later addition at Project site.
   2. Include substantiating test data to show compliance with ACI 318 Chapter 5.

C. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement. The steel reinforcement detailer shall generate all shop drawing bending and installation details from the structural and architectural drawings and specifications. The use of reproductions or photocopies of the contract drawings shall not be permitted.
   1. Provide details of fabrication, bending, and placement, prepared according to ACI 315, "Details and Detailing of Concrete Reinforcement." Include special reinforcement required for openings through concrete structures.
   2. Shop drawing re-submitalls shall clearly identify all revisions to previous submittals.
      a. Heavy ink clouded outlines (revision clouds) shall be drawn around revised areas of individual sheets.
      b. Architect/Engineer will not review information outside of revision clouds on resubmitted drawings.
D. Formwork Shop Drawings: Prepared by or under the supervision of a structural engineer licensed in the State of Oregon detailing fabrication, assembly, and support of formwork.
   1. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and installing and removing reshoring.
   2. Provide form tie layout showing aesthetically appropriate evenly spaced ties horizontally and vertically.

E. Waterstop Shop Drawings: PDF format showing locations and types per manufacturer’s recommendations.

F. Samples: For waterstops and vapor retarder.

G. Welding certificates.

H. Qualification Data: For Installer, manufacturer, and testing agency.
   1. Qualification Data: For firms and persons specified in “Quality Assurance” Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of Architects and Owners, and other information specified.

I. Material Certificates: For each of the following, signed by manufacturers:
   1. Cementitious materials
   2. Admixtures.
   3. Form materials and form-release agents.
   4. Steel reinforcement and accessories.
   5. Fiber reinforcement.
   6. Waterstops.
   7. Curing compounds.
   8. Floor and slab treatments.
   10. Adhesives.
   11. Vapor barriers.
   12. Semirigid joint filler.

J. Floor surface flatness and levelness measurements to determine compliance with specified tolerances.

K. Minutes of preinstallation conference.

L. Construction Joint Layout: Indicate proposed construction joints required to construct the structure. Location of construction joints is subject to approval by the Engineer.

M. Vapor barrier manufacturer’s technical representative reports.

1.04 QUALITY ASSURANCE

A. Perform work of this section in accordance with ACI 301, ACI 117 and ACI 318.

B. Follow recommendations of ACI 305R when concreting during hot weather.

C. Follow recommendations of ACI 306R when concreting during cold weather.

D. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and supervisor who is an ACI-certified Concrete Flatwork Technician.

E. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM 94/C94M requirements for production facilities and equipment.
1. Manufacturer certified according to NRMCA’s “Certification of Ready Mixed Concrete Production Facilities.

F. For slabs-on-grade required to include an under-slab vapor barrier, provide a vapor barrier from a firm experienced in manufacturing vapor barriers and conforming to the requirements specified herein. Do not proceed with placement unless manufacturer's technical representative is present for vapor barrier installation and for every day of concrete slab placement.

G. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.
   1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.
   2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician – Grade 1. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician – Grade II.

H. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant located within a 500 mile radius, obtain aggregate from one source, and obtain approved admixtures through one source.

I. Welding: Qualify procedures and personnel according to AWS D1.4, "Structural Welding Code--Reinforcing Steel."

J. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Section 01 30 00 - Administrative Requirements.
   1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
      a. Contractor’s superintendent.
      b. Independent testing agency responsible for concrete design mixes.
      c. Ready mix concrete manufacturer.
      d. Concrete subcontractor.
      e. Steel reinforcement subcontractor when applicable.
      f. Under-slab vapor barrier
      g. Under-slab vapor barrier manufacturer's technical representative, for slabs on grade.
   2. Review procedures and special conditions and details for field quality control of vapor barrier placement.
   3. Review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, curing procedures, construction contraction and isolation joints, and joint-filler strips, semirigid joint fillers, forms and form removal limitations, shoring and reshoring procedures, vapor-retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, floor and slab flatness and levelness measurement, concrete repair procedures, and concrete protection.

K. Manufacturer’s Technical Representative:
   1. Visit site not less than three times, and more if required to review vapor barrier placement and installation procedures and concrete placement over vapor barrier.
      a. Pre-installation meeting.
      b. Duration of membrane installation for observation of completed membrane installation.
      c. After installation of reinforcing, when applicable, and during placement of concrete
   2. Document site visits in writing with copy to Architect.
1.05 MOCK-UP
   A. See Section 01 40 00 - Quality Requirements, for general requirements for mock-up.
   B. Cast concrete slab-on-grade and formed-surface panels to demonstrate typical joints, surface
      finish, texture, tolerances, and standard of workmanship. See Section 01 43 39.
   C. Construct concrete mock-ups for new architectural concrete placements indicated on the
      drawings, incorporating all components specified.
      1. Construct in a coordinated mock-up, concrete retaining wall mock-up where indicated on
         the drawings, incorporating all components specified for one coordinated assembly in
         conjunction with associated assemblies.
      2. Minimum size of mock-up is indicated on the architectural drawings.
      3. Approved mock-up may remain as part of the Work if undisturbed at time of Substantial
         Completion.

1.06 DELIVERY, STORAGE, AND HANDLING
   A. Deliver, store, and handle steel reinforcement to prevent bending and damage.
   B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other
      contaminants.

1.07 SYSTEM DESCRIPTION
   A. Redesign or Departures from Requirements of the Contract Documents Initiated by Contractor:
      1. Obtain written acceptance from the Architect and Architect's consultants.
      2. Bear costs for Contractor-initiated or construction error due to changes in type, form,
         system, or details of construction from those indicated by the contract documents.
      3. Costs of review of such changes by Architect and Architect's consultants will be deducted
         from the Contract Sum by Change Order.

PART 2 PRODUCTS
2.01 MANUFACTURERS
   A. In other Part 2 articles where titles below introduce lists, the following requirements apply to
      product selection.
      1. Available Products: Subject to compliance with requirements, products that may be
         incorporated into the Work include, but are not limited to, products specified.
      2. Products: Subject to compliance with requirements, provide one of the products specified.
      3. Available Manufacturers: Subject to compliance with requirements, manufacturers offering
         products that may be incorporated into the Work include, but are not limited to
         manufacturers specified.
      4. Manufacturers: Subject to compliance with requirements, provide products by one of the
         manufacturers specified.

2.02 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.
      1. Plywood, metal, or other approved panel materials.
      2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1,
         and as follows:
         a. High-density overlay, Class 1, or better.
   B. Forms for Rectangular Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic,
      paper, or fiber tubes that will produce surfaces with gradual or abrupt irregularities not
      exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist
      plastic concrete loads without detrimental deformation.
C. Void Forms: Biodegradable paper surface, treated for moisture resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads.

D. Chamfer Strips: Wood, metal, PVC, or rubber strips, 1 by 1 inch.

E. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

F. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
   1. Furnish units that will leave no corrodbile metal closer than 1 inch to the plane of exposed concrete surface.
   2. Furnish ties that, when removed, will leave holes not larger than 1 inch in diameter in concrete surface.

2.03 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615, Grade 60, deformed. Refer to General Structural Notes.

B. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 60 percent.

C. Regional Content: Provide steel products which are extracted/harvested and manufactured from within 500 miles of the project site.

D. Low-Alloy-Steel Reinforcing Bars: All reinforcing steel to be welded or bent in field: ASTM A 706, deformed.

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

2.04 REINFORCEMENT ACCESSORIES

A. Joint Dowel Bars: ASTM A 615, Grade 60 plain steel bars, cut bars true to length with ends square and free of burrs.

B. 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" of greater compressive strength than concrete, and as follows:
   1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.

2.05 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.
      a. Fly Ash: ASTM C 618, Class C or F. Refer to General Structural Notes.
      b. Recycled Content: Provide cement and cementitious materials with postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
      c. Regional Content: Provide cement and cementitious materials which are extracted/harvested and manufactured from within 500 miles of the project site.

B. Normal-Weight Aggregate: ASTM C 33, coarse aggregate or better, graded. Provide aggregates from a single source.
   1. Maximum Coarse-Aggregate Size: 1 inch at foundations, 3/4 inch at slabs and walls
a. Regional Content: Provide aggregate materials which are extracted/harvested and manufactured from within 500 miles of the project site.

C. Water: ASTM C 94 and potable.

2.06 ADMIXTURES

   1. Use of admixtures requires Owner approval.

B. Chemical Admixtures:
   1. Use of admixtures requires Owner approval.
   2. Provide approved 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.
      a. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
      b. Retarding Admixture: ASTM C 494/ C494M, Type B.
      c. Water-Reducing and Retarding Admixture: ASTM C494/C 494M, Type D.
      d. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
      e. High-Range, Water-Reducing and Retarding Admixture: ASTM C494/C 494M, Type G.
      f. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.
      g. Substitutions: See Section 01 60 00 - Product Requirements.

C. Waterproofing Admixture: Hydrophobic Waterproofing integral to concrete mix with WRA, hydrophobe and pore blocker for protecting against water ingress and reducing water absorption to 1 percent or less
   1. Use of admixtures requires Owner approval.
   2. Hydrophobic Waterproofing Admixture: Integral to concrete mix with WRA, hydrophobe and pore blocker for protecting against water ingress and reducing water absorption to 1 percent or less.
      a. Manufacturers:
         1) Aquafin, Inc.
         2) Calite
         3) Grace Building Products, Inc.
         4) Hycrete, Inc.
         5) Master Builders, Ltd.
      6) Substitutions: See Section 01 60 00 - Product Requirements.

D. Shrinkage Reducing Admixture (SRA):
   1. Use of admixtures requires Owner approval.
   2. Provide SRA in mixes used at all exposed polished concrete slab applications at the highest dose rate recommended by the manufacturer. Verify compatibility with other admixtures.
      a. Master Builders, MasterLIFE SRA20
      b. Grace Construction Products, Eclipse 200
      c. Substitutions: See Section 01 60 00 - Product Requirements.

E. Synthetic Fiber Reinforcing: Provide synthetic fiber reinforcing in mixes used at all exposed polished concrete slab applications as recommended by the manufacturer. Follow all manufacturer mixing procedures.
   1. Propex Concrete Systems, Novomesh 950
   2. Grace Construction Products, STRUX 90/40
   3. Substitutions: See Section 01 60 00 - Product Requirements.
2.07 WATERSTOPS
A. 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 inch by 1 inch (19 by 25mm).
1. Products:
   a. Colloid Environmental Technologies Company; Volclay Waterstop-RX.
   b. Concrete Sealants Inc., Conseal CS-231.
   c. Greensteel; Swellstop.
   d. Henry Company, Sealants Division; Hydro-Flex.
   e. JP Specialties, Inc.; Superstop.
   f. TCMIraDRI; Mirsastop.
   g. Substitutions: See Section 01 60 00 - Product Requirements.

2.08 ACCESSORY MATERIALS
A. Underslab Vapor Barrier: Polyolefin multi-layer, fabric-, cord-, grid-, or aluminum-reinforced polyethylene or equivalent, complying with ASTM E 1745, Class A; stated by manufacturer as suitable for installation in contact with soil or granular fill under concrete slabs.
1. Single ply polyethylene is prohibited.
2. Water Vapor Permeance: less than .01 perms when tested in accordance with ASTM F-1249/ASTM E-96.
4. Manufacturers:
5. Details, transitions, terminations and penetrations to be installed per manufacturer’s recommendations.

B. Vapor Emission Control Sealer and pH Suppression: Two-component high solids penetrating epoxy sealer for providing an effective membrane barrier to inhibit moisture migration and provide pH isolation. Details, transitions, terminations and penetrations to be installed per manufacturer’s recommendations. See Section 01 45 19 for testing procedures to determine if use of these products is necessary. Use of these products is applicable only when testing indicates need for floor covering application and individual Division 09 floor covering manufacturers do not have a preferred specific product for maintaining floor covering warranties.
1. Manufacturers:
   a. Ardex
   b. Advanced Moisture Control
   c. Aquafin, Inc
   d. Bostik
   e. Dependable Floor Underlayments
   f. Mapei
   g. Substitutions: See Section 01 60 00 - Product Requirements.

C. Slab Isolation System: Roll-out batting with pre-spaced isolators for providing an effective high-performance resilient decoupler creating a floating floor system to minimize floor impact noise and airborne sound transmissions.
1. Manufacturers:
   a. Kinetics Noise Control, Inc.
      1) Product: Model RIM.
   b. Substitutions: See Section 01 60 00 - Product Requirements.

D. Concrete Topical Sealer: Clear single-component high resin solids, water-based low VOC concrete sealer for providing an effective anti-dusting wear surface for exposed concrete floors which are not receiving floor covering, penetrating sealers/hardeners or polished concrete floor surfacing.

2.09 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
   1. Products:
      a. Axim Concrete Technologies; Cimfilm.
      b. Burke by Edoco; BurkeFilm
      c. ChemMasters; Spray-Film
      d. Conspec Marketing & Manufacturing Co., Inc., a Dayton Superior Company; Aquafilm.
      e. Dayton Superior Corporation; Sure Film.
      f. Euclid Chemical Company (the); Eucobar.
      g. Kaufman Products, Inc.; Vapor Aid.
      h. Lambert Corporation; Lambco Skin.
      i. L&M Construction Chemicals, Inc.; E-Con.
      j. MBT Protection and Repair, Div. of ChemRex; Confilm.
      l. Metalcrete Industries; Waterhold.
      m. Nox-Crete Products Group, Kinsman Corporation; Monofilm.
      n. Sika Corporation, Inc.; SikaFilm.
      o. Symons Corporation, a Dayton Superior Company; Finishing Aid.
      p. Unitex; Pro-Film.
      q. US Mix Products Company; US Spec Monofilm ER.
      r. Vexcon Chemicals, Inc.; Certi-Vex EnvioAssist.
      s. Substitutions: See Section 01 60 00 - Product Requirements.

2. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) when dry.


5. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A, 30% solids content minimum. The only place in the project this is applied are the top of exposed concrete slabs that are not receiving other floor finishes that cover the concrete slab visually or concrete polishing.
   a. Products:
      1) Burke By Edoco; Cureseed 1315 WB.
      2) ChemMasters; Polyseal WB.
      3) Conspec Marketing & Manufacturing Co., Inc., a Dayton Superior Company; Sealcure 1315 WB.
      4) Euclid Chemical Company (The); Super Diamond Clear VOX.
      6) Lambert Corporation; UV Safe Seal.
9) Metalcrete Industries; metecure 30.
10) Symons Corporation, a Dayton Superior Company; Cure & Seal 31 Percent E.
11) Tamms Industries, Inc.; LusterSeal WB 300.
12) Unitex; Hydro Seal 25.
14) Vexcon Chemicals, Inc.; Vexcon Starseal 1315.
15) Substitutions: See Section 01 60 00 - Product Requirements.

2.10 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber
B. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80 per ASTM D 2240.
C. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
D. Epoxy-Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class, suitable for application temperature and grade to suit requirements, and as follows:
   1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.
E. Reglets: Fabricate reglets of not less than 0.0217-inch- (0.55-mm-) thick galvanized steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.
F. Weep Hole Sleeve:
   1. Size: Schedule 40 standard steel pipe, 1 inch inside diameter.
   2. Finish: Hot dipped galvanized, G-185 complying with ASTM A 123/A 123 M.

2.11 CONCRETE MIXTURES, GENERAL

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 and in accordance with the following:
   1. Compressive Strength: Refer to General Structural Notes.
   3. Air Content: Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having the air content specified in the General Structural Notes.
B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
   1. Fly Ash: 20 percent.
   2. Combined Fly Ash and Pozzolan: 20 percent.
   4. Combined Fly Ash or Pozzolan and Ground Granulated Blast-Furnace Slag: 50 percent portland cement minimum, with fly ash or pozzolan not exceeding 20 percent.
   5. Silica Fume: 10 percent.
   6. Combined Fly Ash, Pozzolans, and Silica Fume: 30 percent with fly ash or pozzolans not exceeding 20 percent and silica fume not exceeding 10 percent.
   7. Combined Fly Ash or Pozzolans, Ground Granulated Blast-Furnace Slag, and Silica Fume: 50 percent portland cement minimum, with fly ash or pozzolans not exceeding 20 percent and silica fume not exceeding 10 percent.
C. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.
D. Admixtures: Use admixtures according to manufacturer's written instructions.
1. Use water-reducing or high-range water-reducing admixture (superplasticizer) 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.

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

2.13 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 (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

PART 3 EXECUTION
3.01 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 concrete 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. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:
   1. Class A, 1/8 inch for smooth-formed finished surfaces at interior or exterior exposed to view concrete surfaces.
   2. Class B, 1/4 inch for utility formed finished surfaces.
   3. Class D, up to 1 inch for rough-formed finished surfaces hidden from view.
D. Construct forms tight enough to prevent loss of concrete mortar.
E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
   1. Install keyways, reglets, recesses, and the like, for easy removal.
   2. Do not use rust-stained steel form-facing material.
F. Place form ties in patterns evenly space horizontally and vertically.
G. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
H. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
I. Chamfer exterior corners and edges of permanently exposed concrete.
J. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
K. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
L. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
M. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.
3.02 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.
1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."
2. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.

3.03 REMOVING AND REUSING FORMS
A. General: Formwork, for sides of beams, walls, columns, and similar parts of the Work, that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F (10 deg C) for 24 hours after placing concrete if concrete is hard enough to not be damaged by form-removal operations and provided curing and protection operations are maintained.
1. Leave formwork for beam soffits, joists, slabs, and other structural elements that supports weight of concrete in place until concrete has achieved at least 70 percent of its 28-day design compressive strength.
2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.
C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.04 SHORES AND RESHORES
A. Comply with ACI 318, and ACI 301 for design, installation, and removal of shoring and reshoring.
1. Do not remove shoring or reshoring until measurement of slab tolerances is complete.
B. In multistory construction, extend shoring or reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.
C. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

3.05 VAPOR BARRIER
A. Plastic Vapor Barrier: Place, protect, and repair vapor barrier according to ASTM E 1643 and manufacturer's written instructions.
1. Lap joints 6 inches and seal with manufacturer's recommended tape.
2. Install vapor barriers per manufacturer's recommendations.

3.06 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.
B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.
C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.
   1. Weld reinforcing bars according to AWS D1.4, where indicated.

D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

E. Install welded wire fabric in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

### 3.07 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.
   1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints, unless otherwise indicated.
   2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches (38 mm) into concrete.
   3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
   4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
   5. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
   6. Use a bonding agent or roughen interface to ¼” (6mm) amplitude at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

### 3.08 WATERSTOPS

A. Self-Expanding Butyl Strip Waterstops: Install in construction joints as indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of the Work. Field-fabricate joints in waterstops according to manufacturer’s written instructions. Install per manufacturer’s recommendations

### 3.09 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. Do not add water to concrete during delivery, at Project site, or during placement, unless approved by Architect.
   1. Do not add water to concrete after adding high-range water-reducing admixtures to mix.

C. Adjust mix as required to maintain specified air content at the point of discharge.

D. 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. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
   2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
   3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches (150 mm) into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.
E. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
   1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
   3. Screed slab surfaces with a straightedge and strike off to correct elevations.
   4. Slope surfaces uniformly to drains where required.
   5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess water appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

F. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
   1. When average high and low temperature is expected to fall below 40 deg F (4.4 deg C) for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
   2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
   3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators, unless otherwise specified and approved in mixture designs.

G. Hot-Weather Placement: Comply with ACI 301 and as follows:
   1. Maintain concrete temperature below 90 deg F (32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor’s option.
   2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.10 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 to meet preparation requirements for waterproofing and dampproofing.
      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 or to be covered with a coating or covering material applied directly to concrete.
   C. 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 unformed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.11 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. 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 and to floor and slab surfaces 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 to tolerances indicated.

C. Trowel and Fine-Broom Finish: Apply a first trowel finish, to surfaces indicated and to surfaces 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 indicated.

D. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.
1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.

3.12 FLOOR FLATNESS AND LEVELNESS TOLERANCES

A. An independent testing agency, as specified in Section 01 40 00, will inspect finished slabs for conformance to specified tolerances.

B. Screed slab on grade floors level, maintaining the following minimum F(F) Floor Flatness and F(L) Floor Levelness values when measured in accordance with ASTM E 1155 within 48 hours after slab installation; report both composite overall values and local values for each measured section. Verify finish with Architect.
1. Non-critical areas, thickset tile:
   a. F(F): Specified Overall Value (SOV) of 20; Minimum Localized Value (MLV) of 15.
   b. F(L): Specified Overall Value (SOV) of 15; Minimum Localized Value (MLV) of 10.
2. Carpet areas:
   a. F(F): Specified Overall Value (SOV) of 25; Minimum Localized Value (MLV) of 17.
   b. F(L): Specified Overall Value (SOV) of 17; Minimum Localized Value (MLV) of 15.
3. Thinset Flooring:
   a. F(F): Specified Overall Value (SOV) of 35; Minimum Localized Value (MLV) of 30.
   b. F(L): Specified Overall Value (SOV) of 30; Minimum Localized Value (MLV) of 20.
4. Polished Concrete Flooring:
   a. F(F): Specified Overall Value (SOV) of 50; Minimum Localized Value (MLV) of N/A.
   b. F(L): Specified Overall Value (SOV) of N/A; Minimum Localized Value (MLV) of N/A.

C. Screed suspended slab floors level, maintaining the following minimum F(F) Floor Flatness and F(L) Floor Levelness values when measured in accordance with ASTM E 1155 within 48 hours after slab installation; report both composite overall values and local values for each measured section. Verify finish with Architect.
1. Non-critical areas, thickset tile and parking structures:
   a. F(F): Specified Overall Value (SOV) of 20; Minimum Localized Value (MLV) of N/A.
   b. F(L): Specified Overall Value (SOV) of 15; Minimum Localized Value (MLV) of N/A.
2. Carpet Areas:
   a. F(F): Specified Overall Value (SOV) of 25; Minimum Localized Value (MLV) of N/A.
   b. F(L): Specified Overall Value (SOV) of 15; Minimum Localized Value (MLV) of N/A.
3. Thinset Flooring:
   a. F(F): Specified Overall Value (SOV) of 30; Minimum Localized Value (MLV) of N/A.
   b. F(L): Specified Overall Value (SOV) of 24; Minimum Localized Value (MLV) of N/A.
4. Polished Concrete Flooring:
   a. F(F): Specified Overall Value (SOV) of 50; Minimum Localized Value (MLV) of 35.
   b. F(L): Specified Overall Value (SOV) of N/A; Minimum Localized Value (MLV) of N/A.
3.13 MISCELLANEOUS CONCRETE ITEMS

A. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases: Unless shown otherwise in the drawings provide 4" thick concrete pads under mechanical equipment as required. Reinforce with #4 @16" on center each way at center of pad. Dowel to floor structure with #3 hooked dowels with 12" horizontal legs, at 24" on center around perimeter of pad. Drill and epoxy with 3" embedment. Refer to Mechanical drawings for locations. Pad size to extend 6" beyond edge of equipment on all sides. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates of manufacturer furnishing machines and equipment.

3.14 CONCRETE PROTECTION 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 with recommendations in ACI 305R 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./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. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.

D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.

E. 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 with the following materials:
      a. Water.
      b. Continuous water-fog spray.
      c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch (300-mm) lap over adjacent absorptive covers.
   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 (300 mm), 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.
      a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
      b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
      c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of a floor covering used on Project.
   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. 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. Recoil 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.

F. General: Where structural slabs will be polished and exposed to view, protect structural concrete slab finished surface from surface damage and staining resulting from construction activities by utilizing appropriate membrane and sheet materials and other such measures as may be necessary to protect the finished slab surface appearance such as, but not limited to, diapering of equipment to eliminate oil leaks, and restricting construction activities that could be potentially detrimental to exposed to view slab finished surfaces. Protect concrete surfaces to receive polished finish:

1. Moist cure for a minimum of 10 days before covering with protection board.
2. Use Ram Board as protection board, with additional plywood during setting of steel. Do not use Masonite, hardboard.
3. Do not use staining snap lines. Use blue only.
4. Wet cure only, concrete slabs.
5. Slab curing temperature is to remain below 120 degrees F where radiant heating/cooling system plastic piping is integral with slab.
6. Forming and bracing must remain in place for support of structural slab until slab has come up to full strength.
7. Allow slabs to adequately cure to eliminate possibility of discoloring slab surface and silhouetting of protect board onto concrete finish surface. Hardboard may not be used as a protection board.

3.15 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.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch (13 mm) in any dimension in solid concrete but not less than 1 inch (25 mm) in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.

2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.

D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
   1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch (0.25 mm) wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
   2. After concrete has cured at least 14 days, correct high areas by grinding.
   3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
   4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
   5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch (6 mm) to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
   6. Repair defective areas, except random cracks and single holes 1 inch (25 mm) or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least 3/4 inch (19 mm) clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
   7. Repair random cracks and single holes 1 inch (25 mm) or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.16 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports as specified in Section 01 40 00.

B. Testing Agency: Engage a qualified independent testing and inspecting agency to perform tests, and inspections and to submit test reports

C. Inspections: As indicated in the General Structural Notes.

D. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
   1. Testing Frequency: Obtain at least one composite sample for each 150 cu. yd. or fraction thereof of each concrete mix placed each day and at least one composite sample for each 5000 square feet of surface area of slabs or walls.
a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C 143; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.

3. Air Content: ASTM C 231, pressure method, for normal-weight concrete; ASTM C 173, volumetric method, for structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.

4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.

5. Prior to finish flooring surfaces being installed, the relative humidity of the concrete slab shall meet the requirements of the flooring manufacturer or 80 percent, whichever is less, per ASTM F-2170-02 (Relative Humidity Probe Test).

   a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.

7. Compressive-Strength Tests: ASTM C 39; test one laboratory-cured specimen at 7 days, two at 28 days, and hold one for later testing.
   a. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.

8. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

9. Test results shall be reported in writing to Architect, Structural Engineer, concrete manufacturer, Building Official, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, type of break for both 7- and 28-day tests, and air content.

10. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

11. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42 or by other methods as directed by Architect.

12. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

13. Correct deficiencies in the Work that test reports and inspections indicate does not comply with the Contract Documents.

END OF SECTION
PART 1 - GENERAL

1.01 SECTION INCLUDES
A. Bonded abrasive polishing of exposed new and existing concrete floors to a Class B aggregate exposure and a Gloss Level of 3:
   1. Existing floor finish removal from slab.
   2. Joint and crack filler.
   5. Application of floor color stain.
   6. Oil repellent sealer.

1.02 DEFINITIONS
A. Aggregate Exposure: Grinding a concrete floor surface with bonded abrasives to achieve a specified class of exposed aggregate, classified as A, B, C and D with varying levels of exposed aggregate.
B. Finished Gloss: Processing a concrete floor surface to achieve a specified level of finished gloss prior to application of any protective treatment; Flat (ground), satin (honed), semi polished, and highly polished are measured in reflective clarity (DOI), and reflective sheen (specular gloss). Finished Gloss is classified as levels 1, 2, 3 and 4 with varying degrees of reflective clarity, and sheen.

1.03 PERFORMANCE REQUIREMENTS
A. Performance Criteria for final finish:
   1. Abrasion Resistance: ASTM C779 - Up to 20-26% increase in abrasion resistance.
   2. Impact Strength: ASTM C805 - Up to 21% increase impact strength.
   4. Reflectivity: Up to 30% increase in light reflectivity.
   5. Coefficient of friction: 0.6 per ANSI 101.3.
   6. Minimum flatness and level of F(F) of 35 and F(L) of 35 per ASTM E 1155.
   7. Gloss at 60 degrees from vertical of 70 to 85 units per ASTM D 523.
   8. Slip resistance of diamond polished concrete: Provide minimum 0.8 static coefficient of friction at stairs and ramps and to qualify as a slip resistant surface per Voices of Safety International VOSI V41.21 test method.

1.04 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Comply with pertinent provisions of Section 01 60 00- Product Requirements.
C. Certification of Mix Design Review: Submit finish applicator's review and acceptance of the mix design submitted per section 03 30 00 - Cast in Place Concrete for concrete flatwork to receive bonded abrasive polish finish.
D. Product data:
   1. Submit manufacturer's technical data specifications and test data giving descriptive data, curing time, and application requirements.
   2. Finished Floor Slip Resistance: Provide performance data for representative sample of similarly finished concrete flatwork demonstrating compliance with slip resistance requirements.
   3. Submit manufacturer's special concrete finish describing each product to be provided, giving manufacturer's name and product name for the specified material proposed to be provided under this section.
E. Test Reports: Provide certified test reports, prepared by an independent testing laboratory, confirming compliance with specified performance criteria.

F. Installer’s Certification.

G. Installation Instructions: Manufacturer’s recommended installation procedures and instructions for each special concrete finish; which when approved by the Architect, will become the basis for accepting or rejecting actual installation.

H. Pre-installation meeting minutes.

I. Manufacturer’s technical representative to submit to Architect and Owner’s representative field reports for each site visit.

1.05 QUALITY ASSURANCE

A. Source Quality Control: Provide concrete finishing components and materials from single manufacturer or as approved through the substitution request process.

B. Installer Qualifications:
   1. Applicator shall be familiar with the specified requirements and the methods needed for proper performance of work of this section. Applicator must have availability of proper equipment to perform work within scope of this project on a timely basis.
   2. Installer to provide manufacturer trained personnel, experienced, and skilled in application of materials and system finish specified in adequate numbers and maintain supervision over personnel.

C. Manufacturer’s Certification: Letter of certification from concrete finish manufacturer stating that installer is certified applicator of special concrete finishes, and is familiar with proper procedures and installation requirements required by the manufacturer.

D. Field Quality Control:
   1. Notify Architect and Owner’s representative a minimum of 7 days prior to any Work.
   2. Technical representative of materials manufacturer to observe Work in progress and at a minimum these other times:
      a. Pre-installation meeting.
      b. Installation of mock-up.
      c. Observation of completed installation.
   3. Document site visits in writing with copy to Architect.

1.06 MOCK-UPS:

A. Provide mock-ups of each type finish, new and existing slabs, in a selected area where new and existing are contiguous, to demonstrate typical joints, surface finished gloss, color variation (if any), aggregate exposure and standard of workmanship.
   1. Size: 100 square feet for each type (new and existing).
   2. Location: As selected by Architect.
   3. When accepted, mock-up will demonstrate minimum standard of quality required for this work.
   4. Maintain and protect mock-ups during construction in an undisturbed condition as a standard for judging the completed work.
   5. Approved mock-up may remain as part of finished work if undisturbed at time of substantial completion.
   6. Existing Slab Mock-Up:
      a. Prepare floor mock-up in advance of adjoining new slab placement so that mock-ups are at matching elevation.
      b. Slab preparation aesthetics must be approved by owner prior to beginning mock-up.
   7. Notify Architect or Owner Representative seven days in advance of dates and times when mock-ups will be constructed.
1.07 PRE-INSTALLATION CONFERENCE
A. Conduct conference at Project Site two weeks before starting Work of this section.
B. Review preparation and installation procedures and coordinating and scheduling required with related Work.

1.08 DELIVERY, STORAGE AND HANDLING
A. Deliver materials in original containers, with seals unbroken, bearing manufacturer labels indicating brand name and directions for storage.
B. Dispense special concrete finish material from factory numbered and sealed containers. Maintain record of container numbers.

1.09 PROJECT CONDITIONS
A. Protection of concrete floors prior to and after finishing:
   1. No satisfactory chemical or cleaning procedure is available to remove petroleum stains from the concrete surface. Prevention is therefore essential.
   2. All hydraulic powered equipment must be diapered to avoid staining of the concrete.
   3. No trade shall park vehicles on the inside slab. If necessary to complete their scope of work, drop cloths shall be placed under vehicles at all times.
   4. No pipe cutting machine shall be used on the inside floor slab.
   5. Steel will not be placed on interior slab to avoid rust staining.
   6. Acids and acidic detergents shall not come into contact with slab.
   7. All trades shall be informed that the slab must be protected at all times.
B. Environmental limitations:
   1. Comply with manufacturers written instructions for substrate temperature and moisture content, ambient temperature and humidity, ventilation, and other conditions affecting topping performance.
   2. Concrete must be cured a minimum of 28 days or as directed by the manufacturer before application of hardener/sealer can begin.
   3. Application of hardener/sealer shall take place 10 days prior to installation of equipment and substantial completion, thus providing a complete, uninhibited concrete slab for application.
C. Close areas to traffic during floor application and after application, for time period recommended in writing by manufacturer.
D. Protect floor access panels from damage in new and existing exposed concrete floors. Intent is to have access panels flush to adjacent polished concrete floors.

1.10 WARRANTY
A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
B. Seven year non-dusting warranty covering application and use of chemicals, diamond tooling and polishing equipment for installation of polished concrete floor.

PART 2 - PRODUCTS
2.01 MATERIALS
A. Hardener-Sealer-Densifier Requirements:
   1. Densifier: Nano-sized particles of reactive, amorphous colloidal silica in water.
   2. VOC Content: Zero volatile organic compounds.
   3. pH: 9.5-10.5.
   4. Consistency and Color: Non-gel forming with no visible residue or whitening when applied to concrete surfaces.
B. Joint Filler: Semi-rigid, 2-component, self-leveling, 100% solids, rapid curing, polyurea control joint and crack filler with Shore A 80 or higher hardness.
1. Type recommended by hardener-sealer-densifier manufacturer and compatible with hardener-sealer-densifier.

C. Latex Based Grout to fill exposed air pockets and aggregate lost due to grinding process
   1. Type recommended by hardener-sealer-densifier manufacturer and compatible with hardener-sealer-densifier.
   2. Bonding agent allows concrete dust to receive densification process and does not introduce colors outside of concrete matrix, no epoxy based grout product.

D. Concrete Stain:
   1. Acceptable Product: Scofield Lithochrome Chemstain Classic or approved equal.
   2. Color: Match architect's sample - See section 09 90 00 Color Schedule.

E. Oil Repellent Sealer: Ready to use, silane, siloxane and fluoropolymer blended water based solution sealer, quick drying, low-odor, oil and water repellent, VOC compliant and compatible with chemically hardened floors.
   1. Type recommended by hardener-sealer-densifier manufacturer and compatible with hardener-sealer-densifier.

F. Metal-bond and resin-bond diamond tooling appropriate for grinding, polishing and refinement of bonded abrasive polished concrete floor.
   1. 13 millimeter metal-bond, industrial diamond impregnated grinding segment for aggregate exposure and latex grout application.
   2. Resin bond diamond impregnated tooling for refinement and polishing.

2.02 SURFACE PREPARATION EQUIPMENT

A. Grinder: Triple-headed planetary type having fully independent speed/directional control of plate and satellite heads, with minimum 700 pounds grinding pressure and phase correction in conjunction with vacuum filtration system.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrate, with installer present, for conditions affecting performance and quality of finish. Correct conditions detrimental to timely and proper work. Do not proceed until such observations have been made, unsatisfactory conditions are corrected, and have been approved in writing to Architect.

B. Verify that base slab meet finish and surface profile requirements specified in Section 03 30 00 - Cast-In-Place Concrete, and Project Conditions above.

C. Prior to application, verify that floor surfaces are free of construction latents.

D. Concrete must be in place a minimum of 28 days or as directed by the manufacturer before application can begin.

3.02 PREPARATION

A. Protect adjacent finishes and floor that will be exposed.

B. Verify that protection is adequate daily and with each stage of finishing.

3.03 APPLICATION

A. Floor to be prepared for densifier application with specified diamond grinding steps, followed by final polishing steps:
   1. Level One (Flat / Ground) requires 150 grit metal bonded diamonds, 50 grit resin diamonds, and densifier;
   2. Level Two (Satin / Honed) requires 150 grit metal bonded diamonds, 50 grit resin diamonds, 120 grit resin diamonds, 220 grit resin diamonds, densifier and 400 grit resin diamonds;
3. Level Three (Semi-Polished) requires same steps as Level Two, with the addition of an 800 grit resin diamond final polish; Start any of the floor finish applications in presence of manufacturer's technical representative.

B. Sealing, Hardening and Polishing of Concrete Slabs:
   1. Application is to take place at 28 days after new slab has been placed. Existing slabs with cementitious cast underlayment or fill back areas using polymer modified cementious fill should be polished no sooner than 14 days after placement.
   2. Densifier shall be applied by a certified applicator, following applicable procedures as recommended by the manufacturer and as required to match approved mock-up.
   3. Achieve hardening, dust-proofing, and abrasion resistance of the surface without changing the natural appearance of the concrete, except for the sheen.
   4. Finish to within 1/2” of vertical surfaces where practical. Finish remainder of slab to vertical surface with hand held grinder/polisher.
   5. Polish to pre-determined level based on approved mock-up.

C. Concrete Stain: Apply concrete stain in strict conformance with stain manufacturer's instructions and best recommendations. Match approved mock-up.

D. Sealer:
   1. Apply sealer on entire floor as final finish of polished concrete. Follow application directions and burnish as recommended to level required to match mock-up final sheen.

3.04 CLEANING
   A. Keep work area clean and free of debris at all times.
   B. Remove spatter or dusting from adjoining surfaces, as necessary, depending on grinding process.
   C. Repair or replace damaged surfaces caused by preparation, polishing, or cleaning operations.
   D. Remove debris from jobsite.
      1. Dispose of materials in separate, closed containers in accordance with local regulations.

3.05 PROTECTION
   A. Close areas to traffic during floor application and after application, for time period recommended in writing by manufacturer.
   B. Final Protection of Polished Concrete:
      1. Following completion of the final polishing, protect finished work until fully cured in accordance with Manufacturer's recommendations.
      2. After finish work is fully cured, and prior to opening area to traffic, protect from other trades by covering with a breathable product, such as “Ramboard” or thin curing blanket. Do not use hardboard or any wood based products in direct contact with concrete as wood tanins will leave stain patterns on concrete surface.

3.06
   A. Manufacturer, Owner representative, polishing sub and responsible party for facility maintenance to review manufacture recommended maintenance program of polished floor.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Liquid applied, cementitious self-leveling floor underlayment.
   B. Sealer

1.02 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide manufacturer's data sheets documenting physical characteristics and product limitations of underlayment materials. Include information on mixing instructions.
   C. Manufacturer's Instructions: Indicate mix instructions.
   D. Sealer: Submit product data demonstrating compatibility with underlayment and finish floor material.
   E. Certificate: Certify that products meet or exceed specified requirements.

1.03 QUALITY ASSURANCE
   A. Applicator Qualifications: Company specializing in performing the work of this section and approved by manufacturer.

1.04 DELIVERY, STORAGE, AND HANDLING
   A. Store products in manufacturer's unopened packaging until ready for installation.
   B. Keep dry and protect from direct sun exposure, freezing, and ambient temperature greater than 105 degrees F.

1.05 REGULATORY REQUIREMENTS
   A. Conform to applicable code for combustibility or flame spread requirements.

1.06 MOCK-UP
   A. Provide a mock-up for evaluation of surface preparation techniques and application workmanship.
      1. Prepare mock-up in location designated by Architect.
      2. Do not proceed with underlayment work until workmanship of mock-up has been approved by Architect.
   B. Construct mock-up of underlayment material, minimum 10 feet long by 10 feet wide, illustrating all portions of specified work.
   C. Locate where directed.
   D. Mock-up may remain as part of the Work.

1.07 FIELD CONDITIONS
   A. Do not install underlayment until floor penetrations and peripheral work are complete.
   B. Maintain minimum ambient temperatures of 50 degrees F 24 hours before, during and 72 hours after installation of underlayment.
   C. During the curing process, ventilate spaces to remove excess moisture.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. Cementitious Underlayment:
      4. Substitutions: See Section 01 60 00 - Product Requirements.
2.02 MATERIALS
A. Cementitious Underlayment: Blended cement mix, that when mixed with water in accordance with manufacturer's directions will produce self-leveling underlayment with the following properties:
1. Flexural Strength: Minimum 1000 psi after 28 days, tested per ASTM C348.
3. Final Set Time: 1-1/2 to 2 hours, maximum.
4. Thickness: Capable of thicknesses from feather edge to maximum 3-1/2 inch.
5. Surface Burning Characteristics: Flame spread/Smoke developed index of 0/0 in accordance with ASTM E84.
B. Water: Potable and not detrimental to underlayment mix materials.
C. Primer: Manufacturer's recommended type.
D. Joint and Crack Filler: Latex based filler, as recommended by manufacturer.
E. Sealer: Manufacturer's standard sealer that is compatible and accepted by finish flooring materials.

2.03 MIXING
A. Site mix materials in accordance with manufacturer's instructions.
B. Mix to self-leveling consistency without over-watering.

PART 3 EXECUTION
3.01 EXAMINATION

3.02 PREPARATION
B. Vacuum clean surfaces.
C. Prime substrate in accordance with manufacturer's instructions. Allow to dry.
D. Close floor openings.

3.03 APPLICATION
A. Install underlayment in accordance with manufacturer's instructions.
B. Place to indicated thickness, with top surface level to 1/8 inch in 10 ft.

3.04 CURING
A. Once underlayment starts to set, prohibit foot traffic until final set has been reached.
B. Air cure in accordance with manufacturer's instructions.

3.05 FIELD QUALITY CONTROL
A. An independent testing agency will perform field inspection and testing, as specified in Section 01 40 00.
B. Placed Material: Agency will inspect and test for conformance to specification requirements.
   1. Prepare compression test cubes for each placement of 1,000 square feet or less.

3.06 PROTECTION
A. Protect against direct sunlight, heat, and wind; prevent rapid drying to avoid shrinkage and cracking.
B. Do not permit traffic over unprotected floor underlayment surfaces.
3.07 SEALER

A. Sealing: Seal all areas that receive glue down floor goods, including but not limited to; bathrooms, toilet rooms, laundry areas, and all areas within 10 feet of all other sinks with manufacturer's approved sealer and according to the manufacturer's specifications. Any floor areas where the surface has been damaged shall be cleaned and sealed regardless of floor covering or location. Where floor goods manufacturers require special adhesive or installation systems, their requirements supersede these recommendations.

B. Floor Goods Procedures: See the manufacturer's "Procedures for Attaching Finished Floor Goods to Underlayments" brochure for guidelines for installing finished floor goods.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Concrete Block.
B. Concrete Brick.
C. Mortar and Grout.
D. Reinforcement and Anchorage.
E. Flashings.
F.Lintels.
G. Accessories.

1.02 REFERENCE STANDARDS
A. ACI 530/530.1/ERTA - Building Code Requirements and Specification for Masonry Structures and Related Commentaries; American Concrete Institute International; 2011.
G. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2010.

1.03 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data for masonry units, fabricated wire reinforcement, mortar, and masonry accessories.
C. Samples: Submit four samples of decorative block units to illustrate color, texture, and extremes of color range.
D. Manufacturer's Certificate: Certify that masonry units meet or exceed specified requirements.
E. Manufacturer's Certificate: Certify that water repellent admixture manufacturer has certified masonry unit manufacturer as an approved user of water repellent admixture in the manufacture of concrete block.

F. Test Reports: Concrete masonry manufacturer's test reports for units with integral water repellent admixture.

1.04 QUALITY ASSURANCE

A. Comply with provisions of ACI 530/530.1/ERTA, except where exceeded by requirements of the contract documents.

1.05 MOCK-UP

A. Construct a masonry wall as a mock-up panel sized 8 feet long by 6 feet high; include mortar and accessories and structural backup in mock-up.

B. Locate where directed.

C. Approved mock-up may remain as part of the Work.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver, handle, and store masonry units by means that will prevent mechanical damage and contamination by other materials.

B. Handle and store ceramic glazed masonry units in protective cartons or trays. Do not remove from protective packaging until ready for installation.

PART 2 PRODUCTS

2.01 CONCRETE MASONRY UNITS

A. Concrete Block: Comply with referenced standards and as follows:
   1. Size: Standard units with nominal face dimensions of 16 x 8 inches and nominal depths as indicated on the drawings for specific locations.
   2. Special Shapes: Provide non-standard blocks configured for corners.
   3. Load-Bearing Units: ASTM C90, normal weight.
      a. Hollow block, as indicated.
      b. Exposed faces: Manufacturer's standard color and texture where indicated.

B. Concrete Brick:
   1. For architectural and paver use, ASTM C1634 (or ASTM C55-03 Grade N), non-cored (solid), normal weight.
   2. Size: As indicated on drawings.
   3. Special Shapes: Provide non-standard brick configured for corners, lintels, and headers.

2.02 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C150, Type I; color as required to produce approved color sample.
   1. Hydrated Lime: ASTM C207, Type S.


2.03 REINFORCEMENT AND ANCHORAGE

A. Reinforcing Steel: ASTM A615/A615M Grade 40 (280) deformed billet bars; galvanized.

B. Single Wythe Joint Reinforcement: Truss type; ASTM A 82/A 82M steel wire, hot dip galvanized after fabrication to ASTM A 153/A 153M, Class B; 0.1483 inch side rods with 0.1483 inch cross rods; width as required to provide not more than 1 inch and not less than 1/2 inch of mortar coverage on each exposure.
C. Strap Anchors: Bent steel shapes configured as required for specific situations, 1-1/4 in width, 0.105 in thick, lengths as required to provide not more than 1 inch and not less than 1/2 inch of mortar coverage from masonry face, corrugated for embedment in masonry joint, hot dip galvanized to ASTM A 153/A 153M, Class B.

D. Flexible Anchors: 2-piece anchors that permit differential movement between masonry and building frame, sized to provide not more than 1 inch and not less than 1/2 inch of mortar coverage from masonry face.

E. Masonry Veneer Anchors: 2-piece anchors that permit differential movement between masonry veneer and structural backup, hot dip galvanized to ASTM A 153/A 153M, Class B.
   1. Anchor plates: Not less than 0.075 inch thick, designed for fastening to structural backup through sheathing by two fasteners; provide design with legs that penetrate sheathing and insulation to provide positive anchorage.
   2. Wire ties: Manufacturer's standard shape, 0.1875 inch thick.
   3. Vertical adjustment: Not less than 3-1/2 inches.

2.04 FLASHINGS

A. Metal Flashing Materials: Copper, as specified in Section 07 62 00.

2.05 ACCESSORIES

A. Preformed Control Joints: Rubber material. Provide with corner and tee accessories, fused joints.
   1. Manufacturers:
      d. Substitutions: See Section 01 60 00 - Product Requirements.

B. Joint Filler: Closed cell polyvinyl chloride; oversized 50 percent to joint width; self expanding.
   1. Manufacturers:
      d. Substitutions: See Section 01 60 00 - Product Requirements.

C. Cavity Mortar Control: Semi-rigid polyethylene or polyester mesh panels, sized to thickness of wall cavity, and designed to prevent mortar droppings from clogging weeps and cavity vents and allow proper cavity drainage.

D. Building Paper: ASTM D226, Type I ("No.15") asphalt felt.

E. Nailing Strips: Softwood lumber, preservative treated; as specified in Section 06 10 00.

F. Weeps: Polyethylene tubing.
   1. Manufacturers:
      d. Substitutions: See Section 01 60 00 - Product Requirements.

G. Cavity Vents: Polyester mesh.
   1. Manufacturers:
      d. Substitutions: See Section 01 60 00 - Product Requirements.

H. Cleaning Solution: Non-acidic, not harmful to masonry work or adjacent materials.
2.06 MORTAR AND GROUT MIXES

A. Mortar for Unit Masonry: ASTM C270, using the Proportion Specification.
   1. Type S for all applications.
B. Mortar for Unit Masonry: See Structural Notes.
C. Colored Mortar: Proportion selected pigments and other ingredients to match Architect's sample, without exceeding manufacturer's recommended pigment-to-cement ratio.
D. Grout: ASTM C476. Consistency required to fill completely volumes indicated for grouting; fine grout for spaces with smallest horizontal dimension of 2 inches or less; coarse grout for spaces with smallest horizontal dimension greater than 2 inches.
E. Grout: See Structural Notes.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field conditions are acceptable and are ready to receive masonry.
B. Verify that related items provided under other sections are properly sized and located.
C. Verify that built-in items are in proper location, and ready for roughing into masonry work.

3.02 PREPARATION

A. Direct and coordinate placement of metal anchors supplied for installation under other sections.
B. Provide temporary bracing during installation of masonry work. Maintain in place until building structure provides permanent bracing.

3.03 COLD AND HOT WEATHER REQUIREMENTS

A. Comply with requirements of ACI 530/530.1/ERTA or applicable building code, whichever is more stringent.

3.04 COURSING

A. Establish lines, levels, and coursing indicated. Protect from displacement.
B. Maintain masonry courses to uniform dimension. Form vertical and horizontal joints of uniform thickness.
C. Concrete Masonry Units:
   1. Bond: Running.
   2. Coursing: One unit and one mortar joint to equal 8 inches.

3.05 PLACING AND BONDING

A. Lay solid masonry units in full bed of mortar, with full head joints, uniformly jointed with other work.
B. Lay hollow masonry units with face shell bedding on head and bed joints.
C. Buttering corners of joints or excessive furrowing of mortar joints is not permitted.
D. Remove excess mortar and mortar smears as work progresses.
E. Remove excess mortar with water repellent admixture promptly. Do not use acids, sandblasting or high pressure cleaning methods.
F. Interlock intersections and external corners, except for units laid in stack bond.
G. Do not shift or tap masonry units after mortar has achieved initial set. Where adjustment must be made, remove mortar and replace.
H. Perform job site cutting of masonry units with proper tools to provide straight, clean, unchipped edges. Prevent broken masonry unit corners or edges.
I. Cut mortar joints flush where wall tile is scheduled or resilient base is scheduled.
J. Isolate masonry partitions from vertical structural framing members with a control joint as indicated.
K. Isolate top joint of masonry partitions from horizontal structural framing members and slabs or decks with compressible joint filler.

3.06 WEEPS/CAVITY VENTS
A. Install weeps in veneer and cavity walls at 24 inches on center horizontally above through-wall flashing.
B. Install cavity vents in veneer and cavity walls at 32 inches on center horizontally below shelf angles and lintels and near top of walls.

3.07 CAVITY MORTAR CONTROL
A. Do not permit mortar to drop or accumulate into cavity air space or to plug weep/cavity vents.
B. Install cavity mortar control panels continuously throughout full height of exterior masonry cavities during construction of exterior wythe, complying with manufacturer’s installation instructions. Verify that airspace width is no more than 3/8 inch greater than panel thickness. Install horizontally between joint reinforcement. Stagger end joints in adjacent rows. Fit to perimeter construction and penetrations without voids.
C. Install cavity mortar diverter at base of cavity and at other flashing locations as recommended by manufacturer to prevent mortar droppings from blocking weep/cavity vents.

3.08 REINFORCEMENT AND ANCHORAGE - GENERAL
A. Reinforce as indicated on drawings.

3.09 REINFORCEMENT AND ANCHORAGE - MASONRY VENEER
A. Install horizontal joint reinforcement 16 inches on center.
B. Place masonry joint reinforcement in first and second horizontal joints above and below openings. Extend minimum 16 inches each side of opening.
C. Place continuous joint reinforcement in first and second joint below top of walls.
D. Lap joint reinforcement ends minimum 6 inches.
E. Masonry Back-Up: Embed anchors in masonry back-up to bond veneer at maximum 1.77 sq ft of wall surface per anchor. Place additional anchors at perimeter of openings and ends of panels, so maximum spacing of anchors is 8 inches on center.
F. Stud Back-Up: Secure veneer anchors to stud framed back-up and embed into masonry veneer at maximum 1.77 sq ft of wall surface per anchor. Place additional anchors at perimeter of openings and ends of panels, so maximum spacing of anchors is 8 inches on center.
G. Seismic Reinforcement: Connect veneer anchors with continuous horizontal wire reinforcement before embedding anchors in mortar.

3.10 MASONRY FLASHINGS
A. Whether or not specifically indicated, install masonry flashing to divert water to exterior at all locations where downward flow of water will be interrupted.

3.11 LINTELS
A. Install reinforced unit masonry lintels over openings where steel or precast concrete lintels are not scheduled.

3.12 GROUTED COMPONENTS
A. Lap splices minimum per lap splice schedule, see Structural Notes.
B. Support and secure reinforcing bars from displacement. Maintain position within 1/2 inch of dimensioned position.
C. Place and consolidate grout fill without displacing reinforcing.

3.13 CONTROL AND EXPANSION JOINTS
A. Install preformed control joint device in continuous lengths. Seal butt and corner joints in accordance with manufacturer's instructions.

3.14 BUILT-IN WORK
A. As work progresses, install built-in metal door frames and other items to be built into the work and furnished under other sections.
B. Install built-in items plumb, level, and true to line.
C. Bed anchors of metal door and glazed frames in adjacent mortar joints. Fill frame voids solid with grout.
   1. Fill adjacent masonry cores with grout minimum 12 inches from framed openings.
D. Do not build into masonry construction organic materials that are subject to deterioration.

3.15 TOLERANCES
A. Maximum Variation from Alignment of Columns: 1/4 inch.
B. Maximum Variation From Unit to Adjacent Unit: 1/16 inch.
C. Maximum Variation from Plane of Wall: 1/4 inch in 10 ft and 1/2 inch in 20 ft or more.
D. Maximum Variation from Plumb: 1/4 inch per story non-cumulative; 1/2 inch in two stories or more.
E. Maximum Variation of Joint Thickness: 1/8 inch in 3 ft.
F. Maximum Variation from Cross Sectional Thickness of Walls: 1/4 inch.

3.16 CUTTING AND FITTING
A. Cut and fit for chases. Coordinate with other sections of work to provide correct size, shape, and location.
B. Obtain approval prior to cutting or fitting masonry work not indicated or where appearance or strength of masonry work may be impaired.

3.17 FIELD QUALITY CONTROL
A. An independent testing agency will perform field quality control tests, as specified in Section 01 40 00.

3.18 CLEANING
A. Remove excess mortar and mortar droppings.
B. Replace defective mortar. Match adjacent work.
C. Clean soiled surfaces with cleaning solution.
D. Use non-metallic tools in cleaning operations.

3.19 PROTECTION
A. Without damaging completed work, provide protective boards at exposed external corners that are subject to damage by construction activities.

END OF SECTION
PART 1 - GENERAL

1.01 SECTION INCLUDES
A. Surface preparation and shop applied high-performance coating on steel fabrications.
B. Coating System: Thermally fused polymer primer and top coat.

1.02 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: For each type of product indicated.
   1. Proposed preparation and film thicknesses.
C. Samples for Verification: For each type of coating system and in each color and gloss of finish coat indicated.
   1. Submit Samples on prepared steel angle, 12 inches long.
   2. Step coats on Samples to show each coat required for system.
   3. Label each Sample for location and application area.
D. Coordinated Sample: Railing infill panel, coordinate with Section 05 75 00.
E. Applicator's qualifications.
F. Sample warranty.

1.03 QUALITY ASSURANCE
A. Manufacturer's Qualifications: Firm that specializes is high performance thermally fused powders. Member of Powder Coating Institute (PCI).
   1. Provide products from one Manufacturer.
B. Applicator's Qualifications: Experienced powder coater complying with the following:
   1. Approved by Manufacturer.
   2. Member of PCI is preferred.
   3. Established in-house quality control in compliance with PCI recommendations or NACE requirements, including certified inspector.
C. Single Applicator: Arrange for work in this Section by one applicator. Work may be executed in Applicator's shop or fabricator's shop, providing adequate facility for preparation, application, and protection of personnel and products.

1.04 DELIVERY, STORAGE, AND HANDLING
A. Coated Steel Fabrications: Do not handle coated products until coating is set and attains 90% hardness.
   1. Deliver products protected with recycled and recyclable cardboard and paper.

1.05 WARRANTY
A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
B. Manufacturer's and Applicator's 10 year product and application warranty against coating defect including specified performance requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS
A. Acceptable Coating Powders:
   1. Akzo Nobel Interpon Powder Coatings.
   2. Cardinal Industrial Finishes.
   3. PPG Industries, Inc.
   4. Prismatic
   5. Spraylat Powder Coatings.
7. Substitutions: See Section 01 60 00 - Product Requirements.

B. Acceptable Portland Area Applicators:
   1. Portland Powder Coating, Inc.
   2. Powder Tech, Inc.
   3. Tufcoat, Inc.
   4. Eastside Plating.
   5. Substitutions: See Section 01 60 00 - Product Requirements.

C. Acceptable Eugene Area Applicators:
   1. Alltech Finishes, Eugene.
   2. Custom Powderworks, Springfield.
   4. RPB Coatings, Junction City.
   5. Willamette Power-Fab, Albany.
   6. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 COATING POWDER
   A. Primer and top coat from one acceptable manufacturer and recommended by Manufacturer for use together.
   B. Primer: Epoxy or urethane resin with zinc-rich filler or mio-zinc filler, formulated to prevent steel corrosion and create a barrier to water.
   C. Top Coat: Polyurethane color coating for exterior exposure complying with the following:
      1. Performance Requirement: Comply with AAMA 2604.

2.03 FIELD TOUCH-UP COATING
   A. When required by Contractor for field touch-up, provide primer and top coat in liquid form in aerosol cans. Label cans including Project, product and contents, shelf life, basic application instructions.

2.04 PREPARATION
   A. Examine metal fabrications. Notify fabricator of defects that must be corrected before coating. Defects include:
      1. Rough areas not complying with fabrication standard.
      2. Pits or areas that may cause coating failure.
   B. Comply with coating Manufacturer's instructions, but not less than the following.
   C. Steel: SSPC-SP6/NACE No. 3 Commercial Blast Cleaning or SSPC-SP8 Pickling.
   D. Galvanized Hardware: Blast cleaning or as recommended by Manufacturer.

2.05 SHOP FINISHING
   A. Apply primer and top coat within 8 hours of preparation. Products may be held overnight in warm oven, only.
   B. Apply coating in compliance with manufacturer's instructions to achieve thickness, gloss and performance specified.
      1. Primer Thickness: not less than 3.5 mils.
      2. Top Coat Thickness: not less than 2.5 mils.
   C. Apply top coat to pre-gelled primer.
   E. Stair Pans: Mask interior of pan and reinforcing with will be in contact with concrete fill. Lap finish in ¼ inch.
PART 3 - EXECUTION

3.01 INSTALLATION

A. Installation of work finished in this Section is specified in fabrication Sections.
B. Coordinate delivery schedule so that finished fabrications are installed as quickly as possible and as near Substantial Completion as practical.

3.02 FIELD TOUCH UP

A. Prepare surface by SSPC-SP3.
B. Sand adjacent finish to feather edge. Constrain feathering to less than 1 inch strip.
C. Touch up damaged and uncoated surfaces immediately with primer to approximate power version. Apply two coats if necessary.
D. Touch up top coat to approximate powder version. Feather edge. Apply several coats if necessary.

3.03 CLEANING AND PROTECTION

A. Protect work of other trades against damage from coating operation. Correct damage by cleaning, repairing, replacing, and recoating, as approved by Architect, and leave in an undamaged condition.
B. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Structural steel framing members, support members, and struts.
   B. Base plates, shear stud connectors and expansion joint plates.
   C. Grouting under base plates.

1.02 REFERENCE STANDARDS
   K. ASTM A325M - Standard Specification for Structural Bolts, Steel, Heat Treated, 830 MPa Tensile Strength (Metric); 2013.
AB. ASTM F 436M-93 - Specification for Hardened Steel Washers (Metric); 2000.
AC. ASTM F959 - Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners; 2009.
AE. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination; American Welding Society; 2012.

1.03 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: For each type of product indicated.
C. Shop Drawings: Show fabrication of structural-steel components.
   1. Structural steel shop drawings shall contain sufficient detail and information to allow complete fabrication and erection of the structure without reference to the contract drawings either on the fabrication shop floor or at the project site. The steel detailer shall generate all shop drawing fabrication and installation details from the structural and architectural drawings and specifications. The use of reproductions or photocopies of the contract drawings shall not be permitted.
   2. Indicate profiles, sizes, spacing, locations of structural members, openings, attachments, and fasteners.
   3. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
   4. Include embedment drawings.
   5. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.
   6. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pre-tensioned and slip-critical high-strength bolted connections.
   7. Additional seismic submittal requirements:
      a. Identify members and connections that are part of the SLRS as indicated in the construction documents.
      b. Locations of demand critical welds.
      c. Locations and dimensions of protected zones.
      d. Locations of slip critical bolts.
      e. Access hole dimensions, surface profile and finish requirements.
      f. Locations where backing bars and weld tabs are to be removed.
      g. Locations where supplemental fillet welds are required when backing in permitted to remain.
h. Connection assembly sequence where special precautions are required.

i. Non-Destructive Testing (NDT) to be performed by the fabricator, if any.


k. AWS D1.8/D1.8M – Structural Welding Code – Seismic Supplement; 2009.

8. Shop drawing re-submittals shall clearly identify all revisions to previous submittals.
   a. Heavy ink, clouded outlines (revision clouds) shall be drawn around revised areas of individual sheets.
   b. Engineer/Architect will not review information outside of revision clouds on resubmitted drawings.

D. Manufacturer's Mill Certificate: Certify that products meet or exceed specified requirements.

E. Mill Test Reports: Indicate structural strength, destructive test analysis and non-destructive test analysis.

F. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within the previous 12 months.

G. See structural drawings for additional requirements.

1.04 QUALITY ASSURANCE

A. Fabricate structural steel members in accordance with AISC "Steel Construction Manual."

B. Comply with Section 10 of AISC "Code of Standard Practice for Steel Buildings and Bridges" for architecturally exposed structural steel.

C. Fabricator: Company specializing in performing the work of this section with minimum five years of documented experience.

D. Erector: Company specializing in performing the work of this section with minimum five years of documented experience.

E. Fabricator and Erector shall follow the AISC 341 Appendix Q "Quality Assurance Plan".

PART 2 PRODUCTS

2.01 MATERIALS

A. Steel Angles and Plates: ASTM A36/A36M.

B. Steel W Shapes and Tees: ASTM A992/A992M.

C. Rolled Steel Structural Shapes: ASTM A992/A992M.

D. Steel Shapes, Plates, and Bars: ASTM A 242/A 242M high-strength, corrosion-resistant structural steel.

E. Steel Shapes, Plates, and Bars: ASTM A529/A529M high-strength, carbon-manganese structural steel, Grade 50.

F. Steel Plates and Bars: ASTM A572/A572M, Grade 50 (345) high-strength, columbium-vanadium steel.

G. Cold-Formed Structural Tubing: ASTM A500, Grade B.

H. Hot-Formed Structural Tubing: ASTM A501, seamless or welded.

I. Steel Bars: ASTM A108 Grades 1015 through 1020.

J. Steel Plate: ASTM A514/A514M.

K. Steel Sheet: ASTM A1011/A1011M, Designation SS, Grade 30 hot-rolled, or ASTM A1008/A1008M, Designation SS, Grade 30 cold-rolled.


M. Shear Stud Connectors: Made from ASTM A 108 Grade 1015 bars.
N. Structural Bolts, Nuts and Washers: Carbon steel, ASTM A307, Grade A galvanized to ASTM A 153/A 153M, Class C.

O. High-Strength Structural Bolts, Nuts, and Washers: ASTM A325 (ASTM A325M), Type 1, medium carbon, galvanized.

P. High-Strength Structural Bolts: ASTM A490 (ASTM A490M), with matching ASTM A563 (ASTM A563M) nuts and ASTM F436 washers; Type 1 alloy steel.

Q. Unheaded Anchor Rods: ASTM F1554, Grade 36, plain, with matching ASTM A563 or A563M nuts and ASTM F436 Type 1 washers.

R. Headed Anchor Rods: ASTM F1554, Grade 36, straight, with matching ASTM A563 or A563M nuts and ASTM F436 Type 1 washers. Use setting templates with jamb nuts top and bottom as required.

S. Welding Materials: AWS D1.1; type required for materials being welded.

T. Sliding Bearing Plates: Teflon coated.

U. Grout: Non-shrink, non-metallic aggregate type, complying with ASTM C1107/C1107M and capable of developing a minimum compressive strength of 7,000 psi at 28 days.

V. Shop and Touch-Up Primer: Fabricator's standard, complying with VOC limitations of authorities having jurisdiction.

W. Touch-Up Primer for Galvanized Surfaces: Fabricator's standard, complying with VOC limitations of authorities having jurisdiction.

2.02 FABRICATION

A. Shop fabricate to greatest extent possible.

B. Space shear stud connectors as indicated.

C. Continuously seal joined members by continuous welds. Grind exposed welds smooth.

D. Fabricate connections for bolt, nut, and washer connectors.

E. Develop required camber for members.

F. Cut, drill or punch standard bolt holes perpendicular to metal surfaces.

2.03 FINISH

A. Prepare structural component surfaces in accordance with SSPC SP 2.

B. Shop prime structural steel members. Do not prime surfaces that will be fireproofed, field welded, in contact with concrete, or high strength bolted.

C. Leave structural steel members un-primed.

D. Galvanize structural steel members to comply with ASTM A123/A123M. Provide minimum 1.7 oz/sq ft galvanized coating.

2.04 SOURCE QUALITY CONTROL

A. Provide shop testing and analysis of structural steel as required in structural notes.

B. High-Strength Bolts: Provide testing and verification of shop-bolted connections in accordance with AISC "Specification for Structural Joints Using ASTM A325 or A490 Bolts".

C. Welded Connections: Visually inspect all shop-welded connections and test using one of the following:
   1. Radiographic testing performed in accordance with ASTM E94.
   2. Ultrasonic testing performed in accordance with ASTM E164. Use for all Full Penetration welds.
   3. Liquid penetrant inspection performed in accordance with ASTM E165.
   4. Magnetic particle inspection performed in accordance with ASTM E709.
PART 3 EXECUTION

3.01 ERECTION

A. Erect structural steel in compliance with AISC "Code of Standard Practice for Steel Buildings and Bridges".

B. Grout solidly between column plates and bearing surfaces, complying with manufacturer's instructions for nonshrink grout. Trowel grouted surfaces smooth, splaying neatly to 45 degrees.

3.02 TOLERANCES

A. Maximum Variation From Plumb: 1/4 inch per story, non-cumulative.

B. Maximum Offset From True Alignment: 1/4 inch.

3.03 FIELD QUALITY CONTROL

A. An independent testing agency will perform field quality control tests, as specified in Section 01 40 00.

B. High-Strength Bolts: Provide testing and verification of field-bolted connections in accordance with AISC "Specification for Structural Joints Using ASTM A325 or A490 Bolts".

C. Welded Connections: Visually inspect all field-welded connections and using one of the following:
   1. Radiographic testing performed in accordance with ASTM E94.
   2. Ultrasonic testing performed in accordance with ASTM E164. Use for all Full Penetration Welds.
   3. Liquid penetrant inspection performed in accordance with ASTM E165.
   4. Magnetic particle inspection performed in accordance with ASTM E709.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Roof deck.
   B. Composite floor deck.
   C. Bearing plates and angles.
   D. Stud shear connectors.

1.02 REFERENCE STANDARDS
   E. AWS D1.3 - Structural Welding Code - Sheet Steel; American Welding Society; 2008.
   F. SDI (DM) - Publication No.31, Design Manual for Composite Decks, Form Decks, Roof Decks; Steel Deck Institute; 2007.
   H. SSPC-Paint 25 - Zinc Oxide, Alkyd, Linseed Oil Primer for Use Over Hand Cleaned Steel, Type I and Type II; Society for Protective Coatings; 1997 (Ed. 2004).

1.03 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittals procedures.
   B. Shop Drawings: Indicate deck plan, support locations, projections, openings, reinforcement, pertinent details, and accessories.
   C. Product Data: Provide deck profile characteristics, dimensions, structural properties, and finishes.
   D. Certificates: Certify that products furnished meet or exceed specified requirements.
   E. Submit manufacturer's installation instructions.
   F. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within the previous 12 months.

1.04 QUALITY ASSURANCE
   A. Installer Qualifications: Company specializing in performing the work of this Section with minimum three years of experience.

1.05 DELIVERY, STORAGE, AND HANDLING
   A. Cut plastic wrap to encourage ventilation.
   B. Separate sheets and store deck on dry wood sleepers; slope for positive drainage.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. Steel Deck:

2.02 STEEL DECK
   A. All Deck Types: Select metal deck in accordance with SDI Design Manual.
   B. Roof Deck: Non-composite type, fluted steel sheet:
1. Galvanized Steel Sheet: ASTM A653/A653M, Structural Steel (SS), with G90/Z275 galvanized coating.
   a. Grade as required to meet performance criteria.
2. Primer: Shop coat of manufacturer's standard primer paint over cleaned and phosphatized substrate.
3. Structural Properties:
5. Nominal Height: As indicated.
6. Profile: Fluted; SDI WR.
7. Formed Sheet Width: As indicated.
10. Fire Resistance Classification: Comply with UL Assembly Number _____.SERA?

C. Composite Floor Deck: Fluted steel sheet embossed to interlock with concrete:
2. Primer: Shop coat of manufacturer's standard primer paint over cleaned and phosphatized substrate.
3. Structural Properties:
5. Minimum Metal Thickness, Excluding Finish: As indicated.
6. Nominal Height: As indicated.
7. Profile: Fluted; SDI WR.
8. Formed Sheet Width: As indicated.
11. Fire Resistance Classification: Comply with UL Assembly Number _____.SERA?

2.03 ACCESSORY MATERIALS
A. Bearing Plates and Angles: ASTM A36/A36M steel, unfinished.
B. Stud Shear Connectors: Made from ASTM A 108 Grade 1015 bars.
D. Fasteners: Galvanized hardened steel, self tapping.
E. Weld Washers: Mild steel, uncoated, 3/4 inch outside diameter, 1/8 inch thick.
F. Shop and Touch-Up Primer: SSPC-Paint 25, zinc oxide, complying with VOC limitations of authorities having jurisdiction.
G. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20, complying with VOC limitations of authorities having jurisdiction.
H. Flute Closures: Closed cell foam rubber, 1 inch thick; profiled to fit tight to the deck.

2.04 FABRICATED DECK ACCESSORIES
A. Sheet Metal Deck Accessories: Metal closure strips, wet concrete stops, and cover plates, 22 gage thick sheet steel; of profile and size as indicated; finished same as deck.
B. Cant Strips: Formed sheet steel, 20 gage thick, 45 degree slope, 3 1/2 inch nominal width and height, flange for attachment.
C. Roof Sump Pans: 14 gage sheet steel, flat bottom, sloped sides, recessed 1-1/2 inches below roof deck surface, bearing flange 3 inches wide, sealed watertight.
D. Floor Drain Pans: 14 gage sheet steel, flat bottom, sloped sides, recessed 1-1/2 inches below floor deck surface, bearing flange 3 inches wide, sealed watertight.
PART 3 EXECUTION

3.01 EXAMINATION

3.02 INSTALLATION

A. Erect metal deck in accordance with SDI Design Manual and manufacturer's instructions. Align and level.
B. Clinch lock seam side laps.
C. At mechanically fastened male/female side laps fasten at 24 inches on center maximum.
D. At welded male/female side laps weld at 18 inches on center maximum.
E. Weld deck in accordance with AWS D1.3.
F. At deck openings from 6 inches to 18 inches in size, provide 2 x 2 x 1/4 inch steel angle reinforcement. Place angles perpendicular to flutes; extend minimum two flutes beyond each side of opening and fusion weld to deck at each flute.
G. Where deck changes direction, install 6 inch minimum wide sheet steel cover plates, of same thickness as deck. Fusion weld 12 inches on center maximum.
H. At floor edges, install concrete stops upturned to top surface of slab, to contain wet concrete. Provide stops of sufficient strength to remain stationary without distortion.
I. At openings between deck and walls, columns, and openings, provide sheet steel closures and angle flashings to close openings.
J. Close openings above walls and partitions perpendicular to deck flutes with single row of foam cell closures.
K. Place metal cant strips in position and fusion weld.
L. Position roof drain pans with flange bearing on top surface of deck. Fusion weld at each deck flute.
M. Position floor drain pans with flange bearing on top surface of deck. Fusion weld at each deck flute.
N. Weld stud shear connectors through steel deck to structural members below.
O. Immediately after welding deck and other metal components in position, coat welds, burned areas, and damaged surface coating, with touch-up primer.
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Formed steel stud exterior wall framing.
B. Exterior wall sheathing.
C. Formed steel joist framing and bridging.
D. Water-resistive barrier over sheathing.

1.02 REFERENCE STANDARDS
A. AISI SG02-1 - North American Specification for the Design of Cold-Formed Steel Structural Members; American Iron and Steel Institute; 2001 with 2004 supplement. (replaced SG-971)
F. ASTM C955 - Standard Specification for Load-Bearing (Transverse and Axial) Steel Studs, Runners (Tracks), and Bracing or Bridging for Screw Application of Gypsum Panel Products and Metal Plaster Bases; 2011c.
G. PS 1 - Structural Plywood; 2009.
H. SSPC-Paint 15 - Steel Joist Shop Primer; Society for Protective Coatings; 1999 (Ed. 2004).

1.03 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data on standard framing members; describe materials and finish.
C. Shop Drawings: Indicate framing layout.
D. Manufacturer's Installation Instructions: Indicate special procedures and conditions requiring special attention.

1.04 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing the types of products specified in this section, and with minimum three years of documented experience.
B. Installer Qualifications: Company specializing in performing the work of this section with minimum three years of experience.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Metal Framing, Connectors, and Accessories:

2.02 FRAMING MATERIALS
A. Studs and Track: ASTM C955; studs formed to channel, "C", or "Sigma" shape; U-shaped track in matching nominal width and compatible height.
B. Framing Connectors: Factory-made, formed steel sheet.
   1. Material: ASTM A653/A653M SS Grade 33 and 40 (minimum), with G90/Z275 hot dipped galvanized coating for thicknesses less than 10 gage (0.118 inch), and factory punched holes and slots.
2.03 WALL SHEATHING
   A. Gypsum Sheathing: ASTM C 1396/C 1396M, water-resistant core, V-shaped long edges, 1/2 inch thick.
   B. Glass Mat Faced Gypsum Sheathing: ASTM C 1177/C 1177M, water-resistant core, square long edges, 1/2 inch thick.
   C. Wall Sheathing: Extruded polystyrene foam board, ASTM C 578, Type IV; tongue and groove long edges; 3/4 inch thick.
   D. Sure-Board: Or approved equal.

2.04 ACCESSORIES
   A. Bracing, Furring, Bridging: Formed sheet steel, thickness determined for conditions encountered; finish to match framing components.
   B. Shop and Touch-Up Primer: SSPC-Paint 15, complying with VOC limitations of authorities having jurisdiction.
   C. Water-Resistive Barrier: As specified in Section 07 25 00.

2.05 FASTENERS
   A. Self-Drilling, Self-Tapping Screws, Bolts, Nuts and Washers: Hot dip galvanized per ASTM A153/A153M.
   B. Anchorage Devices: Powder actuated.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that substrate surfaces are ready to receive work.

3.02 INSTALLATION OF STUDS
   A. Install components in accordance with manufacturers’ instructions and ASTM C 1007 requirements.

3.03 WALL SHEATHING
   A. Wall Sheathing: Secure with long dimension perpendicular to wall studs, with ends over firm bearing and staggered, using self-tapping screws.
      1. Place water-resistive barrier horizontally over wall sheathing, weather lapping edges and ends.

3.04 TOLERANCES

END OF SECTION
PART 1  GENERAL
1.01  SECTION INCLUDES
   A. Delegated design, load-bearing cold formed steel furring assemblies for wall cladding systems.

1.02  QUALITY ASSURANCE
   A. Designer Qualifications: Design framing system under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed in the State of the project.

1.03  SUBMITTALS
   A. Product Data: For each type of product indicated.
   B. LEED Submittals: Complete LEED Checklist and Tracking Form, Section 01 35 15, and other data for the following LEED Credits. Requirements and definitions are located in Section 01 35 15 and Section 01 60 00.
      2. Credit MR 5: List products that are extracted, harvested or recovered as well as manufactured or processed within 500 straight-line miles of Project Site, or percent of regional material by weight. Include address and distance of material source and product manufacture, product cost data.

PART 2  PRODUCTS
2.01  MANUFACTURERS
   A. Metal Framing, Connectors, and Accessories:
      1. Substitutions: See Section 01 60 00 - Product Requirements.

2.02  FRAMING SYSTEM
   A. Provide primary and secondary framing members, bridging, bracing, plates, gussets, clips, fittings, reinforcement, and fastenings galvanized in conformance with ASTM A 123 or of stainless steel and as required to provide a complete structurally designed framing system.
   B. Design Criteria: Provide completed framing system having the following characteristics:
      1. Design: Calculate structural characteristics of cold-formed steel framing members according to AISI North American Specification for the Design of Cold-Formed Steel Structural Members.
      2. Structural Performance: Design, engineer, fabricate, and erect to withstand specified design loads for project conditions within required limits.
      3. Design Loads: In accordance with applicable codes.
      4. Deflections: Live load deflection meeting the following, unless otherwise indicated:
      5. Capable of withstanding the following loads:
         a. Vertical Assembly: _____ psf positive and _____ psf negative.
         b. Horizontal Assembly: _____ psf live and dead loads.
      6. Horizontal Deflection: Designed to permit maximum deflection of 1/180 of span.
      7. Vertical Deflection: Non-axial loadbearing framing designed to accommodate not less than 1/2 in vertical deflection.
      8. Able to tolerate movement of components without damage, failure of joint seals, undue stress on fasteners, or other detrimental effects when subject to seasonal or cyclic day/night temperature ranges.
      9. Able to accommodate construction tolerances, deflection of building structural members, and clearances of intended openings.

2.03  FRAMING MATERIALS
   A. Studs and Track: ASTM C 955; studs formed to channel, "C", or "Sigma" shape with punched web; U-shaped track in matching nominal width and compatible height.
B. Framing Connectors: Factory-made formed steel sheet, ASTM A 653/A 653M SS Grade 50, with G60/Z180 hot dipped galvanized coating and factory punched holes.
   1. Structural Performance: Maintain load and movement capacity required by applicable code, when evaluated in accordance with AISI North American Specification for the Design of Cold Formed Steel Structural Members; minimum 16 gage, 0.06 inch thickness.
   2. Provide non-movement connections for tie-down to foundation, floor-to-floor tie-down, roof-to-wall tie-down, joist hangers, gusset plates, and stiffeners.

2.04 WALL SHEATHING
A. Wall Sheathing: Plywood; PS 1, Grade C-D, Exposure I.
B. Wall Sheathing: Particleboard; ANSI A208.1, Grade M-3 EXTERIOR GLUE.
C. Wall Sheathing: Fiberboard; ASTM C 208, Type IV, Grade 1 regular, square edges.
D. Gypsum Sheathing: ASTM C 1396/C 1396M, water-resistant core, V-shaped long edges, 1/2 inch thick.
E. Glass Mat Faced Gypsum Sheathing: ASTM C 1177/C 1177M, water-resistant core, square long edges, 1/2 inch thick.
F. Wall Sheathing: Extruded polystyrene foam board, ASTM C 578, Type IV; tongue and groove long edges; 3/4 inch thick.

2.05 ACCESSORIES
A. Bracing, Furring, Bridging: Formed sheet steel, thickness determined for conditions encountered; finish to match framing components.
B. Shop and Touch-Up Primer: SSPC-Paint 15, complying with VOC limitations of authorities having jurisdiction.
C. Water-Resistive Barrier: As specified in Section 07 25 00.

2.06 FASTENERS
A. Self-Drilling, Self-Tapping Screws, Bolts, Nuts and Washers: Hot dip galvanized per ASTM A 153/A 153M.
B. Anchorage Devices: Power actuated.

PART 3 EXECUTION

3.01 INSTALLATION OF STUDS
A. Install components in accordance with manufacturers' instructions and ASTM C 1007 requirements.

3.02 WALL SHEATHING
A. Wall Sheathing: Secure with long dimension perpendicular to wall studs, with ends over firm bearing and staggered, using self-tapping screws.
   1. Place water-resistive barrier horizontally over wall sheathing, weather lapping edges and ends.

3.03 TOLERANCES

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Shop fabricated steel items.
   B. Manufactured metal items.

1.02 DESIGN REQUIREMENTS
   A. Design railing assemblies, wall rails, and attachments to resist lateral force of 200 lbs at any point without damage or permanent set. Test in accordance with ASTM E 935.
   B. Design and fabrication of railings in longer than 12 feet are required to meet more stringent requirements than industry standards to achieve a visual aesthetic straight line appearance and higher level of tolerance in joint smoothness without gaps.

1.03 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable.
      1. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.
   C. Samples: Manufactured units.
   D. Welders' Certificates: Submit certification for welders employed on the project, verifying AWS qualification within the previous 12 months.

1.04 QUALITY ASSURANCE
   A. Design beams and railings under direct supervision of a Professional Engineer experienced in design of this Work and licensed in the State in which the Project is located.

1.05 MOCK-UP
   A. See Section 01 40 00 - Quality Requirements, for general requirements for mock-up.
   B. Construct in a coordinated mock-up, Enclosure Panel mock-up where indicated on the drawings, incorporating all components specified for one enclosure panel, in conjunction with concrete retaining wall in Section 03 30 00 and Metal Roof Panels in Section 07 41 13.
      1. Minimum size of mock-up is indicated on the drawings.
      2. Approved mock-up may remain as part of the Work.

PART 2 PRODUCTS

2.01 MATERIALS - STEEL
   A. Steel Sections: ASTM A 36/A 36M.
   B. Steel Tubing: ASTM A 500, Grade B cold-formed structural tubing.
   C. Plates: ASTM A 283.
   E. Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, galvanized to ASTM A 153/A 153M where connecting galvanized components.
   F. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.
   G. Shop Primer: Multi-purpose structural steel primer, complying with VOC limitations of authorities having jurisdiction.
      1. Tnemec Series 394 Mio-Zinc filled polyurethane primer.
   H. Touch-Up Primer for Galvanized Surfaces, Shop and Field: SSPC-Paint 20, Type II - Organic, complying with VOC limitations of authorities having jurisdiction.
1. Tnemec Series 135 Modified epoxy primer. Tint to match zinc.

2.02 MANUFACTURED UNITS

A. Slotted Channel Framing: Cold-formed metal channels with continuous slot complying with MFMA-3.
   2. Material: Steel complying with ASTM A 1008/A 1008M, commercial steel, Type B.
   3. Fasteners and Accessories: Designed for use and loads, same finish as channel.
   4. Acceptable Manufacturer: Unistrut Corp.

B. Perforated Metal Panels:
   1. Cold Rolled Steel Sheet Gauge: 11 gauge
   2. Size: As indicated
   4. Finish: Galvanized and and shop primed for field finish.
   5. Application:
      a. Security layer of delegated design exterior enclosure panels.
      b. Around coiling overhead door openings as indicated.

C. Metal Downspout Boots: See Section 07 62 00.

2.03 FABRICATION

A. Fit and shop assemble items in largest practical sections, for delivery to site.

B. Fabricate items with joints tightly fitted and secured.

C. Grind exposed joints within 10 feet of finished floor surface, flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius within human reach zone.

D. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

2.04 FABRICATED ITEMS

A. Delegated Design Ladders: Steel; in compliance with ANSI A14.3; with mounting brackets and attachments; galvanized finish.
   1. Side Rails: 3/8 x 2 inches members spaced at 20 inches.
   2. Rungs: one inch diameter solid round bar spaced 12 inches on center.
   3. Space rungs 7 inches from wall surface.

B. Delegated Design Ships Ladders and Railings:
   1. Fabricate to detail from structural steel complying with referenced standards.
      b. Stringers: 10” structural channel.
      c. Treads: Heavy duty welded serrated bar grating treads with 12 inch center to center spacing; 1 x 1/8 inch bars at 1/2 inches on center with 4 inch cross bar centers.
      d. Railings: Welded handrails of 1 1/2” x 14 gage square tubing.
      e. Finish: Galvanized to G-90 finish for exterior exposure.
   2. Base and Top Mounting brackets and attachments; prime paint finish.

C. Delegated Design Exterior Gates: Structurally designed and fabricated to detail from structural steel, and perforated sheet metal panels complying with reference standards, fencing type security exterior enclosure panels to be mechanically attached to structural steel frame components by means of attachment brackets:
   1. Jointing: Fully welded, with continuously welded connections ground smooth and flush.
   2. Assembly Finish: Galvanized and painted, see Section 09 96 00.
3. Accessories:
   a. Brackets and Fasteners: Per anchoring and securing requirements.
      1) Finish: Galvanized and shop primed for field finish.
      2) Color: Custom color matching Architect's sample.
      1) Finish: Galvanized and shop primed for field finish.
   c. Perforated Metal Panels:
      1) Finish: Galvanized and shop primed for field finish.
      2) Color: Custom color matching Architect's sample.
   d. Exposed Fastener Finish: Matching color.

D. Delegated Design Enclosure Panels: Structurally designed and fabricated to detail from structural steel, and perforated sheet metal panels complying with reference standards, fencing type security exterior enclosure panels to be mechanically attached to structural steel frame components by means of attachment brackets:
   1. Jointing: Fully welded, with continuously welded connections ground smooth and flush.
   2. Assembly Finish: Galvanized and painted, see Section 09 96 00.

3. Accessories:
   a. Brackets and Fasteners: Per anchoring and securing requirements.
      1) Finish: Galvanized and shop primed for field finish.
      2) Color: Custom color matching Architect's sample.
      1) Finish: Galvanized and shop primed for field finish.
   c. Perforated Metal Panels:
      1) Finish: Galvanized and shop primed for field finish.
      2) Color: Custom color matching Architect's sample.
   d. Exposed Fastener Finish: Matching color.

E. Delegated Design Solid Panels: Structurally design and fabricate to detail from structural steel and steel panel for exterior assembly, with steel angle frame complying with reference standards.
   1. Jointing: Fully welded, with continuously welded connections ground smooth and flush except perforated panel to angle frame is skip welded and ground smooth and flush.
   2. PT-21:
      a. Box Rail Hangers with Delrin: As required to fit selected box and panel load.
   5. Exposed Fastener Finish: Matching color.

F. Wall Opening Closure Frame:
   1. Fabricated to wall opening dimensions as detailed, and field verified, from sheet metal panels complying with reference standards, and mechanically attached to wall by means of expansion anchoring fasteners through prefabricated fastener recesses so fastener head flushes with exposed frame face.
      a. Cold Rolled Steel Sheet Gauge: 11 gauge
      b. Jointing: Fully welded, with continuously welded connections ground smooth and flush.
      c. Assembly Finish: Finish: Galvanized and and shop primed for field finish.
      e. Exposed Fastener Finish: Matching color.

G. Delegated Design Railings: Design, fabricate, and test railing assemblies in accordance with the most stringent requirements of ASTM E 985 and applicable local code.
1. Aesthetic Design Intent: As indicated.
2. Material: Round structural steel pipe or tube complying with referenced standards.
4. Dimensions: As indicated on drawings.
5. Finish: Galvanized and and shop primed for field finish.
6. Railing Conditions:
   a. Wall mounted handrails.
   b. Stair railings and guardrails.
   c. Free-standing railings at steps.
7. Accessories: Per anchoring and securing requirements.

H. Welded Heavy Duty Bar Grates with Anchored Embed Angle Frames:
   1. Exterior Pit Sump Grate: 1-1/4 x 1/4 inches 12 WH 4; galvanized finish.

I. Bar Grate Walk Surfacing: See Structural Drawings.
   1. Location: Mechanical Penthouse.

2.05 FINISHES - STEEL
A. Prime paint all steel items.
   1. Exceptions: Galvanize items to be embedded in concrete or masonry and items specified for exterior exposure finish.
B. Prime Painting: One coat, 2.5 mils dry film thickness.
C. Galvanizing of Structural Steel Members: Galvanize after fabrication to ASTM A123/A123M requirements.
D. Galvanizing of Non-structural Items: Galvanize after fabrication to ASTM A123/A123M requirements.

2.06 FABRICATION TOLERANCES
A. Squareness: 1/8 inch maximum difference in diagonal measurements.
B. Maximum Offset Between Faces: 1/16 inch.
C. Maximum Misalignment of Adjacent Members: 1/16 inch.
D. Maximum Bow: 1/8 inch in 48 inches.
E. Maximum Deviation From Plane: 1/16 inch in 48 inches.

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify that field conditions are acceptable and are ready to receive work.

3.02 PREPARATION
A. Clean and strip primed steel items to bare metal where site welding is required.
B. Supply setting templates to the appropriate entities for steel items required to be cast into concrete or embedded in masonry.

3.03 INSTALLATION
A. Install items plumb and level, accurately fitted, free from distortion or defects.
B. Provide for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.
C. Obtain approval prior to site cutting or making adjustments not scheduled.
D. After erection, prime welds, abrasions, and surfaces not shop primed or galvanized, except surfaces to be in contact with concrete.
3.04 TOLERANCES

A. Maximum Variation From Plumb: 1/4 inch per story, non-cumulative.
B. Maximum Offset From True Alignment: 1/4 inch.

END OF SECTION
PART 1 - GENERAL

1.01 WORK INCLUDES
A. Trench covers/gratings.
B. Trench liners/drains.

1.02 RELATED WORK
A. Cast-in-place Concrete: Section 03 30 00.

1.03 SYSTEM DESCRIPTION
A. Trench covers/gratings shall be cast-in-place installation or blockout at Contractor's option.
B. Trench covers/gratings shall cover the trench completely and shall be flush with surrounding finish floor surfaces to allow unrestricted pedestrian traffic.
C. Allowable load on trench covers/gratings shall be 100 psf uniform load and/or 250 lbs. concentrated load (see load chart in product catalog) with no more than 1/16 inch deflection.
D. Trench liners/drains shall be water-resistant (leak resistant).
   1. Additional waterproofing (silicone sealant) shall be provided where hydrostatic pressure is present.
E. Ceramics trench cover/grating shall be coordinated with the Owner's (OFCI) ceramics rinse sink discharge plumbing penetration of trench cover/grating.

1.04 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide component dimensions, describe components within assembly, anchorage and fasteners, internal drainage details and other features relative to each individual application.
C. Manufacturer's Certificate: Certify that the products supplied meet or exceed the specified and indicated requirements.
D. Submit installation instructions with shop drawings showing complete fabrication details for all trench covers/gratings, access covers, and trench liners/drains, including required anchorage to surrounding construction, recesses, blocking, and connections between similar and dissimilar trench cover/grating assemblies.
E. Manufacturer's Certificate: Certify that the products supplied meet or exceed the specified and indicated requirements.
F. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE
A. Manufacturer: Obtain trench covers/gratings and trench liners/drain assemblies through one source from a single manufacturer.
   1. Manufacturer shall have a minimum of ten (10) years of experience in the fabrication of trench assemblies.
B. Installer: Firm with not less than three (3) years of successful experience in the installation of systems similar to those required by this project and acceptable to the manufacturer of the system.

1.06 DELIVERY, STORAGE AND HANDLING
A. Provide temporary protective cover on stainless steel finished surfaces.
B. Deliver trench covers/gratings, access covers, and trench liner to jobsite in new, clean, unopened crates of sufficient size and strength to protect materials during transit.
C. Store components in original containers in a clean, dry location.
D. Handle components with equipment of sufficient size to preclude hazard to personnel or damage to components.

1.07 WARRANTY
A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
B. Submit manufacturer's warranty that materials furnished will perform as specified for a period of not less than one (1) year when installed in accordance with manufacturer's recommendations.

PART 2 - PRODUCTS
2.01 MANUFACTURERS
   1. Product: Aco Drain
B. Acceptable manufacturers pending conformance to Design Basis requirements and indicated and specified requirements:
   1. Balco Inc.
   3. Substitutions approved in compliance with Section 01 60 00.

2.02 MATERIALS
A. Trench Covers/Gratings: Load Class A pedestrian rated, ADA compliant, stainless steel, Type 317 with number 4 finish
B. Trench Liner/Drain: 5 sided, sealed rectangular box assembly.
   2. Width: As indicated, or as required to accommodate required conditions.
   3. Depth: As indicated, or as required to accommodate required conditions.
C. Abrasive: Two (2) part Epoxy combined with aluminum oxide grit.
D. Fasteners, accessories, and other materials required for complete installation to manufacturer's instructions.

2.03 FABRICATION
A. Fabricate trench cover/grating, and trench liner/drain assemblies as detailed. Provide splice covers and closures as necessary for complete installation.
   1. Fabricate trench covers/gratings, access covers, of indicated lengths and widths to fit trench liner/drain frames.
   2. Fabricate splices, special transitions, corner units, corner fittings, intersections, and end closures as required.
   3. Cast, or miter and weld joints shall be factory manufactured.
   4. Provide necessary and related parts, devices, anchors, and other items required for water-resistant installations.
B. Trench covers/gratings shall have a smooth surface.

2.04 FINISHES
A. Stainless Steel: Stainless steel surfaces in contact with concrete shall be prime painted.
B. Abrasive: Abrasive shall be black.

PART 3 - EXECUTION
3.01 EXAMINATION
A. Verify that field measurements and blockout dimensions are as shown on shop drawings prior to releasing materials for fabrication by the manufacturer.
B. Examine conditions under which work is to be performed and shall notify the contractor in writing of unsatisfactory conditions. Installer shall not proceed until unsatisfactory conditions have been corrected in a manner acceptable to the installer.

3.02 INSTALLATION
   A. Install trench covers/gratings and trench liners/drains in accordance with the manufacturer’s written installation instructions. Anchor spacing shall be in accordance with approved shop drawings.
   B. Align work plumb, level, and, as required, flush with adjacent surfaces.
   C. Make allowances for change in trench size due to difference between installation and existing building construction.

3.03 CLEANING
   A. Clean exposed surfaces as recommended by the manufacturer.

3.04 ADJUSTING AND PROTECTION
   A. Inspect system components for proper fit. Adjust, repair or replace components not conforming to requirements. Repair or replacement of an individual unit shall be as approved by the Architect.
   B. Finished units shall be without damage. Units damaged during shipping or construction shall be repaired by the contractor at the expense of the party damaging the material, in accordance with the contract requirements.
   C. Protect installation from damage by work of other Sections. Where required, remove and store trench covers and install temporary protection over trench; re-install trench covers prior to Substantial Completion of the work.

3.05 GENERAL RESPONSIBILITY
   A. Any variation from this specification resulting in additional cost to any other contractor or subcontractor on this project shall be the sole financial responsibility of the contractor for the work of this section.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Exposed timber structural framing.
B. Rough opening framing for doors, windows, and roof openings.
C. Underlayment.
D. Fire retardant treated wood materials.
E. Miscellaneous framing and sheathing.
F. Communications and electrical room mounting boards.
G. Concealed wood blocking, nailers, and supports.

1.02 REFERENCE STANDARDS


1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide technical data on insulated sheathing, wood preservative materials, and application instructions.
C. Manufacturer’s Certificate: Certify that wood products supplied for rough carpentry meet or exceed specified requirements.

1.04 QUALITY ASSURANCE

A. Lumber: Comply with PS 20 and approved grading rules and inspection agencies.

1.05 DELIVERY, STORAGE, AND HANDLING

A. General: Cover wood products to protect against moisture. Support stacked products to prevent deformation and to allow air circulation.
B. Fire Retardant Treated Wood: Prevent exposure to precipitation during shipping, storage, or installation.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Dimension Lumber: Comply with PS 20 and requirements of specified grading agencies.
   1. Grading Agency: Any grading agency whose rules are approved by the Board of Review, American Lumber Standard Committee (www.alsc.org) and who provides grading service for the species and grade specified; provide lumber stamped with grade mark unless otherwise indicated.
B. Lumber fabricated from old growth timber is not permitted.
C. Provide sustainably harvested wood and harvested within a 500 mile radius of the project site.

2.02 DIMENSION LUMBER

A. Sizes: Nominal sizes as indicated on drawings, S4S.
B. Moisture Content: S-dry or MC16.
C. Miscellaneous Framing, Blocking, Nailing, Grounds, and Furring:
   1. Lumber: S4S, No. 2 or Standard Grade.
2.03 CONSTRUCTION PANELS
   A. Communications and Electrical Room Mounting Boards: PS 1 A-D plywood, or medium density fiberboard; 3/4 inch thick; flame spread index of 25 or less, smoke developed index of 450 or less, when tested in accordance with ASTM E84.

2.04 FACTORY WOOD TREATMENT
   A. Treated Lumber and Plywood: Comply with requirements of AWPA U1 - Use Category System for wood treatments determined by use categories, expected service conditions, and specific applications.
      1. Fire-Retardant Treated Wood: Mark each piece of wood with producer's stamp indicating compliance with specified requirements.
      2. Preservative-Treated Wood: Provide lumber and plywood marked or stamped by an ALSC-accredited testing agency, certifying level and type of treatment in accordance with AWPA standards.
   B. Fire Retardant Treatment:
      1. Exterior Type: AWPA U1, Category UCFB, Commodity Specification H, chemically treated and pressure impregnated; capable of providing a maximum flame spread rating of 25 when tested in accordance with ASTM E84, with no evidence of significant combustion when test is extended for an additional 20 minutes both before and after accelerated weathering test performed in accordance with ASTM D2898.
         a. Kiln dry wood after treatment to a maximum moisture content of 19 percent for lumber and 15 percent for plywood.
         b. Do not use treated wood in direct contact with the ground.
      2. Interior Type A: AWPA U1, Use Category UCFA, Commodity Specification H, low temperature (low hygroscopic) type, chemically treated and pressure impregnated; capable of providing a maximum flame spread rating of 25 when tested in accordance with ASTM E84, with no evidence of significant combustion when test is extended for an additional 20 minutes.
         a. Kiln dry wood after treatment to a maximum moisture content of 19 percent for lumber and 15 percent for plywood.
         b. Treat rough carpentry items as indicated.
         c. Do not use treated wood in applications exposed to weather or where the wood may become wet.

END OF SECTION
PART 1 GENERAL
1.01 SECTION INCLUDES
   A. Plywood structural wood decking.

1.02 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide technical data on wood preservative materials.
   C. Shop Drawings: Indicate deck framing layout.

1.03 QUALITY ASSURANCE
   A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience and certified by AITC.
   B. Installer: Company specializing in performing work of the type specified in this section with minimum three years of experience.

1.04 REGULATORY REQUIREMENTS
   A. Conform to applicable code for fire retardant requirements.

1.05 DELIVERY, STORAGE, AND HANDLING
   A. Protect glue laminated members in accordance with AITC 111 requirements for unwrapped material.

PART 2 PRODUCTS
2.01 WOOD MATERIALS
   A. Wood fabricated from old growth timber is not permitted.
   B. Plywood Decking: PS 1 veneer plywood; APA Rated Sheathing, Span Rating 32/16; Exterior grade; 1 A interior veneer appearance grade; sanded.
   C. Tongue and Groove Decking: 4x Douglas-Fir Select Dex or approved equal.

2.02 ACCESSORIES
   A. Fasteners and Anchors:
      1. Fastener Type and Finish: Hot-dipped galvanized steel for high humidity and preservative-treated wood locations, unfinished steel elsewhere.
      2. See Structural Notes

PART 3 EXECUTION
3.01 EXAMINATION
   A. Verify that support framing is ready to receive decking.

3.02 PREPARATION
   A. Coordinate placement of bearing items.

3.03 INSTALLATION - PLYWOOD DECKING
   A. Install decking perpendicular to framing members, with ends staggered over firm bearing. On sloped surfaces, lay decking with tongue upward.
   B. Engage plywood tongue and groove edges.
   C. Allow expansion space at edges and ends.

3.04 TOLERANCES
   A. Surface Flatness of Decking Without Load: 1/4 inch in 10 feet maximum, and 1/2 inch in 30 feet maximum.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Moisture resistant wall sheathing fire-rated.
   B. Structural moisture resistant wall sheathing fire-rated.
   C. Accessories.

1.02 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Manufacturer's technical data on sheathing product to be used, including:
      1. Preparation instructions and recommendations.
      2. Storage and handling requirements and recommendations.
      3. Installation methods.
   C. Manufacturer's Certificate: Certify that products supplied meet or exceed specified requirements.

1.03 DELIVERY, STORAGE, AND HANDLING
   A. General: Cover products to protect against moisture. Support stacked products to prevent deformation and to allow air circulation.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. Gypsum Sheathing Type X Fire-Rated:
      1. Georgia-Pacific; www.gpgypsum.com
      4. Substitutions: See Section 01 60 00 - Product Requirements.
   B. Structural Gypsum Sheathing:
      1. Sure-Board Series 200 Type X Fire-Rated:
      2. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 MATERIALS
   A. Sheathing: Glass mat faced gypsum, ASTM C 1177C/1177M, Type X fire-resistant core, long edges.
      1. Fire Resistance:
         a. Dens-Glass Gold Fireguard: One hour rated systems when tested in accordance with ASTM E 119, UL Classified.
         b. If roofing manufacturer will not warrant the roof system with Dens-Glass Gold, provide manufacturer's approved sheathing where interfacing with roofing system.
         c. Sheathing must also be rated to conform to roofing installation requirements including roofing temperature required for hot application roofing.
      2. Thickness: 5/8 inch for rated assemblies.
      3. Edges: Square.

2.03 ACCESSORIES
   A. Fasteners and Anchors:
   B. Self-Adhered Membrane Weather Barriers: See Section 07 25 09.
   C. Self-Adhered Membrane Flashing: See Section 07 25 11.
1. Use adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. Sealant: Manufacturer's Silicone Sealant; gunnable silicone.

**PART 3 EXECUTION**

**3.01 EXAMINATION**

A. Do not begin installation until framing is complete and properly prepared.

B. If framing is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

**3.02 INSTALLATION**

A. Wall: Sheathing: Install in accordance with manufacturer's instructions and building code.

B. Secure with long dimension perpendicular to wall studs, with ends over firm bearing and staggered, using screws.

C. Gypsum Sheathing Fastening: Screw to steel studs and runners with bugle head screws spaced, sized, and located as required by building code.
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Glue laminated wood beams and purlins.
B. Steel hardware and attachment brackets.

1.02 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide technical data on wood preservative materials, application technique and resultant performance information.
C. Shop Drawings: Indicate framing system, sizes and spacing of members, loads and cambers, bearing and anchor details, bridging and bracing, framed openings.

1.03 QUALITY ASSURANCE

A. Manufacturer/Fabricator Qualifications: Company specializing in manufacture of glue laminated structural units with three years of documented experience, and certified by AITC in accordance with AITC A190.1.
B. Erector Qualifications: Company specializing in erection of products of the type specified, with three years of experience.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Protect members to AITC requirements for not wrapped.
B. Leave individual wrapping in place until finishing occurs.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Glued-Laminated Structural Units:
   4. Rosboro: www.rosboro.com
   5. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 GLUED-LAMINATED UNITS

A. Glued-Laminated Units: Fabricate in accordance with AITC 117 Industrial grade.
   1. Verify dimensions and site conditions prior to fabrication.
   2. Cut and fit members accurately to length to achieve tight joint fit.
   3. Fabricate member with camber built in.
   4. Do not splice or join members in locations other than those indicated without permission.
   5. After end trimming, seal with penetrating sealer in accordance with AITC requirements.

2.03 MATERIALS

A. Lumber: Softwood lumber conforming to RIS grading rules with 12 percent maximum moisture content before fabrication. Design for the following values indicated on structural drawings.
B. Steel Connections and Brackets: ASTM A36/A36M weldable quality, galvanize per ASTM A 123/A 123M.
C. Hardware: ASTM A325 (ASTM A325M) Type 1 high strength heavy hex bolts and ASTM A563 (ASTM A563M) nuts, hot-dip galvanized to meet requirements of ASTM A 153/A 153M, matching washers.

2.04 FABRICATION

A. Fabricate glue laminated structural members in accordance with AITC Industrial grade.
B. Welding: Perform welding in accordance with AWS D1.1.
C. Verify dimensions and site conditions prior to fabrication.
D. Cut and fit members accurately to length to achieve tight joint fit.
E. Fabricate steel hardware and connections with joints neatly fitted, welded, and ground smooth.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that supports are ready to receive units.
   B. Verify sufficient end bearing area.

3.02 PREPARATION
   A. Coordinate placement of bearing items.

3.03 ERECTION
   A. Lift members using protective straps to prevent visible damage.
   B. Set structural members level and plumb, in correct positions or sloped where indicated.
   C. Provide temporary bracing and anchorage to hold members in place until permanently secured.
   D. Fit members together accurately without trimming, cutting, splicing, or other unauthorized modification.
   E. Swab and seal the interior wood surfaces of field drilled holes in members with primer.

3.04 TOLERANCES
   A. Framing Members: 1/2 inch maximum from true position.

END OF SECTION
PART 1 - GENERAL

1.01 SECTION INCLUDES
A. Wood veneer plywood cabinets.
B. Cabinet hardware.
C. Shop finishing.

1.02 SUBMITTALS
A. Product data for each type of product and process specified in this section and incorporated into items of architectural woodwork during fabrication, finishing, and installation.
B. Shop drawings showing location of each item, including dimensioned plans and elevations, large-scale details, attachment devices, and other components. Show materials, laminate colors, sinks, fittings, hardware, and other accessories. Show sink centerlines. Show locations of steel counter support locations, access panel locations, and Owner furnished under counter key board and mouse supports.
C. Samples for verification purposes of the following:
   1. Panel 18 inches by 18 inches with edge, finished, each laminate.
   2. Each exposed hardware item.
   3. Drawer guide and door hinge.
D. Qualification data for firms and persons specified in “Quality Assurance” article to demonstrate their capabilities and experience. Include list of completed projects with project names, addresses, names of Architects and Owners, and other information specified.

1.03 QUALITY ASSURANCE
   2. Shop Finish: Section 5. Grade specified in Part 2.
B. Installer: Employee of Manufacturer or subcontracted to Manufacturer.
C. Solid Surfacing Fabricator: Trained and certified by solid surfacing manufacturer.

1.04 DELIVERY, STORAGE, AND HANDLING
A. Protect woodwork during transit, delivery, storage, and handling to prevent damage, soiling, and deterioration.
B. Do not deliver woodwork until painting, wet work, grinding, and similar operations that could damage, soil, or deteriorate woodwork have been completed in installation areas. If woodwork must be stored in other than installation areas, store only in areas whose environmental conditions meet requirements specified in “Project Conditions.”

1.05 PROJECT CONDITIONS
A. Environmental Conditions: Obtain and comply with Woodwork Manufacturer's and Installer's coordinated advice for optimum temperature and humidity conditions for woodwork during its storage and installation. Do not install woodwork until these conditions have been attained and stabilized so that woodwork is within plus or minus 1.0 percent of optimum moisture content from date of installation through remainder of construction period.
B. Field Measurements: Where woodwork is indicated to be fitted to other construction, check actual dimensions of other construction by accurate field measurements before manufacturing woodwork; show recorded measurements on final shop drawings. Coordinate manufacturing schedule with construction progress to avoid delay of Work.
   1. Verify locations of concealed framing, blocking, reinforcements, and furring that support woodwork by accurate field measurements before being enclosed. Record measurements on final shop drawings.
2. Where field measurements cannot be made without delaying the work, guarantee dimensions and proceed with manufacture of woodwork without field measurements. Provide allowance for trimming at site and coordinate construction to ensure that actual dimensions correspond to guaranteed dimensions.

1.06 WARRANTY
A. Manufacturer's warranty against warpage, delamination, hardware failures, fasteners failures.
B. Warranty Period: 5 years
   1. Repair or replace product, Owner's option.

PART 2 - PRODUCTS
2.01 MANUFACTURERS
A. Custom Cabinet Shop, Member of AWI or WI.
   1. Not less than 10 years experience and complete knowledge of AWI standards.

2.02 MATERIALS
A. General: Provide materials that comply with reference standard and specified requirements.
B. Formaldehyde Free: Provide composite wood products with no added formaldehyde, made without urea-formaldehyde adhesives or binders.
C. Lumber: Birch, plain sawn.
   1. FSC certified.
D. Wood Veneer: Baltic Birch, plain sliced.
   1. HPVA Grade A.
   2. FSC certified.

2.03 HARDWARE AND ACCESSORIES
A. Hardware Quality: ANSI/BHMA A156.9, Grade 1
B. Hardware Finishes: ANSI/BHMA A156.18 for BHMA code number indicated.
   1. Satin Chromium Plated: BHMA 652 or 626
C. Door and Drawer Pulls: Continental Hardware Bar Pull, or approved.
   1. Dimensions: 7 3/8 x 1/2 x 1 1/2
D. Bumper: Clear rubber.
F. Concealed Hinge for Flush Overly: European style, steel, self-closing, 170 degree swing.
   1. Provide hinge stops, where cabinet door, opens 90 degrees, will hit wall, casework or equipment. Provide Hefele, Grass, or approved equal.
G. Magnetic Catch: heavy-duty magnetic with a maximum 5 lb., minimum 3 lb. pull.
H. Drawer Glides: Knape & Vogt or equivalent by Accuride, full extension type as follows:
   1. No. 8405 at 6-inch and less.
   2. No. 8505 at drawers greater than 6 inches deep.
I. Locks: Olympus, 700SC and 800SC. Provide locks where shown. Key locks separately.
   Provide 3 keys per lock.
J. Multiple hole adjustable shelf support:
   1. Each shelf shall have 5 mm nickel plated steel, plug-in, retainer type security pin support clips let into shelf bottoms to prevent sliding.
   2. Drill shelf clip holes at 1-1/4 inch on center, full height of cabinet, two columns per cabinet side.
   3. Provide four support clips at each shelf indicated, six at shelves over 42 inches in length.
2.04 WOOD VENEER CLAD CABINETS

A. Grade: Custom.
B. Panels: Flat
C. Wood Veneer Cladding: Comply with cabinet Grade and the following:
   1. Species: Baltic Birch.
   3. Semi-Exposed Surfaces and Door Backs: Grade A same species.
   4. Drawer Backs: Grade B same species.
   5. Edgeband: No edgeband, ease edges.
D. Drawers: Full depth of case.
E. Adjustable Shelves: 1 per 12 inches unless indicated otherwise.
F. Base Cabinet Toe: 3 1/2 inches high, 3 inches deep.
G. Underside of Wall Cabinet: Type “B” flush, each cabinet finished individually.
H. Provide closure panels, soffits, and filler panels indicated in Drawings.
I. Finish: Transparent.
J. Pulls: See 2.03 Hardware and Accessories.

2.05 WOOD VENEER CLAD PANELS

A. Grade: Custom.
B. Panels: Flat
C. Wood Veneer Cladding: Comply with cabinet Grade and the following:
   1. Species: Baltic Birch.
   3. Edgeband: No edgeband, ease edges.
D. Finish: Transluscent.
E. Fasteners:
   2. Type: Simpson Swaneze Trim Head screws 2-1/4 -inches, or of size to suit application; or approved.

2.06 CABINET FABRICATION

A. Wood Moisture Content: Comply with requirements of referenced quality standard for moisture content of lumber in relation to relative humidity conditions existing during time of fabrication and in installation areas.
B. Fabricate woodwork to dimensions, profiles, and details indicated. Ease edges to radius indicated for the following:
   1. Corners of cabinets and edges of solid wood (lumber) members less than 1 inch in nominal thickness: 1/16 inch.
   2. Edges of rails and similar members more than 1 inch in nominal thickness: 1/8 inch.
C. Complete fabrication, including assembly, finishing, and hardware application, before shipment to project site to maximum extent possible. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
D. Factory-cut openings, to maximum extent possible, to receive hardware, appliances, plumbing fixtures, electrical work, and similar items. Field cutting of sink and grommet cutouts allowed. Locate openings accurately and use templates or roughing-in diagrams to produce accurately
sized and shaped openings. Smooth edges of cutouts and, where located in countertops and similar exposures, seal edges of cutouts with a water-resistant coating.

E. Rear edges of upper cabinets shall be concealed. No rear of any cabinet shall be exposed. Rears of upper cabinets shall be inserted into rabbits to allow for scribe for a tight fit against wall.

F. Edge Band: Pressure bonded to core with waterproof, hot melt adhesive at exposed and semi-exposed edges.

G. Drawer Box Construction: Lock shoulder.

H. Shelf Supports: Recessed standards with adjustable shelf support, 4 at shelves 32 inches wide and less, 5 at shelves wider than 32 inches.

I. Shelves: ¾ inch thick core less than 32 inches, 1 inch thick core greater than 32 inches any dimension.

J. All cabinetry enclosing flipper door hardware to be completely removable for access and removal of flipper door hardware.

2.07 COUNTERTOP FABRICATION, GENERAL

A. Comply with AWI Section 400, Division 400C. Premium grade unless indicated otherwise.

B. Counter-Mounted Fixtures: Prepare countertops in shop for field cutting openings for counter-mounted fixtures. Mark tops for cutouts and drill holes at corners of cutout locations. Make corner holes of largest radius practical.

C. Fittings: Drill countertops in shop for plumbing fittings, undercounter soap dispensers, and similar items.

D. Provide ¾ inch thick marine plywood sub-top and metal supports where no base cabinets support countertop.
   1. Metal supports indicated in Drawings, fabricated per Section 05 50 00, opaque paint finish per Section 09 90 00.

2.08 LAMINATED COUNTERTOPS

A. Grade: Premium.

B. Core: MDF-X, 3/4 inch thick with 1-1/2 inch built-up edges.

C. HPDL Finish:
   1. Exposed Surfaces: HGS/HFS (0.050-inch nominal thickness).
   2. Balance Sheet: 0.020-inch thick minimum, matching top color where exposed.
   3. Provide self-edge unless wood edge is indicated in Drawings.

D. Wood Veneer Finish: Transparent finish.

E. Edge: Plastic laminate self edge.

F. Splashes: HPDL, scribe top edge to wall.
   1. 4 inch high unless indicated otherwise.

2.09 SOLID SURFACING COUNTERTOPS

A. Fabricate plastic tops from Solid Surfacing where indicated in Drawings. Provide material thickness indicated. Provide detailing indicated.
   1. Product: Corian, or approved.

B. Fabricate tops in one piece with shop-applied backsplashes and edges, where indicated.
   Comply with solid-surfacing-material manufacturer's written recommendations for adhesives, sealers, fabrication, and finishing.

C. Countertop Substrate: Fabricate ¾ inch thick plywood. Provide marine plywood at tops with sinks.
2.10 STAINLESS STEEL COUNTERTOPS
A. Fabricator: Member in good standing of NOMMA or NAAMM or certified by NSF.
   1. Hanset Stainless Inc.
   2. Others approved by 01 60 00 substitution procedure.
B. Stainless Steel: ASTM A 666 Type 304 stainless steel sheet; 14 gage, 0.07 inch minimum sheet thickness.
   1. Finish: Directional satin, 150 grit (NAAMM No. 4).
C. Edge Detail: Flush top, 1 1/2 inch face, 1 3/4 inch return with 1/4 inch gap to subtop.
   1. Fabricate to overhang fronts and ends of cabinets 3/4 inch, except where top butts against cabinet or wall.
D. Back and End Splash: wherever counter edge abuts vertical surface unless otherwise indicated.
   1. Height: 4 inches, unless otherwise indicated.
   2. Depth: ¾ inch return.
E. Fabricate tops in one piece including nosings and back and end splashes.
   1. Quality Standards: Metal work per NOMMA No. 1 Ornamental Grade.
   2. Weld joints; grind smooth and polish to match.
   3. Provide stainless steel hat channel stiffeners, welded or soldered to underside, where indicated on drawings.
   4. Provide wall clips for support of back/end splash turndowns.
   5. Ease exposed corners and edges, 1/32 inch radius or more.
   7. Prepare all cutouts accurately to size; replace tops having improperly dimensioned or unnecessary cutouts or fixture holes.
F. Plywood Substrate: PS 1 Exterior Type, AC veneer grade, minimum 5-ply; minimum 3/4 inch thick; join lengths using metal splines.
G. Adhesives: Chemical resistant waterproof adhesive as recommended by manufacturer of materials being joined.

2.11 WALL SHELVING
A. Quality: AWs Section 600, Custom grade.
B. Shelves: Baltic Birch, plain sliced, HPVA Grade A, FSC certified, clear finish.
C. Wall Supports: Knapp & Vogt, extra heavy duty standards and supports.
   1. Standard: No. 85WH
   2. Shelf Support: Double Bracket, No. 185WH
D. Wall shelving blocking where shelving occurs at relites: Hardwood spacer, painted white and 1 inch by 2 inch by 1/8 inch extruded aluminum tube, shop finished white.

2.12 SHOP FINISHING
A. Wood Finishes: AWI Section 1500 Premium grade.
B. Transparent Finish: Polyurethane, water-based.

PART 3 - EXECUTION
3.01 PREPARATION
A. Before installing casework, examine shop-fabricated work for completion and complete work as required.
B. Measure all areas for scribe fit.
3.02 INSTALLATION
A. Comply with AWI Section 1700 for specified grade, and the following.
B. Install casework plumb, level, true, and straight with no distortions. Shim as required with concealed shims. Install to a tolerance of 1/8 inch in 8'-0" for plumb and level (including tops) and with no variations in flushness of adjoining surfaces.
C. Scribe and cut casework to fit adjoining work and refinish cut surfaces or repair damaged finish at cuts.
D. Cabinets: Install without distortion so that 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 the installation of hardware and accessory items as indicated.
   1. Mount wall cabinets to resist 200 pounds per linear foot.
E. Tops: Anchor securely to base units and other support systems as indicated.
   1. Anchor tops to support 400 pound concentrated load.
F. Sinks: Verify sink locations and sizes before cutting openings in countertops.
G. Complete the finishing work specified in this section to whatever extent not completed at shop or before installation of casework.

3.03 ADJUSTMENT AND CLEANING
A. Repair damaged and defective casework where possible to eliminate defects functionally and visually; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.
B. Clean, lubricate, and adjust hardware.
C. Clean casework on exposed and semi-exposed surfaces. Touch up factory-applied finishes to restore damaged or soiled areas.

3.04 PROTECTION
A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensures that casework is being without damage or deterioration at time of Substantial Completion.

3.05 SCHEDULE
A. Plastic Laminate (PLAM):
   1. PLAM-1
      a. Location: Countertops (Craft Center)
      b. Manufacturer: Wilsonart
      c. Color: D90 North Sea
B. Plywood (PWD):
   1. PWD-1
      a. Location: Countertops
      b. Manufacturer: TBD
      c. Product: Plywood
   2. PWD-X
      a. Location: Wet location countertops
      b. Manufacturer: TBD
      c. Product: Marine Grade Plywood
C. Solid Surface (SS):
   1. SS-1
      a. Location: Vertical and Horizontal Surfaces
      b. Manufacturer: Corian
ARCHITECTURAL WOOD CASEWORK

2. SS-2
   a. Not Used
   c. Color: Nocturne
d. Finish: TBD
e. Thickness: 3/4 inch

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Fluid applied membrane waterproofing.
B. Cant strips and other accessories.
C. Drainage panels and Protection boards.

1.02 REFERENCE STANDARDS

1.03 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data for membrane.
C. Shop Drawings: Indicate special joint or termination conditions and conditions of interface with other materials.
D. Manufacturer's Installation Instructions: Indicate special procedures.
E. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.04 QUALITY ASSURANCE
A. Perform Work in accordance with NRCA Roofing and Waterproofing Manual for waterproofing system.
B. Manufacturer Qualifications: Company specializing in manufacture of fluid-applied waterproofing membranes with ten years experience.
C. Installer Qualifications: Company specializing in installation of fluid-applied waterproofing approved by manufacturer.

1.05 FIELD CONDITIONS
A. Maintain ambient temperatures above 40 degrees F for 24 hours before and during application and until cured.

1.06 WARRANTY
A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
B. Contractor shall correct defective Work within a five year period after Date of Substantial Completion; remove and replace materials concealing waterproofing at no cost to Owner.
C. Provide five year manufacturer warranty for waterproofing failing to resist penetration of water, except where such failures are the result of structural failures of building. Hairline cracking of concrete due to temperature change or shrinkage is not considered a structural failure.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Cold-Applied, Single Component, Rapid Curing, Modified Polymer Elastomeric Waterproofing Membrane Manufacturers:
      a. Product: TREMproof 250GC -
   2. Acceptable manufacturers pending conformance to Design Basis Manufacturer:
NOTICE OF ALTERNATE BILLING CYCLE: The Contract allows the Owner to require the submission of billings or estimates in billing cycles other than 30-day cycles. Billings or estimates shall be submitted monthly ending on the last day of the month.

NOTICE OF EXTENDED CERTIFICATION PROVISION: The Contract will allow the Owner to certify billings and estimates within 20 days after the billings and estimates are received from the original contractor.

NOTICE OF EXTENDED PAYMENT PROVISION: The Contract will allow the Owner to make payment within 30 days after the date a billing or estimate is received.

c. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 MEMBRANE AND FLASHING MATERIALS
A. Cold-Applied Elastomeric Membrane: WP-1, complying with ASTM C 836, one component.
   1. Cured Thickness: 120 mils, minimum.
   2. Suitable for installation over damp and green concrete substrates.
   3. VOC Content: VOC compliant.

2.03 ACCESSORIES
A. Protection Board: Type capable of preventing damage to waterproofing due to backfilling and construction traffic.
   1. Use one of the following:
      a. Polystyrene foam board, 1 inch thick at tunnel roof over drainage panel.
B. Drainage Panel: Drainage layer with geotextile filter fabric on earth side.
      a. Products:
         2) JDR Enterprises, Inc; J-DRain 200; www.j-drain.com.
         3) Mar-flex Waterproofing & Building Products; Type II Drain Core Foundation Dimpleboard: www.mar-flex.com.
         4) Substitutions: See Section 01 60 00 - Product Requirements.
   2. Attachment: Type recommended by manufacturer and compatible with waterproof membrane.
C. Counterflashings: As recommended by membrane and protection board manufacturer.

PART 3 EXECUTION
3.01 EXAMINATION
A. Verify existing conditions before starting work.
B. Verify substrate surfaces are free of frozen matter, dampness, loose particles, cracks, pits, projections, penetrations, or foreign matter detrimental to adhesion or application of waterproofing system.
C. Verify that substrate surfaces are smooth, free of honeycomb or pitting, and not detrimental to full contact bond of waterproofing materials.
D. Verify that items that penetrate surfaces to receive waterproofing are securely installed.

3.02 PREPARATION
A. Protect adjacent surfaces not designated to receive waterproofing.
B. Do not apply waterproofing to surfaces unacceptable to manufacturer.
C. Seal cracks and joints with sealant using methods recommended by sealant manufacturer.

3.03 INSTALLATION
A. Apply waterproofing in accordance with manufacturer's instructions to specified minimum thickness.
B. Apply waterproofing in accordance with manufacturer's instructions to specified minimum thickness.
C. Seal membrane and flashings to adjoining surfaces. Install termination bar at all edges. Install counterflashing over all exposed edges.
3.04 INSTALLATION - DRAINAGE PANEL AND PROTECTION BOARD

A. Place drainage panel directly against membrane, butt joints, place to encourage drainage downward. Scribe and cut boards around projections, penetrations, and interruptions.

B. Place protection board directly against drainage panel; butt joints. Scribe and cut boards around projections, penetrations, and interruptions.

C. Adhere protection board to substrate with compatible adhesive.

3.05 FIELD QUALITY CONTROL

A. Owner will provide testing services in accordance with Section 01 40 00 - Quality Requirements. Contractor shall provide temporary construction and materials for testing.

END OF SECTION
PART 1  GENERAL
1.01  SECTION INCLUDES
   A. Board insulation and integral vapor retainer at cavity wall construction, perimeter foundation wall, underside of floor slabs, over roof deck, over roof sheathing, and exterior wall behind _________ wall finish.
   B. Batt insulation in exterior wall, ceiling, and roof construction.
   C. Batt insulation for filling perimeter window and door shim spaces and crevices in exterior wall and roof.
   D. Vapor retainer sheet.

1.02  SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide data on product characteristics, performance criteria, and product limitations.
   C. LEED Submittals: Complete LEED Checklist and Tracking Form, Section 01 33 00, and other data for the following LEED Credits. Requirements and definitions are located in Section 01 35 15 and Section 01 60 00.
      1. Credit MR 3: Salvaged, refurbished or reused materials; product cost data.
      3. Credit MR 5: List products that are extracted, harvested or recovered as well as manufactured within 500 straight-line miles of Project Site, or percent of regional material by weight. Include address and distance of material source and product manufacture. Product cost data.
      4. Credit MR 6: Rapidly Renewable material content for each product. Product cost data.
      5. Credit MR 7: Chain of custody documentation for products containing FSC certified wood. New wood cost data.
      6. Credit EQ 4.1: Manufacturers' product data for adhesives and sealants, including printed statement of VOC content.
      7. Credit EQ 4.2: Manufacturers' product data for paints and coatings, including printed statement of VOC content and list of prohibited chemical quantities.
   D. LEED Submittals: Complete LEED Checklist and Tracking Form, Section 01 33 00, and other data for the following LEED Credits. Requirements and definitions are located in Section 01 35 15 and Section 01 60 00.
      1. Credit MR 3: Salvaged, refurbished or reused materials; product cost data.
      3. Credit MR 5: List products that are extracted, harvested or recovered as well as manufactured within 500 straight-line miles of Project Site, or percent of regional material by weight. Include address and distance of material source and product manufacture. Product cost data.
      4. Credit EQ 4.1: Manufacturers' product data for adhesives and sealants, including printed statement of VOC content.
   E. Manufacturer's Installation Instructions: Include information on special environmental conditions required for installation and installation techniques.
   F. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.03  QUALITY ASSURANCE
   A. Insulation Labeling: An R-value identification mark shall be applied (by manufacturer) to each piece of insulation 12 inches or greater in width.
1. Alternately, the insulation installers have provided a signed, dated, and posted certification listed they type, manufacturer, and R-value of insulation installed.

PART 2 PRODUCTS

2.01 FOAM BOARD INSULATION MATERIALS

A. Expanded Polystyrene Board Insulation: ASTM C 578; with the following characteristics:
   1. Flame Spread Index: 25 or less, when tested in accordance with ASTM E84.
   2. Smoke Developed Index: 450 or less, when tested in accordance with ASTM E84.
   3. Type II, 1.35 pcf, 15.0 psi compressive strength, Type IX, 1.8 pcf, 25 psi compressive strength for under slabs.
   4. Board Size: As indicated
   5. Board Thickness: As indicated
   6. Thermal Resistance: R-Value of 4.0 minimum per inch.

B. Extruded Polystyrene Board Insulation: ASTM C 578, Type IV; Extruded polystyrene board with natural skin surfaces; with the following characteristics:
   1. Flame Spread Index: 25 or less, when tested in accordance with ASTM E84.
   2. Smoke Developed Index:  450 or less, when tested in accordance with ASTM E84.
   3. Board Size: As indicated
   4. Board Thickness: As indicated
   5. Thermal Resistance: LTTR-Value of 5.0 minimum per inch.

2.02 BATT INSULATION MATERIALS

A. Where batt insulation is indicated, either glass fiber or mineral fiber batt insulation may be used, at Contractor's option. Where mineral fiber batt insulation is indicated, mineral fiber batt insulation must be used.

B. Glass Fiber Batt Insulation: Flexible preformed batt or blanket, complying with ASTM C665; friction fit.
   1. Combustibility: Non-combustible, when tested in accordance with ASTM E136.
   2. Formaldehyde Content: Zero.
   3. Thermal Resistance: R of 3.7 per inch.

C. Mineral Fiber Batt Insulation: Flexible or semi-rigid preformed batt or blanket, complying with ASTM C665; friction fit; unfaced flame spread index of 0 (zero) when tested in accordance with ASTM E84.
   1. Smoke Developed Index: 0 (zero), when tested in accordance with ASTM E84.

2.03 SPRAY FOAM INSULATION

A. Insulating Foam Sealant:
   1. Design Basis: Great Stuff by Dow.
   2. Locations:
      a. Where board insulation does not meet or does not entirely fill cavity.
      b. Inside stud cavities surrounding openings.
      c. Roof to wall connections.
      d. Underside of bays and floor overhangs.
      e. Bay roofs
      f. Miscellaneous cavities and other locations indicated.

2.04 VAPOR RETARDER

A. Sheet Vapor Retarder: Reinforced laminated plastic, ASTM C-1136 Type II with the following characteristics:
   1. Permeance: 0.02 perm per ASTM E-96-A.
   2. Combustibility: Non-combustible when tested in accordance with ASTM E 136.
5. Acceptable Product: Lamtec WMP-10

B. Vapor Retarder Tape: Tape: Same membrane as vapor retarder sheet, self-adhering type, mesh reinforced, 2 inch wide.
C. adhesive-Sealant: Dow Corning 795.

2.05 ACCESSORIES
A. Perforated Cover Sheet: White scrim reinforced polyethylene film sheet capable of protecting and supporting batt insulation under concrete.
B. Tape: Bright aluminum self-adhering type, mesh reinforced, 2 inch wide.
C. Insulation Fasteners: Impaling clip of unfinished steel with washer retainer and clips, to be adhered to surface to receive insulation, length to suit insulation thickness and substrate, capable of securely and rigidly fastening insulation in place.
D. Adhesive: Type recommended by insulation manufacturer for application.

PART 3 EXECUTION

3.01 BOARD INSTALLATION AT FOUNDATION PERIMETER
A. Install boards horizontally on foundation perimeter.
B. Cut and fit insulation tightly to protrusions or interruptions to the insulation plane.

3.02 BOARD INSTALLATION AT EXTERIOR WALLS
A. Install boards horizontally on walls.
B. Cut and fit insulation tightly to protrusions or interruptions to the insulation plane.

3.03 BOARD INSTALLATION AT CAVITY WALLS
A. Install boards to fit snugly between wall ties.
B. Install boards horizontally on walls.
C. Cut and fit insulation tightly to protrusions or interruptions to the insulation plane.

3.04 BOARD INSTALLATION UNDER CONCRETE SLABS
A. Place insulation under slabs on grade after base for slab has been compacted.
B. Cut and fit insulation tightly to protrusions or interruptions to the insulation plane.
C. Prevent insulation from being displaced or damaged while placing vapor retarder and placing slab.

3.05 BOARD INSTALLATION OVER LOW SLOPE ROOF DECK

3.06 BOARD INSTALLATION OVER STEEP SLOPE ROOF SHEATHING OR ROOF STRUCTURE
A. Installation of board insulation over steep slope roof structure or roof sheathing is specified in Section 06 10 00.

3.07 BATT INSTALLATION
A. Install insulation in accordance with manufacturer’s instructions.
B. Install in exterior wall and roof spaces without gaps or voids. Do not compress insulation.
C. Trim insulation neatly to fit spaces. Insulate miscellaneous gaps and voids.
D. Fit insulation tightly in cavities and tightly to exterior side of mechanical and electrical services within the plane of the insulation.
3.08 VAPORETARDER INSTALLATION

A. In exterior stud-framed walls, attach sheet vapor retarder to inside stud faces with adhesive. Lap edges over stud faces, seal laps with tape. Lap ends onto adjacent construction; seal ends with sealant.
   1. Seal penetrations and openings in vapor retarder sheet to penetration or frame of opening with sealant or tape.

B. At window and door openings install sheet vapor retarder between frame and adjacent wall seal material and attach with adhesive. Seal laps with tape. Position lap seal over firm bearing.
   1. When edge of frame will be concealed, apply tape between frame and vapor retarder to form a continuous membrane integrating frame.

C. Apply sealants and adhesives within recommended application temperature ranges. Consult manufacturer temperature is out of this range.

3.09 QUALITY ASSURANCE

A. Insulation mark installation: insulating materials are to be installed such that the manufacturer's R-value mark is readily observable upon inspection.

3.10 PROTECTION

A. Do not permit installed insulation to be damaged prior to its concealment.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Self-Adhered Water-Resistive Air Barrier Membrane
B. Air Barriers: Materials that form a system to stop passage of air through exterior walls, joints between exterior walls and roof, and joints around frames of openings in exterior walls.
C. Through wall flashing membrane.

1.02 DEFINITIONS
A. Weather Barrier: Assemblies that form either water-resistive barriers, air barriers, or vapor retarders.
B. Air Barrier: Air tight barrier made of material that is relatively air impermeable but water vapor permeable, both to the degree specified, with sealed seams and with sealed joints to adjacent surfaces. Note: For the purposes of this specification, vapor impermeable air barriers are classified as vapor retarders.
C. Vapor Retarder: Air tight barrier made of material that is relatively water vapor impermeable, to the degree specified, with sealed seams and with sealed joints to adjacent surfaces. Water Vapor Permeance: For purposes of conversion, 57.2 ng/(Pa s sq m) = 1 perm.
D. Water-Resistive Barrier: Water-shedding barrier made of material that is moisture-resistant, to the degree specified, intended to be installed to shed water without sealed seams.

1.03 REFERENCE STANDARDS
C. ASTM International (ASTM):

1.04 PERFORMANCE REQUIREMENTS
A. Provide an air barrier membrane system constructed to perform as a continuous air barrier, and as a liquid water drainage plane flashed to discharge to the exterior any incidental condensation or water penetration. Membrane system shall accommodate movements of building materials by providing expansion and control joints as required, with accessory air sealant materials at such locations, changes in substrate, perimeter conditions and penetrations.
B. Air barrier membrane system shall bridge and seal the following air leakage pathways and gaps:
   1. Connections of the walls to the roof air barrier.
   2. Connections of the walls to the foundations.
   3. Seismic and expansion joints.
   4. Openings and penetrations of window and door frames, store front, curtain wall.
   5. Piping, conduit, duct and similar penetrations.
6. Masonry ties, screws, bolts and similar penetrations.
7. All other air leakage pathways in the building envelope.

1.05 PREINSTALLATION CONFERENCE
A. Preinstallation Meeting: Convene a meeting at least one week prior to starting work; require attendance of affected installers; invite Architect, Consultant, and Owner.

1.06 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Submit documentation from an approved independent testing laboratory certifying compliance with,
   1. the resistance to Hydrostatic Pressure,
   2. ASTM D 882 - Tensile Properties,
   3. ASTM E 84 – Class A Surface Burning Characteristics,
   4. ASTM E 96/E 96M - Test Methods for Water Vapor Transmission of Materials,
   5. ASTM E 2178 - Standard Test Method For Air Permeance of Building Materials, and
C. Submit documentation from an approved independent testing laboratory certifying the membrane meets ICC-ES AC38 - Acceptance Criteria for Water-Resistive Barriers.
D. Submit manufacturers' current product data sheets, details and installation instructions for the water-resistive vapor permeable air barrier membrane components and accessories.
E. Submit samples of the following:
   1. Manufacturer's sample warranty
   2. Each Weather Barrier sheet, minimum 10 by 10 inches (254 by 254 mm)
   3. Components, minimum 12-inch (305-mm) lengths
   4. Membrane flashings and lap seam tapes
   5. Fasteners, clips, strapping and ties
   6. Sealants

1.07 FIELD CONDITIONS
A. Maintain temperature and humidity recommended by the materials manufacturers before, during and after installation.
B. Do not apply weather barriers to damp or wet substrates or during snow, rain, fog or mist.
C. Verify the substrates are free of materials that could prevent barrier adhesion.

1.08 WARRANTY
A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
B. Provide 12 year manufacturer's material and labor warranty to cover failure to prevent penetration of water for air barrier membrane materials, sealant and flashing membrane.

PART 2 PRODUCTS
2.01 WEATHER BARRIER ASSEMBLIES
A. Air Barrier:
   1. On outside surface of sheathing of exterior walls use air barrier of type indicated.

2.02 AIR BARRIER MEMBRANE (WATER VAPOR PERMEABLE AND WATER-RESISTIVE)
A. Primary water resistive air barrier membrane shall be Blueskin SA manufactured by Henry; a self-adhering air barrier membrane with an engineered film specifically designed to be water resistant and vapor permeable. Membrane shall have the following physical properties:
WEATHER BARRIERS

1. Air leakage: <0.004 CFM/ft² @ 1.57 lbs/ft² [<0.02L/m² @ 75Pa] when tested in accordance with ASTM E2178.
2. Water Vapor Permeance: 29 perms to ASTM E96, Method B.
3. Tested to ASTM E2357 for Air Leakage of Air Barrier Assemblies.
6. Surface Burning Characteristics: Class A, when tested in accordance with ASTM E84: Flame Spread Rating of 0 and Smoke Development Classification of 105
7. Basis Weight: Minimum 160 gm/m², when tested in accordance with TAPPI Test Method T-410.
8. Tensile Strength: 40 lbF MD and 29 lbF CD per ASTM D882.
10. Cyclic and Elongation: Pass at 100 cycles, -29 degrees C (-20 degrees F) per ICC-ES AC 48.

B. Self-adhering membrane for window sill pan flashings shall be Blueskin SA manufactured by Henry; an SBS modified bitumen, self-adhering sheet membrane which is integrally laminated to a blue polyethylene film. Membrane shall have the following physical properties:
   1. Membrane Thickness: 0.040 inches (40 mils).
   2. Low temperature flexibility: -30 degrees F to ASTM D146.
   3. Elongation: 200% minimum to ASTM D412-modifed.
   5. Lap Peel Strength 25 lbf/in width to ASTM D903 180° bend.
   6. Auxiliary tested component of ASTM E2357 for Air Leakage of Air Barrier Assemblies.

C. Self-adhering membrane for all window jambs, headers, door openings, inside and outside corners, and other transitions shall be pre-cut BlueskinVP 160 manufactured by Henry; a self-adhering sheet air barrier membrane with an engineered film specifically designed to be water resistant and vapor permeable. Membrane shall have the following physical properties:
   1. Air leakage: <0.004 CFM/ft² @ 1.57 lbs/ft² [<0.02L/m² @ 75Pa] when tested in accordance with ASTM E2178.
   2. Water Vapor Permeance: 29 perms to ASTM E96, Method B.
   3. Tested to ASTM E2357 for Air Leakage of Air Barrier Assemblies.
   6. Surface Burning Characteristics: Class A, when tested in accordance with ASTM E84: Flame Spread Rating of 0 and Smoke Development Classification of 105.
   7. Basis Weight: Minimum 160 gm/m², when tested in accordance with TAPPI Test Method T-410.
   8. Tensile Strength: 40 lbF MD and 29 lbF CD per ASTM D882.
   10. Cyclic and Elongation: Pass at 100 cycles, -29 degrees C (-20 degrees F) per ICC-ES AC 48.

D. Through-wall flashing membrane (Self-Adhering) shall be Blueskin TWF manufactured by Henry; an SBS modified bitumen, self-adhering (Yellow) sheet membrane complete with a cross-laminated polyethylene film. Membrane shall have the following physical properties:
   1. Membrane Thickness: 0.0394 inches (40 mils)
   2. Film Thickness: 4.0 mils
   3. Flow (ASTM D5147): Pass @ 212 degrees F
   4. Puncture Resistance: 134 lbf to ASTM E 154
   5. Tensile Strength (film): 5000 psi ASTM D882
6. Tear Resistance: 17lbs. MD to ASTM D1004  
7. Low temperature flexibility: -22 degrees F to CGSB 37-GP-56M

2.03 SEALANTS  
A. Polyurethane Sealant: Type as specified in Section 07 90 05. Verify compatibility of sealant with weather-resistive barrier and related self-adhered membrane.  
B. Silicone Sealant: Type as specified in Section 07 90 05. Verify compatibility of sealant with weather-resistive barrier and related self-adhered membrane.  
C. Sealant Backers: As specified in Section 07 90 05.  
D. Primers, Cleaners, and Other Sealant Materials: As recommended by sealant manufacturer, appropriate to application, and compatible with adjacent materials.

2.04 ACCESSORIES  
1. Self-Adhered Membrane (SAM): Composite, self-adhesive, flashing product consisting of a pliable, rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film to produce an overall thickness of not less than 0.025 inch.  
   a. Products:  
      1) Henry Company; Blueskin SA.  
      2) Substitutions: See Section 01 60 00 - Product Requirements.  
B. Thinners and Cleaners: As recommended by material manufacturer.  
C. Tapes:  
1. Weather-Resistive Barrier Tapes: Seal all laps of weather-resistive barrier to eliminate uncontrolled air leakage.  
D. Primers: Provide self-adhered flashing manufacturer’s recommended primer to aid in adhesion between substrate and flashing membrane.  
E. Fasteners: As recommended by barrier manufacturer.

PART 3 EXECUTION  
3.01 EXAMINATION  
A. Verify that surfaces and conditions are ready to accept the work of this section.

3.02 PREPARATION  
A. Remove projections, protruding fasteners, and loose or foreign matter that might interfere with proper installation.  
B. Clean and prime substrate surfaces to receive adhesives in accordance with manufacturer's instructions.  
C. Verify that surfaces and conditions are ready to accept the Work of this section. Notify Architect in writing of any discrepancies. Commencement of the Work or any parts thereof shall mean acceptance of the prepared substrates.  
D. All surfaces must be dry, sound, clean and free of oil, grease, dirt, excess mortar or other contaminants detrimental to the adhesion of the water resistive air barrier membrane and flashings. Fill voids and gaps in substrate greater than ¼ inch in width to provide an even surface. Strike masonry joints full-flush.  
E. Minimum application temperature self-adhered membrane and flashings to be above 20 degrees F (minus 6.0 degrees C).  
F. Ensure all preparatory Work is complete prior to applying primary self-adhered vapor permeable air barrier sheet membrane.
3.03 INSTALLATION

A. Install materials in accordance with manufacturer's instructions.

B. Openings and Penetrations in Exterior Weather Barriers:
   1. Install flashing over sills, covering entire sill frame member, extending at least 5 inches onto weather barrier and at least 6 inches up jambs; mechanically fasten stretched edges.
   2. Complete detail Work around corners, wall openings, building transitions and penetrations prior to field applications.
   3. Install self-adhered vapor permeable air barrier sheet over the outside face of the substrate, measure and pre-cut into manageable sized sheets to suit the application conditions.
   4. Install self-adhered vapor permeable air barrier sheet complete and continuous to substrate in a sequential overlapping weatherboard method starting at bottom or base of wall and working up.
   5. Stagger all end lap seams.
   6. Roll installed membrane with roller to ensure positive contact and adhesion with substrate.
   7. At openings to be filled with frames having nailing flanges, seal head and jamb flanges using a continuous bead of sealant compressed by flange and cover flanges with at least 4 inches wide; do not seal sill flange.
   8. At openings to be filled with non-flanged frames, seal weather barrier to all sides of opening framing, using flashing at least 9 inches wide, covering entire depth of framing.
   9. At head of openings, install flashing under weather barrier extending at least 2 inches beyond face of jambs; seal weather barrier to flashing.
  10. At interior face of openings, seal gap between window/door frame and rough framing, using joint sealant over backer rod.
  11. Service and Other Penetrations: Form flashing around penetrating item and seal to weather barrier surface.

C. Inside and Outside corners:
   1. Pre-treat inside and outside corners with self-adhered air barrier transition and flashing membrane extending a minimum of 5 inches from inside and outside corners, or overlap field material a minimum of 3 inches in each direction.
   2. Align and position self-adhered air barrier transition and flashing membrane, remove protective film and press firmly into place. Provide minimum 3 inch overlap at all side laps and minimum 3 inch overlap at all end laps of membrane.
   3. Roll membrane and lap seams with roller to ensure positive contact and adhesion.

3.04 FIELD QUALITY CONTROL

A. Make notification when sections of work are complete to allow review prior to covering self-adhered water-resistant vapor permeable air barrier system.

B. Owner to engage independent consultant to observe substrate and membrane installation prior to placement of cladding systems and provide written documentation of observations.

3.05 PROTECTION

A. Protect wall areas covered with self-adhered water-resistant vapor permeable air barrier from damage due to construction activities, high wind conditions, and extended exposure to inclement weather.

B. Review condition of self-adhered water-resistant vapor permeable air barrier prior to installation of cladding. Repair, or remove and replace damaged sections with new membrane.

C. Recommend to cap and protect exposed back-up walls against wet weather conditions during and after application of membrane, including wall openings and construction activity above completed self-adhered water-resistant vapor permeable air barrier installations.
D. Remove and replace Water-Resistive weather barrier membrane affected by chemical spills or surfactants

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Manufactured metal panels for walls and soffits, with insulation, liners, related flashings, and accessory components.

1.02 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Shop Drawings: Indicate dimensions, layout, joints, construction details, methods of anchorage.
   C. Samples: Submit two samples of wall panel and soffit panel, 12 inch by 12 inch in size illustrating finish color, sheen, and texture.

1.03 QUALITY ASSURANCE
   A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.
   B. Installer Qualifications: Company specializing in performing the work of this section with minimum three years of experience.

1.04 DELIVERY, STORAGE, AND HANDLING
   A. Protect panels from accelerated weathering by removing or venting sheet plastic shipping wrap.
   B. Store prefinished material off ground and protected from weather. Prevent twisting, bending, or abrasion, and provide ventilation to stored materials. Slope metal sheets to ensure drainage.
   C. Prevent contact with materials that may cause discoloration or staining of products.

1.05 WARRANTY
   A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
   B. Correct defective work within a five year period after Substantial Completion for degradation of panel finish, including color fading caused by exposure to weather.
   C. Correct defective Work within a five year period after Substantial Completion, including defects in water tightness and integrity of seals.
   D. Correct defective Work within a ten year period after Substantial Completion, including delaminations or other structural failures.

PART 2 PRODUCTS

2.01 MANUFACTURED METAL PANELS
   A. Wall Panel System: Factory fabricated prefinished metal panel system, site assembled.
      1. Provide exterior panels, interior liner panels, soffit panels, and subgirt framing assembly.
      2. Design and size components to withstand dead and live loads caused by positive and negative wind pressure acting normal to plane of wall.
      4. Movement: Accommodate movement within system without damage to components or deterioration of seals, movement within system; movement between system and perimeter components when subject to seasonal temperature cycling; dynamic loading and release of loads; and deflection of structural support framing.
      5. Drainage: Provide positive drainage to exterior for moisture entering or condensation occurring within panel system.
      6. Fabrication: Formed true to shape, accurate in size, square, and free from distortion or defects; pieces of longest practical lengths.
      7. Corners: Factory-fabricated in one continuous piece with minimum 18 inch returns.
METAL WALL PANELS


B. Exterior Panels:
   1. Profile: Vertical; style as indicated.
   2. Side Seams: Double-interlocked, tight-fitting, sealed with continuous gaskets.

C. Liner Panels:
   1. Profile: Vertical; style as indicated.
   2. Side Seams: Interlocking, sealed with continuous bead of sealant.

D. Subgirts:
   1. 16 gage thick formed stainless steel sheet.
   2. Profile as indicated; to attach panel system to building.

E. Internal and External Corners: Same material, thickness, and finish as exterior sheets

F. Expansion Joints: Same material, thickness and finish as exterior sheets; ____ gage; manufacturer's standard brake formed type, of profile to suit system.

G. Trim: Same material, thickness and finish as exterior sheets; brake formed to required profiles.

H. Anchors: Galvanized steel.

2.02 ACCESSORIES

A. Gaskets: Manufacturer's standard type suitable for use with system, permanently resilient; ultraviolet and ozone resistant.

B. Sealants: As specified in Section 07 90 05.

C. Fasteners: Manufacturer's standard type to suit application; with soft neoprene washers, stainless steel. Exposed fasteners same finish as panel system.

2.03 FABRICATION

A. Form sections true to shape, accurate in size, square, and free from distortion or defects.

B. Form pieces in longest practicable lengths.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that building framing members are ready to receive panels.

B. Verify that water-resistive barrier has been installed over substrate completely and correctly.

3.02 PREPARATION

A. Install subgirts perpendicular to panel length, securely fastened to substrates and shimmed and leveled to uniform plane. Space at intervals indicated.

3.03 INSTALLATION

A. Install panels on walls and soffits in accordance with manufacturer's instructions.

B. Fasten panels to structural supports; aligned, level, and plumb.

C. Provide expansion joints where indicated.

D. Use concealed fasteners unless otherwise approved by Architect.

E. Seal and place gaskets to prevent weather penetration. Maintain neat appearance.
3.04 TOLERANCES
   A. Maximum Offset From True Alignment Between Adjacent Members Butting or In Line: 1/16 inch.

3.05 CLEANING
   A. Remove site cuttings from finish surfaces.
   B. Clean and wash prefinished surfaces with mild soap and water; rinse with clean water.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Thermoplastic membrane roofing system, including all components specified for mechanical penthouse and exterior work area roof.


C. Commencement of work by Contractor shall constitute acknowledgement by Contractor that this specification can be satisfactorily executed, under the project conditions and with all necessary prerequisites for warranty acceptance by roofing membrane manufacturer. No modification of the Contract Sum will be made for failure to adequately examine the Contract Documents or the project conditions.

1.02 DEFINITIONS

A. Roofing Terminology: Refer to ASTM D1079 for definition of terms related to roofing work not otherwise defined in the section.

B. LTTR: Long Term Thermal Resistance, as defined by CAN-ULC S770.

1.03 PERFORMANCE REQUIREMENTS

A. Install a watertight TPO fully adhered membrane roofing system with base flashing system and compatible components that will not permit passage of liquid water and will withstand wind loads, thermally induced movement, and exposure to weather without failure.

B. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by membrane roofing manufacturer based on testing and field experience.

C. Roof System Design: Provide membrane roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist uplift pressure calculated according to ASCE/SEI 7.
   1. Corner Uplift Pressure: 105 lbf./sq. ft.
   2. Perimeter Uplift Pressure: 75 lbf./sq. ft.
   3. Field-of-Roof Uplift Pressure: 60 lbf./sq. ft.

D. FM Listing: Provide TPO membrane roofing system, base flashings, and component materials that meet requirements of FM 4450 and FM 4470 as part of a roofing system and that are listed in Factory Mutual's "Approved Guide" for Class 1 or noncombustible construction, as applicable. Identify materials with FM markings.
   1. Roofing system shall comply with Fire/Windstorm Classification: Class 1A-90.

1.04 REFERENCE STANDARDS

A. American Society of Civil Engineers (ASCE) - ASCE 7 - Minimum Design Loads for Buildings and Other Structures, Current Revision.

B. ANSI/SPRI WD-1 "Wind Design Standard for Roofing Assemblies".

C. ASTM International (ASTM):
   5. ASTM D4601 Type II - Standard Specification for asphalt impregnated and coated glass fiber base sheets.
D. Factory Mutual (FM Global):
   1. Approval Guide.
      a. Factory Mutual Standard 4470 - Approval Standard for Class 1 Roof Covers.
      b. Loss Prevention Data Sheets 1-28, 1-29.

E. International Code Council (ICC):


H. Underwriters Laboratories (UL):
   1. TGFU R1306 - "Roofing Systems and Materials Guide".


1.05 ADMINISTRATIVE REQUIREMENTS

A. Pre-Installation Conference: Before start of roofing work, Contractor shall hold a meeting to discuss the proper installation of materials and requirements to achieve the warranty.
   1. Require attendance with all parties directly influencing the quality of roofing work or affected by the performance of roofing work including roofing membrane product representative.
   2. Notify Architect well in advance of meeting.

1.06 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data:
   1. Provide membrane manufacturer's printed data sufficient to show that all components of roofing system, including insulation and fasteners, comply with the specified requirements and with the membrane manufacturer's requirements and recommendations for the system type specified; include data for each product used in conjunction with roofing membrane.
      b. Technical data sheets for splice tape and adhesives.
      c. Technical data sheet for batten strips and fasteners.
      d. Technical data sheet for each insulation type.
      e. Technical data sheet for each cover board type.
      f. Technical data sheet for each type of metal edging.
      g. Technical data sheet for pavers.
      h. Where UL or FM requirements are specified, provide documentation that shows that the roofing system to be installed is UL-Classified or FM-approved, as applicable; include data itemizing the components of the classified or approved system.
      i. Installation Instructions: Provide manufacturer's instructions to installer, marked up to show exactly how all components will be installed; where instructions allow installation options, clearly indicate which option will be used.

C. Shop Drawings: Provide:
   1. The roof membrane manufacturer's standard details customized for this project for all relevant conditions, including flashings, base tie-ins, roof edges, terminations, expansion joints, penetrations, and drains.
   2. For tapered insulation, provide project-specific layout and dimensions for each board.
D. Specimen Warranty: Submit prior to starting work.

E. Installer Qualifications: Letter from manufacturer attesting that the roofing installer meets the specified qualifications.

F. Pre-Installation Notice: Copy to show that manufacturer's required Pre Installation Notice (PIN) has been accepted and approved by the manufacturer.

G. Executed Warranty.

1.07 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that has FM Approvals approved for membrane roofing system identical to that used for this Project.

B. Installer Qualifications: Roofing installer shall have the following:
   2. Current Firestone Partners in Quality Contractor status.
   3. Current Firestone Red Shield Licensed Contractor status with Master Contractor status at least once in the last three years.
   5. Current approval, license, or authorization as applicator by the manufacturer.
   6. Fully staffed office within 100 miles of the job site.
   7. At least five years of experience in installing specified system.
   8. Capability to provide payment and performance bond to building owner.
   9. Capability to provide a payment performance bond.
   10. Firm shall have been in continuous business under the same name for a minimum of 10 years.

C. Source Limitation: Obtain components for membrane roofing system approved by roof membrane manufacturer.

D. Exterior Fire-Test Exposure: ASTM E108, Class A for application and roof slopes indicated, as determined by testing identical membrane roofing materials by a qualified testing agency. Materials shall be identified with appropriate markings of applicable testing agency.

E. Fire Resistance Ratings: Where indicated, provide fire-resistance-rated roof assemblies identical to those of assemblies tested for fire resistance per ASTM E119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

F. Pre-installation Roof Conference: Conduct conference at Project site. Shall include:
   1. Meet with Owner, Owner’s insurer if applicable, Architect, Roof Consultant, testing and inspecting agency representative, roofing Installer, roofing system manufacturer’s representative, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
   2. Review methods and procedures related to roofing installation, including manufacturer’s written instructions.
   3. Review and finalize construction schedule and verify availability of materials, Installer’s personnel, equipment and facilities needed to make progress and avoid delays.
   4. Review structural loading limitations of roof deck during and after roofing.
   5. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect roofing system.
   6. Review governing regulations and requirements for insurance and certificates, if applicable.
   7. Review temporary protection requirements for roofing system during and after installation.
   8. Review roof observation and repair procedures after roofing installation.
1.08 DELIVERY, STORAGE AND HANDLING
   A. Deliver products in manufacturer's original containers, dry and undamaged, with seals and labels intact and legible.
   B. Store materials clear of ground and moisture, in a cool shaded area, and with weather protective covering.
   C. Keep combustible materials away from ignition sources.

1.09 PROJECT CONDITIONS
   A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer’s written instructions and warranty requirements.
   B. Provide tarps or plastic sheeting required to protect opened roofs and flashings and to prevent the entrance of moisture or rain water into the existing structure until new materials have been applied and roof is in a watertight condition.
   C. Have necessary waterproof canvas or plastic sheeting readily available in case of emergency. The Contractor will be held liable for any damage to building interior due to Contractor’s negligence.
   D. Roofing materials shall not be applied when water in any form (i.e., rain, dew, ice, frost, snow, etc.) is present on the deck.
   E. Roofing materials shall not be applied when dirt, dust, debris, oil, etc. is present on the deck.
   F. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer’s written instructions and warranty requirements.
   G. End of Work Day: The roof system is to be water tight by the end of each work day, using methods as outlined in the Project Documents.

1.10 WARRANTY
   A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
   B. Comply with all warranty procedures required by manufacturer, including notifications, scheduling, and inspections.
   C. Warranty: Membrane Manufacturer's Limited Warranty covering membrane, roof insulation, and other indicated components of the system, for the term indicated.
      1. Limit of Liability: No dollar limitation.
      2. Materials warranty includes roofing membrane, base flashings, roofing accessories, fasteners, substrate board, roof level insulation, cover boards, walkway products, and other components of membrane roofing system.
      3. Scope of Coverage: Repair leaks in the roofing system caused by:
         a. Ordinary wear and tear of the elements.
         b. Manufacturing defect in brand materials.
         c. Defective workmanship used to install these materials.
         d. Warranty Period: Twenty (20) years from date of final acceptance.
   D. Warranty: Installer's Limited Warranty covering system installation.
      1. Include all components of roofing system such as roof membrane base flashing, fasteners, substrate boards, and other components of roofing system.
      2. Warranty Period: Five (5) years from date of final acceptance.

PART 2 PRODUCTS
2.01 ROOFING SYSTEM DESCRIPTION
   A. Roofing System: Thermoplastic Polyolefin (TPO) single-ply membrane.
1. Membrane Attachment: Fully adhered.
2. Comply with applicable local building code requirements.
4. Provide assembly complying with Factory Mutual Global (FM) Roof Assembly Classification, FM DS 1-28 and 1-29, and meeting minimum requirements of FM 1-90 wind uplift rating.

### B. Roofing System Components: Listed in order from the top of the roof down:

1. Membrane: Fully adhere, thickness as specified.
2. Insulation Cover Board: Gypsum-based board, 1/2-inch thick for mechanical penthouse and 5/8 inch thick at Craft Center exterior work area roof without insulation; adhesive attached.
3. Insulation:
   a. Maximum Board Thickness: 3-inches; use as many layers as necessary; stagger joints in adjacent layers, all layers adhered.
   b. Tapered: Slope as indicated; provide minimum R-value at thinnest point; place tapered layer on bottom.
   c. Total R Value: 25 minimum at the mechanical penthouse and no insulation at the Craft Center exterior work area roof.
   d. Crickets: Tapered insulation of same type as specified for top layer; slope as indicated.
4. Vapor Retarder Material: No vapor retarder at the Craft Center exterior work area roof.
5. Substrate Board: Gypsum-based board at mechanical penthouse.
   a. Metal Deck: 1/2-inch thick; gypsum-based board mechanically attached at mechanical penthouse.
   b. Metal Deck: 3/4 inch plywood mechanically attached to metal deck at exterior work area roof. Plywood is to be preservative and fire retardent treated.

### 2.02 TPO MEMBRANE MATERIALS

#### A. Roofing Membrane: thermoplastic polyolefin (TPO) reinforced with a polyester, weft-inserted scrim, complying with ASTM D6878, with the following properties:

1. Thickness: 0.080 inch.
5. Color:
   a. White at mechanical penthouse.
   b. Gray, min SRI >78, see roof plans for location, with matching accessories at exterior work area roof.
   a. Roofing systems manufactured by others are acceptable provided the roofing system is completely equivalent in materials and warranty conditions and the manufacturer meets the following qualifications:
      1) Specializing in manufacturing the roofing system to be provided.
      2) Minimum ten years of experience manufacturing the roofing system to be provided.
      3) Able to provide a no dollar limit, single source roof system warranty that is backed by corporate assets in excess of one billion dollars.
      4) ISO 9002 certified.
      5) Able to provide polyisocyanurate insulation that is produced in own facilities.
6) Roofing systems manufactured by the companies listed below are acceptable provided they are completely equivalent in materials and warranty conditions:
   (a) Carlisle-SynTec Incorporated.
   (b) Johns Manville.
   (c) Substitution see Section 01 60 00 for substitution requirements.

7. Provide assembly complying with Factory Mutual Corporation (FM) Roof Assembly Classification, FM DS 1-28 and 1-29, and meeting minimum requirements of FM 1-90 wind uplift rating.

2.03 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 authorities having jurisdiction.

B. Bonding Adhesives: A high-strength, synthetic rubber adhesive used for bonding the membrane to various surfaces. The adhesive is applied to both the membrane and the substrate.

C. Cut Edge Sealant: A white or clear sealant used to seal cut edges of reinforced membrane.

D. Water Cut-Off Mastic: Used as a mastic to prevent moisture migration at drains, compression terminations and beneath conventional metal edging.

E. Universal Single-Ply Sealant: A 100% solids, solvent free, VOC free, one part polyether sealant that provides a weather tight seal to a variety of building materials. It is white in color and is used for general caulking such as above termination bars and metal counter flashings and at scuppers.

F. Thermoplastic One-Part Pourable Sealer: A one-part, moisture curing, elastomeric polyether sealant used to fill TPO Molded Pourable Sealant Pockets.

G. Weathered Membrane Cleaner: Used to prepare membrane for heat welding that has been exposed to the elements or to remove general construction contaminants.

H. TPO Primer: Solvent-based, low solids primer used to prepare the surface of membrane prior to application of pressure-sensitive securement strips.

I. Pressure-Sensitive Securement Strips:

J. Metal Termination Bars: Manufacturer’s standard, predrilled stainless steel or aluminum bar, approximately 1-inch by 1/8-inch thick; with anchors.

K. Metal Battens: Manufacturer’s standard, aluminum-zinc-alloy-coated or zinc-coated steel sheet, approximately 1-inch wide by 0.05-inch thick, pre-punched.

L. Walkway Pads: Manufacturer’s standard white, Factory-formed, nonporous, heavy-duty, TPO, slip-resisting, surface-textured walk pads approximately 3/16 inch thick.

M. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approval 4470, designed for fastening membrane to substrate, and acceptable to roofing system manufacturer.

N. Miscellaneous Accessories: Provide preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, reinforced TPO securement strips, T-joint covers, in-seam sealants, termination reglets, cover strips, and other accessories.

2.04 COVER BOARD

A. Cover Board: ASTM C1177/C1177M, glass-mat faced on both sides of board surface pre-treated with bond-improving primer, water-resistant gypsum substrate, ½ -inch thick or 5/8 inch thick.
   1. Manufacturer: Same manufacturer as roof membrane.
B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate panel to roof deck. Exterior work area roof must have stainless steel fasteners.

2.05 ROOF INSULATION

A. Insulation Units: ASTM C 1289, Type II; Rigid closed-cell polyisocyanurate foam board, felt or glass-fiber mat facer on both major surfaces.
   1. Produced using HC blowing agents in lieu of HCFCs, in accordance with standards mandated by the Environmental Protection Agency.
   2. Thermal Resistance: Tested for Long Term Thermal Resistance (LTTR) in accordance with CAN/ULC-S770.
   3. Compressive Strength: Nominal 20 psi per ASTM D 1621.
   4. Flame Spread: 35 or less per ASTM E 84.
   5. Unit size shall be 4-foot by 8-foot.
   6. Maximum Unit thickness shall be 3-inches.
   7. Total R Value: as indicated above.
   8. Overall thickness of insulation units shall equal that as indicated on the Drawings and as required to achieve specified slopes.
   9. Insulation units shall be installed in minimum two consecutive and separate layers, with joints of each layer offset from previous layer of insulation; unless otherwise indicated.

B. Tapered Insulation Units (for crickets): ASTM C 1289, Type II; Rigid closed-cell polyisocyanurate foam board, felt or glass-fiber mat facer on both major surfaces.
   1. Provide factory-tapered insulation boards fabricated to finish slope of 1/4-inch per 12-inches unless otherwise indicated.
   2. Unit size shall be 4-foot by 4-foot.
   3. Produced using HC blowing agents in lieu of HCFCs, in accordance with standards mandated by the Environmental Protection Agency.
   4. Slope as indicated on the Drawings; provide minimum R-value at thinnest point; place tapered layer on bottom.

C. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to the slope of 1/4-inch per 12-inches unless otherwise indicated. Use the following materials or Tapered Insulation Units.
   1. Cellulosic-Fiber Board Insulation: ASTM C 208, Type II, Grade 2, fibrous-felted, rigid insulation boards of wood fiber or other cellulosic-fiber and water-resistant binders, asphalt impregnated, chemically treated for deterioration.
   2. Cellulosic-Fiber Board Insulation shall not exceed four feet in greatest dimension (use Tapered Insulation for applications exceeding four feet wide), unless applied as a tapered edge strip.

D. Insulation Adhesive:
   1. Adhesive material shall meet FM I-90 (Class 4450) with approved insulation boards.
   2. Material to be supplied in pressurized cylinders with a net weight of 23 lbs. per container.
   3. Approved Manufacturers:
      c. Substitution see Section 01 60 00 for substitution requirements.

2.06 VAPOR RETARDER

A. Glass Fiber Mat Reinforced Styrene-Butadiene-Styrene (SBS) Rubber Modified, Self-Adhesive Asphalt Sheet as follows:
   1. Manufacturer Products:
      a. MB Base SA, as manufactured by Firestone.
   2. No vapor retarder required at exterior work area roof.
2.07 SUBSTRATE BOARD

A. Substrate Board: ASTM C1177/C1177M, glass-mat faced on both sides of board surface pre-treated with bond-improving primer, water-resistant gypsum substrate,
   1. Manufacturer:
      a. Georgia-Pacific Corporation; Dens Deck Prime Roof Board.
      b. 1/2-inch or 1/4-inch in designated areas.

B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening to the specific substrate panel or roof deck type.

2.08 METAL ACCESSORIES

A. Metal Roof Edging and Fascia: Continuous metal edge member serving as termination of roof membrane and retainer for metal fascia; watertight with no exposed fasteners; mounted to roof edge nailer.
   1. Wind Performance:

B. Parapet Copings: Formed metal coping with galvanized steel anchor/support cleats for capping any parapet wall; watertight, maintenance free, without exposed fasteners; butt type joints with concealed splice plates; mechanically fastened as indicated; Firestone PTCF.
   1. Wind Performance:
      a. At least the minimum required when tested in accordance with ANSI/SPRI ES-1 Test Method RE-3, current edition.

2.09 ACCESSORY MATERIALS

A. Wood Nailers: PS 20 dimension lumber, Structural Grade No. 2 or better Southern Pine, Douglas Fir; or PS 1, APA Exterior Grade plywood; pressure preservative treated.
   1. Width: 3-1/2 inches, nominal minimum, or as wide as the nailing flange of the roof accessory to be attached to it.

PART 3 INSTALLATION

3.01 GENERAL

A. Install roofing, insulation, flashings, and accessories in accordance with roofing manufacturer's published instructions and recommendations for the specified roofing system. Where manufacturer provides no instructions or recommendations, follow good roofing practices and industry standards. Comply with federal, state, and local regulations.

B. Obtain all relevant instructions and maintain copies at project site for duration of installation period.

C. Do not start work until Pre-Installation Notice has been submitted to manufacturer as notification that this project requires a manufacturer's warranty.

D. Perform work using competent and properly equipped personnel.
E. Temporary closures, which ensure that moisture does not damage any completed section of the new roofing system, are the responsibility of the applicator. Completion of flashings, terminations, and temporary closures shall be completed as required to provide a watertight condition.

F. Install roofing membrane only when surfaces are clean, dry, smooth and free of snow or ice; do not apply roofing membrane during inclement weather or when ambient conditions will not allow proper application; consult manufacturer for recommended procedures during cold weather. Do not work with sealants and adhesives when material temperature is outside the range of 60 to 80 degrees F.

G. Protect adjacent construction, property, vehicles, and persons from damage related to roofing work; repair or restore damage caused by roofing work.
   1. Protect from spills and overspray from adhesives, sealants and coatings.
   2. Particularly protect metal, glass, plastic, and painted surfaces from adhesives, and sealants within the range of wind-borne overspray.
   3. Protect finished areas of the roofing system from roofing related work traffic and traffic by other trades.

H. Until ready for use, keep materials in their original containers as labeled by the manufacturer.

I. Consult membrane manufacturer's instructions, container labels, and Material Safety Data Sheets (MSDS) for specific safety instructions. Keep all adhesives, sealants, primers and cleaning materials away from all sources of ignition.

3.02 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with the following requirements and other conditions affecting performance of roofing system:
   1. Verify that roof openings and penetrations are in place and set and braced and that roof drains are securely clamped in place.
   2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
   3. Verify that all curbs, wall surfaces, equipment supports, and other roof penetrations that will receive roofing materials will allow the installation of full-height flashings. Verify heights of all penetrations which are located within crickets and slope upgrades; extend penetrations where necessary.

B. FM Global Roof Inspection: Arrange for a Factory Mutual Global technical representative to inspect preparation of decks which are ready to receive new roofing to ensure preparation is within FMG parameters to obtain required FMG coverage.

C. Manufacturer’s Roof Inspection: Arrange for roofing system manufacturer’s technical personnel to inspect preparation of decks to receive roofing and general installation procedures.
   1. Notify Owner 48 hours in advance of date and time of inspection.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

E. Verify that the specification and drawing details are workable and not in conflict with the roofing manufacturer’s recommendations and instructions; start of work constitutes acceptance of project conditions and requirements.

3.03 PREPARATION

A. Remove all of the existing roof system down to the roof deck including all existing composition base flashings. Dispose of all materials properly. Perform asbestos removal in accordance with federal, state and local regulations and dispose of waste in legal manner.
   1. At penetrations, remove all existing flashings, including lead, asphalt, mastic, etc.
   2. At walls, curbs, and other vertical and sloped surfaces, remove loose and unsecured flashings; remove mineral surfaced and coated flashings; remove excessive asphalt to provide a smooth, sound surface for new flashings.
B. Prior to proceeding, prepare roof surface so that it is clean, dry, and smooth, and free of sharp edges, fins, roughened surfaces, loose or foreign materials, oil, grease and other materials that may damage the membrane.
   1. Moisture includes rain, dew, ice, frost, snow, and the like.
   2. Dust and debris include dirt, oil, and other materials not inherent in the substrate.
   3. Cleaned roof substrates shall be acceptable to the manufacturer and FM Global prior to being covered by new roof system materials.

C. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecasted.

D. Inspect all substrate for irregularities and defects that prohibit the proper installation of new roofing materials. Notify the Owner of all defects for proper correction, prior to installation of new materials.

E. Prepare all surfaces and details in accordance with Manufacturer’s printed instructions and these contract documents.

F. Protect building surfaces and equipment from damage and contamination from roofing work.

G. Take appropriate measures to ensure that fumes from adhesive solvents are not drawn into the building through air intakes.

H. Fill all surface voids in the immediate substrate that are greater than 1/4 inch wide with fill material acceptable insulation to membrane manufacturer.

I. Wood Nailers: Provide wood nailers at all perimeters and other locations where indicated on the drawings, of total height matching the total thickness of insulation being used.
   1. Install with 1/8 inch gap between each length and at each change of direction.
   2. Mechanically fasten to deck to resist force of 200 lbf per linear foot.

J. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the work day or when rain is forecasted. Remove and discard temporary seals before beginning work on adjoining roofing.

3.04 SUBSTRATE BOARD INSTALLATION

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 the specific existing roof deck according to recommendations in FM Approvals’ “RoofNav” and FM Global Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification.
   2. Fasten substrate board to the specific existing roof deck to resist uplift pressure at corners, perimeter, and filed of roof according to membrane roofing system manufacturers’ written instructions.

3.05 VAPOR RETARDER INSTALLATION

A. General: Vapor Retarder is intended to be a temporary weatherproof membrane capable of withstanding hydrostatic water pressure generated by storm water during the course of construction, as well as an effective Vapor Retarder after being covered.

B. Apply product called for by the manufacturer, primer or membrane adhesive, in a single layer over area to receive Vapor Retarder according to manufacturer’s approved special application instructions.
   1. Use roller applied application at a rate of 200 ft2/gallon (4.9 m2/L 0.5gal/square 0.20L/m2).
   2. Full spray application of adhesive.

C. Fully adhere Vapor Retarder in a single layer over area to receive Vapor Retarder, side and end lapping each sheet a minimum of 2-inches and 6-inches respectively.
D. Completely press field of Vapor Retarder, side laps, and end laps with a roller; achieving full adhesion of sheet and laps. Firmly press in all T-joints with a neoprene roller.
E. Provide temporary waterproof tie-offs at the end of each work day as required; using approved materials and tie-off configuration.
F. Protect Vapor Retarder from construction related activities, traffic contaminants, excessive exposure to sun light, and debris.
G. Inspect and repair Vapor Retarder each work day until covered, as required to maintain waterproof integrity.
H. Ensure that all penetrations and edge conditions are sealed to prevent moisture and air drive into the roofing system.

3.06 INSULATION INSTALLATION
A. Install insulation in configuration and with attachment method(s) specified in PART 2, under Roof Insulation.
B. Install insulation in a manner that will not compromise the vapor retarder integrity.
C. Comply with membrane roofing system and insulation manufacturer’s written instructions for installing roof insulation.
D. Install only as much insulation as can be covered with the completed roofing system before the end of the day's work or before the onset of inclement weather.
E. Lay roof insulation in courses parallel to roof edges.
F. Install tapered insulation under area of roofing to conform to slopes indicated.
G. Install one or more layers of insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2-inches or greater, install two (2) or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6-inches in each direction.
   1. Install bottom layer of insulation over Vapor Barrier using adhesive applied in continuous ½-¾-inch wide ribbon spaced 8-inches on center, or as otherwise recommended by the manufacturer for wind uplift rating.
   2. Install top layer of insulation secured to the first (bottom) layer of insulation with adhesive applied in continuous ½-¾-inch wide ribbon spaced 8-inches on center, or as otherwise recommended by the manufacturer for wind uplift rating.
H. Trim surface of insulation where necessary at roof drains and install tapered units within sumps as shown on drawings so the completed surface is flush and does not restrict flow of water.
I. Neatly and tightly fit insulation to all penetrations, projections, and nailers, with gaps not greater than 1/4 inch. Fill gaps greater than 1/4 inch with acceptable insulation. Do not leave the roofing membrane unsupported over a space greater than 1/4 inch.
J. Cold Adhesive Attachment: Apply in accordance with membrane manufacturer's instructions and recommendations; "walk-in" and weight individual roof insulation boards to obtain maximum adhesive contact.

3.07 COVER BOARD INSTALLATION
A. 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 adhere to the insulation assembly.
   1. Adhere cover boards according to requirements in FM Approval's “RoofNav” for specified Windstorm Resistance Classification.
   2. Adhere cover boards to resist uplift pressure at corners, perimeter, and field of roof.
3.08 ADHERED MEMBRANE ROOFING INSTALLATION

A. Start installation of membrane roofing in presence of membrane roofing system manufacturer’s technical personnel.
B. Place membrane without stretching over substrate and allow to relax at least 30 minutes before attachment or splicing; in colder weather allow for longer relax time.
C. Accurately align membrane roofing and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
D. Lay out the membrane pieces so that field and flashing splices are shingled to shed water.
E. Apply Bonding Adhesive in accordance with the manufacturer's published instructions, to the exposed underside of the membrane and the corresponding substrate area. Do not apply Bonding Adhesive along the splice edge of the membrane to be hot air welded over the adjoining sheet. Allow the adhesive to dry until it is tacky but will not string or stick to a dry finger touch.
   1. Roll the coated membrane into the coated substrate while avoiding wrinkles. Brush down the bonded section of the membrane sheet immediately after rolling the membrane into the adhesive with a soft bristle push broom to achieve maximum contact.
   2. Fold back the unbonded half of the sheet and repeat the bonding procedures.
F. Hot air weld the membrane in accordance with the manufacturer's specifications. At all splice intersections, roll the seam with a silicone roller immediately after welder crossed the membrane step-off to ensure a continuous hot air welded seam.
G. Install membrane without wrinkles and without gaps or fishmouths in seams; weld and test seams and laps in accordance with membrane manufacturer's instructions and details.
H. Probe all seams once the hot air welds have thoroughly cooled (approximately 30 minutes).
I. Repair all seam deficiencies the same day they are discovered.
J. Apply Cut Edge Sealant on all cut edges of reinforced membrane (where the scrim reinforcement is exposed) after seam probing is complete per manufacturer's instructions.
K. Adhered Membrane: Bond membrane sheet to substrate using membrane manufacturer's recommended bonding material, application rate, and procedures.
   1. Do not apply bonding material to fleece backing or to seaming area of membrane.
L. Edge Securement: Secure membrane at all locations where membrane terminates or goes through an angle change greater than 2 in 12-inches using mechanical fastened reinforced perimeter fastening strips, plates, or metal edgings indicated or recommended by the roofing manufacturer.
   1. Exceptions: Round pipe penetrations less than 18-inches in diameter and square penetrations less than 4-inches square.
   2. Metal edging is not merely decorative; ensure anchorage of membrane as intended by roofing manufacturer.
M. Repair tears, voids, and lapped seams in roofing that does not comply with requirements.
N. Spread sealant or mastic bed over deck drain flange at roof drains and securely seam membrane roofing in place with clamping ring.

3.09 FLASHING AND ACCESSORIES INSTALLATION

A. Install flashings, including laps, splices, joints, bonding, adhesion, and attachment, as required by membrane manufacturer's recommendations and details.
B. Metal Accessories: Install metal edgings, gravel stops, and copings in locations indicated on the drawings, with horizontal leg of edge member over membrane and flashing over metal onto membrane.
   1. Follow roofing manufacturer's instructions.
C. Existing Scuppers: Remove scupper and install new scupper unless noted otherwise.
D. Scuppers: Set in sealant and secure to structure; flash as recommended by manufacturer.
E. Roofing Expansion Joints: Install as shown on drawings and as recommended by roofing manufacturer.
F. Flashing at Walls, Curbs, and Other Vertical and Sloped Surfaces: Install weather tight flashing at all walls, curbs, parapets, curbs, skylights, and other vertical and sloped surfaces that the roofing membrane abuts to; extend flashing at least 8 inches high above membrane surface.
   1. Use the longest practical flashing pieces.
G. Roof Drains:
   1. Existing Drains: Remove all existing flashings, drain leads, roofing materials and cement from the drain; remove clamping ring.
   2. Taper insulation around drain to provide smooth transition from roof surface to drain. Use specified pre-manufactured tapered insulation with facer or suitable bonding surface to achieve slope; slope not to exceed manufacturer’s recommendations.
   3. Position membrane, then cut a hole for roof drain to allow 1/2 to 3/4 inch of membrane to extend inside clamping ring past drain bolts.
   4. Make round holes in membrane to align with clamping bolts; do not cut membrane back to bolt holes.
   5. Apply sealant on top of drain bowl where clamping ring seats below the membrane

3.10 FINISHING AND WALKWAY PAD INSTALLATION
A. Install walkways at access points to the roof, around rooftop equipment that may require maintenance, and where indicated on the drawings.
   1. Use specified walkway pads unless otherwise indicated.
B. Install walkway pads in areas and in patterns as indicated on the Drawings. Weld walkway products to roof membrane surface according to roofing system manufacturer’s written instructions.
C. Install walkway pads leaving minimum 3-inches/maximum 4-inch gap between edges of individual walk pads for proper drainage.
D. Cut walkway pads that occur in drainage ways to allow for unobstructed water flow.
E. If installing walkway pads over field fabricated splices or if installation within 6 inches of a splice edge cannot be avoided, adhere another layer of flashing over the splice and extending beyond the walkway pad a minimum of 6 inches on either side.

3.11 FIELD QUALITY CONTROL
A. See Section 01 40 00 - Quality Requirements, for additional requirements.
B. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform roof test and inspection sand to prepare test reports.
C. Final Roof Inspection: Arrange for roofing system manufacturer’s technical personnel (i.e. not a sales person) to inspect roofing installation on completion for warranty purposes and submit report to Architect.
   1. Notify Owner and Architect 48 hours in advance of date and time of inspection.
D. Perform all corrections necessary for issuance of warranty.
E. Additional testing and inspecting, at Contractor’s expense, will be performed to determine compliance of replaced or additional Work with specified requirements.

3.12 CLEANING
A. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.
**B.** Clean all contaminants generated by roofing work from building and surrounding areas, including adhesives, sealants, and coatings.

**C.** Repair or replace building components and finished surfaces damaged or defaced due to the work of this section; comply with recommendations of manufacturers of components and surfaces.

**D.** Remove leftover materials, trash, debris, equipment from project site and surrounding areas.

### 3.13 PROTECTION

**A.** Protect membrane roofing system from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.

**B.** Correct deficiencies in or remove membrane roofing system that does not comply with requirements, repair substrates, and repair or reinstall membrane roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

**END OF SECTION**
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Fabricated sheet metal items, including flashings, counterflashings, gutters, downspouts, stainless steel gutter and downspout, and other items indicated in Schedule.

1.02 RELATED REQUIREMENTS
   A. Section 06 10 00 - Rough Carpentry: Wood nailers.
   B. Section 07 61 00 - Sheet Metal Roofing.
   C. Section 07 90 05 - Joint Sealers.
   D. Section 09 90 00 - Painting and Coating: Field painting.

1.03 REFERENCE STANDARDS
   E. SMACNA (ASMM) - Architectural Sheet Metal Manual; Sheet Metal and Air Conditioning Contractors' National Association; 2012.

1.04 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. See Section 01 33 16 - Delegated Design Procedures.
   C. Shop Drawings: Indicate material profile, jointing pattern, jointing details, fastening methods, flashings, terminations, and installation details.
      1. Three dimensional axonometric views of flashings, pans and sheet metal details.
   D. Samples: Submit two samples 12 x 12 inch in size illustrating metal finish color.

1.05 QUALITY ASSURANCE
   A. Perform work in accordance with SMACNA Architectural Sheet Metal Manual requirements and standard details, except as otherwise indicated.
   B. Maintain one copy of each document on site.
   C. Fabricator and Installer Qualifications: Company specializing in sheet metal work with 10 years of documented experience.

1.06 PRE-INSTALLATION CONFERENCE
   A. Convene one week before starting work of this section.

1.07 DELIVERY, STORAGE, AND HANDLING
   A. Stack material to prevent twisting, bending, and abrasion, and to provide ventilation. Slope metal sheets to ensure drainage.
   B. Prevent contact with materials that could cause discoloration or staining.

1.08 DOWNSPOUT PERFORMANCE PARAMETERS
   A. Sized for rainfall intensity determined by a storm occurrence of 1 in 10 years in accordance with SMACNA Architectural Sheet Metal Manual with the following parameters:
1. Design in accordance with this section and for any additional locations per the contract documents.

PART 2 PRODUCTS

2.01 SHEET MATERIALS

A. Pre-Finished Galvanized Steel: ASTM A653/A653M, with G90/Z275 zinc coating; minimum 0.02 inch thick base metal, shop pre-coated with modified silicone coating.
   1. PVDF (Polyvinylidene Fluoride) Coating: Superior Performance Organic Finish, AAMA 2605; multiple coat, thermally cured fluoropolymer finish system; color as scheduled.
B. Stainless Steel: ASTM A666 Type 304, soft temper, 18 gauge, and 0.015 inch thick; smooth No. 4 finish.

2.02 ACCESSORIES

A. Fasteners: Stainless steel, with soft neoprene washers.
B. Underlayment: ASTM D2178, glass fiber roofing felt.
C. Flexible Flashing Underlayment: Product specified in Sectin 07 25 00 or 07 27 00.
D. Slip Sheet: Rosin sized building paper.
E. Primer: Zinc chromate type.
F. Protective Backing Paint: Zinc molybdate alkyd.
G. Plastic Cement: ASTM D4586, Type I.

2.03 FABRICATION

A. Form sections true to shape, accurate in size, square, and free from distortion or defects.
B. Form pieces in longest possible lengths, except where noted otherwise.
C. Hem exposed edges on underside 1/2 inch; miter and seam corners.
D. Form material with flat lock seams, except where otherwise indicated. At moving joints, use sealed lapped, bayonet-type or interlocking hooked seams.
E. Fabricate corners from one piece with minimum 18 inch long legs; seam for rigidity, seal with sealant.
F. Fabricate flashings to allow toe to extend 2 inches over roofing gravel. Return and brake edges.

2.04 ROOF PENETRATIONS

A. Comply with NRCA and SMACNA requirements.
B. Roof Drains and Vents: Stainless steel ASTM A666 Type 304, soft temper, 0.015 inch thick; smooth No. 4 finish.
C. Posts, pipes, and Conduit: Prefinished galvanized steel cone shape and counter flashing with draw-band and top sealant channel.
D. Equipment Pads: Galvanized steel.

2.05 GUTTER AND DOWNSPOUT FABRICATION

A. Gutters: Profile as indicated.
   1. Material: Stainless steel, ASTM A666 Type 304, soft temper, 18 gauge; smooth No. 4 finish.
   2. Factory fabricate with weld seams ground flush for two equal continuous runs for shipping to site. Site weld and grind flush center joint with finish to match balance.
   3. Weld all seams and grind flush for continuous smooth No. 4 finish.
B. Downspouts: Profile as indicated.
SERA Architects, Inc.  Package 1 - PERMIT / CONSTRUCTION

NOTICE OF ALTERNATE BILLING CYCLE: The Contract allows the Owner to require the submission of billings or estimates in billing cycles other than 30-day cycles. Billings or estimates shall be submitted monthly ending on the last day of the month.

NOTICE OF EXTENDED CERTIFICATION PROVISION: The Contract will allow the Owner to certify billings and estimates within 20 days after the billings and estimates are received from the original contractor.

NOTICE OF EXTENDED PAYMENT PROVISION: The Contract will allow the Owner to make payment within 30 days after the date a billing or estimate is received.

1. Material: Stainless steel, ASTM A666 Type 304, soft temper, 18 gauge; smooth No. 4 finish.
2. Weld seams and grind flush for continuous runs.
C. Accessories: Profiled to suit gutters and downspouts.
   1. Anchorage Devices: In accordance with SMACNA requirements.
   2. Gutter Supports: Brackets.
   3. Downspout Supports: Brackets.
D. Downspout Boots: Cast iron. Size to meet application requirements.
E. Seal metal joints.

2.06 METAL CANOPY ROOF
A. Performance Requirements: Provide complete engineered system complying with specified requirements and capable of remaining weather tight while withstanding anticipated movement of substrate and thermally induced movement of roofing system.
B. Metal Roofing: Factory-formed panels with factory-applied finish.
   1. Zinc-coated steel conforming to ASTM A 653/A 653M; minimum G60 galvanizing.
   2. Steel Thickness: Minimum 0.0358 inch.
   3. Profile: Deep Fluted Ribs as shown and as required to span; mechanically fasten to canopy.
   5. Length: Full length of canopy slope, without lapped horizontal joints.
   6. Width: Maximum panel coverage of 24 inches.
C. Finish: Fluoropolymer Coating System: Manufacturer's standard multi-coat thermocured coating system, including minimum 70 percent fluoropolymer color topcoat with minimum total dry film thickness of 0.9 mil; color and gloss to match sample.
D. Miscellaneous Sheet Metal Items: Provide flashings, trim, closure strips, and caps of the same material, thickness, and finish as used for the roofing panels. Items completely concealed after installation may optionally be made of stainless steel.
E. Sealants: As specified in Section 07 90 05 Joint Sealers.
   1. Exposed sealant must cure to rubber-like consistency.
   2. Concealed sealant must be non-hardening type.

PART 3 EXECUTION
3.01 EXAMINATION
A. Verify roof openings, curbs, pipes, sleeves, ducts, and vents through roof are solidly set, reglets in place, and nailing strips located.
B. Verify roofing termination and base flashings are in place, sealed, and secure.

3.02 PREPARATION
A. Install starter and edge strips, and cleats before starting installation.
B. Back paint concealed metal surfaces with protective backing paint to a minimum dry film thickness of 15 mil.

3.03 INSTALLATION
A. Secure flashings in place using concealed fasteners. Use exposed fasteners only where permitted.
B. Apply plastic cement compound between metal flashings and felt flashings.
C. Fit flashings tight in place. Make corners square, surfaces true and straight in planes, and lines accurate to profiles.
D. Seal metal joints watertight.
E. Secure gutters and downspouts in place using concealed fasteners.
F. Slope gutters 1/8 inch per foot minimum, unless indicated otherwise.
G. Connect downspouts to downspout boots. Grout connection watertight.

3.04 FIELD QUALITY CONTROL
A. See Section 01 40 00 - Quality Requirements, for field inspection requirements.
B. Inspection will involve surveillance of work during installation to ascertain compliance with specified requirements.

3.05 SCHEDULE
A. Trim and Through-Wall Flashing in masonry
   1. Thickness: 0.0239 inch stainless steel
   2. Finish: Prefinished in custom color.
B. Gutters, and Downspouts.
   1. Thickness: 16 gauge stainless steel.
C. Coping, Cap, Parapet, Sill and Fascia Flashings:
   1. Thickness: 0.0396 inch
   2. Finish: Prefinished in two separate custom colors
D. Flashings Associated with TPO roofing, including Cricket, Eave, and Gutter Drip
   1. Thickness: 0.0239 inch
   2. Finish: Prefinished in custom color.
E. Flashings Associated with all other types of Roofing
   1. Thickness: 0.0239 inch
   2. Finish: Prefinished in custom color.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Fireproofing of interior structural steel at mechanical penthouse.
   B. Delegated design for fireproofing of exterior exposed structural steel deck.
   C. Preparation of fireproofing for application of finish specified elsewhere.

1.02 REFERENCE STANDARDS

1.03 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittals procedures.
   B. Product Data: Provide data indicating product characteristics.
   C. Test Reports: Reports from reputable independent testing agencies for proposed products, indicating compliance with specified criteria, conducted under conditions similar to those on project, for:
      1. Bond Strength.
      2. Bond Impact.
      3. Fire tests using substrate materials similar those on project.
   D. Manufacturer's Installation Instructions: Indicate special procedures.
   E. Manufacturer's Certificate: Certify that sprayed-on fireproofing products meet or exceed requirements of contract documents. The following certificates of approval are a requirement of the contract documents:
      2. UL-Underwriters Laboratory.
      3. Factory Mutual Approvals.
   F. Manufacturer's Field Reports: Indicate environmental conditions under which fireproofing materials were installed.

1.04 QUALITY ASSURANCE
   A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.
   B. Installer Qualifications: Company specializing in performing work of the type specified in this section, and:
      1. Having minimum five years of documented experience.
      2. Approved by manufacturer.
C. Manufacturer's Technical Representative:
   1. Visit site not less than three times, and more if required to review fireproofing placements and installation procedures.
      a. Pre-installation meeting.
      b. Installation of mock-up.
      c. Duration of fireproofing installation for observation of completed installation.
   2. Document site visits in writing with copy to Architect.

1.05 MOCK-UP
   A. Construct mock-up, 100 square feet in size.
   B. Conform to project requirements for fire ratings.
   C. Locate where directed.
   D. Examine installation within one hour of application to determine variances from specified requirements due to shrinkage, temperature, and humidity.
   E. Where shrinkage and cracking are evident, adjust mixture and method of application as necessary. Remove materials and re-construct mock-up.
   F. Mock-up may remain as part of the Work.

1.06 FIELD CONDITIONS
   A. Do not apply spray fireproofing when temperature of substrate material and surrounding air is below 40 degrees F or when temperature is predicted to be below said temperature for 24 hours after application.
   B. Provide ventilation in areas to receive fireproofing during application and 24 hours afterward to dry applied material.
   C. Provide temporary enclosure to prevent spray from contaminating air.
   D. Do not allow roof traffic during installation of roof fireproofing and drying period.

1.07 WARRANTY
   A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
   B. Correct defective Work within a five year period after Date of Substantial Completion.
      1. Include coverage for fireproofing to remain free from cracking, checking, dusting, flaking, spalling, separation, and blistering.
      2. Reinstall or repair failures that occur within warranty period.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. Sprayed-On Fireproofing:
         c. Product: CAFCO - Mechanical Penthouse steel structure high density cover for low density fireproofing at 8 feet and below.
      2. Acceptable manufacturers pending conformance to basis requirements and requirements specified herein:
         c. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 FIREPROOFING ASSEMBLIES
   A. Provide delegated design fireproofing assemblies as required for meeting fireproofing requirements of steel deck assemblies indicated on the drawings.
B. Provide a fire rated assembly rating of 2 hours for roof assembly to UL Design No. P819. See Section 07 81 23 - Intumescent Mastic Fireproofing for treatment of supporting steel members.

C. Provide delegated design fireproofing assemblies as required for meeting fireproofing requirements of steel assemblies at mechanical penthouse indicated on the drawings.

2.03 MATERIALS

A. Low Density Sprayed Fire-Resistive Material for Interior Applications: Manufacturer’s standard factory mixed material, which when combined with water is capable of providing the indicated fire resistance, and conforming to the following requirements:
   1. Bond Strength: 150 pounds per square foot, minimum, when tested in accordance with ASTM E736 when set and dry.
   2. Effect of Impact on Bonding: No cracking, spalling or delamination, when tested in accordance with ASTM E760.
   3. Corrosivity: No evidence of corrosion, when tested in accordance with ASTM E937.
   4. Surface Burning Characteristics: Maximum flame spread of 0 and maximum smoke developed of 0, when tested in accordance with ASTM E84.
   5. Effect of Deflection: No cracking, spalling, or delamination, when tested in accordance with ASTM E759.
   6. Fungal Resistance: No growth after 28 days when tested according to ASTM G21.

B. Sprayed Fire-Resistive Material for Exterior Applications: Manufacturer’s standard factory mixed material, which when combined with water is capable of providing the indicated fire resistance, and conforming to the following requirements:
   1. Recommended by manufacturer for permanent exterior exposure.
   3. Dry Density: As required by fire resistance design.
   4. Effect of Impact on Bonding: No cracking, spalling or delamination, when tested in accordance with ASTM E760.
   5. Corrosivity: No evidence of corrosion, when tested in accordance with ASTM E937.
   6. Air Erosion Resistance: Weight loss of 0.025 g/sq ft, maximum, when tested in accordance with ASTM E859 after 24 hours.
   7. Surface Burning Characteristics: Maximum flame spread of 0 and maximum smoke developed of 0, when tested in accordance with ASTM E84.
   8. Products:
      a. Substitutions: See Section 01 60 00 - Product Requirements.

2.04 ACCESSORIES

A. Primer Adhesive: Of type recommended by fireproofing manufacturer.
B. Overcoat: As recommended by manufacturer of fireproofing material.
C. Metal Lath: Expanded metal lath; 3.4 lb/sq ft, galvanized finish.
D. Water: Clean, potable.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that surfaces are ready to receive fireproofing.
B. Verify that clips, hangers, supports, sleeves, and other items required to penetrate fireproofing are in place.
C. Verify that ducts, piping, equipment, or other items that would interfere with application of fireproofing have not been installed.
D. Verify that voids and cracks in substrate have been filled. Verify that projections have been removed where fireproofing will be exposed to view as a finish material.
3.02 PREPARATION
A. Perform tests as recommended by fireproofing manufacturer in situations where adhesion of fireproofing to substrate is in question.
B. Remove incompatible materials that could affect bond by scraping, brushing, scrubbing, or sandblasting.
C. Prepare substrates to receive fireproofing in strict accordance with instructions of fireproofing manufacturer.
D. Apply fireproofing manufacturer's recommended bonding agent on primed steel.
E. Protect surfaces not scheduled for fireproofing and equipment from damage by overspray, fall-out, and dusting. Mask-off adjacent intumescent mastic fireproofing areas to eliminate possibility of fireproofing overspray.
F. Close off and seal duct work in areas where fireproofing is being applied.

3.03 APPLICATION
A. Install metal lath over structural members as indicated or as required by UL Assembly Design Numbers.
B. Apply primer adhesive in accordance with manufacturer's instructions.
C. Apply fireproofing in thickness and density necessary to achieve required ratings, with uniform density and texture.
D. Apply fireproofing in sufficient thickness to achieve required ratings, with as many passes as necessary to cover with monolithic blanket of uniform density and texture.
E. In exposed locations, trowel surface smooth and form square edges, using tools and procedures recommended by fireproofing manufacturer.
F. Apply overcoat at the rate recommended by fireproofing manufacturer.

3.04 FIELD QUALITY CONTROL
A. Inspect the installed fireproofing after application and curing for integrity, prior to its concealment. Ensure that actual thicknesses, densities, and bond strengths meet requirements for specified ratings and requirements of the Authority Having Jurisdiction.
B. Re-inspect the installed fireproofing for integrity of fire protection, after installation of subsequent Work.

3.05 CLEANING
A. Remove excess material, overspray, droppings, and debris.
B. Remove fireproofing from materials and surfaces not required to be fireproofed.

END OF SECTION
PART 1  GENERAL
1.01  SECTION INCLUDES
   A. Thin-film intumescent fire-resistant coatings for exposed structural steel.
   B. Protective and/or decorative topcoats.

1.02  SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittals procedures.
   B. Product Data: Manufacturer's data sheets on each product to be used, including:
      1. Performance characteristics and test results.
      2. Preparation instructions and recommendations.
      3. Storage and handling requirements and recommendations.
      4. Installation methods.
   C. Selection Samples: For decorative top coat, color chips representing manufacturer's full range of available colors and sheens.
   D. Verification Samples: For each thickness, color, sheen, and finish required, samples not less than 4 inches square on steel substrate, illustrating finished appearance.
   E. Test Reports: Published fire-resistant designs for structural elements of the types required for the project, indicating hourly ratings of each assembly.
   F. Certificates: Certify that intumescent fireproofing provided for this project meets or exceeds specified requirements in all respects.

1.03  QUALITY ASSURANCE
   A. Manufacturer Qualifications: Company that specializes in manufacturing the type of products specified, with minimum of 10 years of documented experience.
   B. Installer Qualifications: Approved, certified, or supervised by manufacturer of intumescent fireproofing, with not less than 5 years of documented experience.
   C. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship. Approved mock-up will serve as a standard of comparison for subsequent work of this section.
      1. Finish at least 100 sq ft of steel in areas designated by Architect.
      2. Evaluate mock-up for compliance with specified requirements, including thickness and finish texture.
      3. Do not proceed with remaining work until workmanship, color, and sheen are approved by Architect.
      4. Refinish mock-up area as required to produce acceptable work.
      5. Approved mock-up may remain as part of the project.

1.04  DELIVERY, STORAGE, AND HANDLING
   A. Deliver materials in manufacturer's original, unopened containers with identification labels and testing agency markings intact and legible.
   B. Store products in manufacturer's unopened packaging until ready for installation.
      1. Store at temperatures not less than 50 degrees F in dry, protected area.
      2. Protect from freezing, and do not store in direct sunlight.
      3. Dispose of any materials that have come into contact with contaminants of any kind prior to application.
   C. Dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.05  FIELD CONDITIONS
   A. Protect areas of application from windblown dust and rain.
B. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.
   1. Provide temporary enclosures as required to control environmental conditions.
   2. Do not apply intumescent fireproofing when ambient temperatures are below 50 degrees F without specific approval from manufacturer.
   3. Maintain relative humidity between 40 and 60 percent in areas of application.
   4. Maintain ventilation in enclosed spaces during application and for not less than 72 hours afterward.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. Intumescent Fireproofing:
      4. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 SYSTEM REQUIREMENTS
   A. Fireproofing: Provide intumescent thin-film fire-resistive coating systems tested by an independent testing agency in accordance with ASTM E119 and acceptable to authorities having jurisdiction.
      1. Provide assemblies listed by UL or FM.

2.03 MATERIALS
   A. Fire-Resistive Coating System: Thin film intumescent coating system for the fire protection of structural steel.
      1. For Interior Use:
         a. Isolatek International: CAFCO SprayFilm WB5.
   B. Sealers and Primer: As required by tested and listed assemblies, and as recommended by fireproofing manufacturer to suit specific substrate conditions.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Examine substrates to determine if they are in satisfactory condition to receive intumescent fireproofing. Verify that they are clean and free of oil, grease, incompatible primers, or other foreign substances capable of impairing bond to fireproofing system.
   B. Do not begin installation until substrates have been properly prepared. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION
   A. Thoroughly clean surfaces to receive fireproofing.
   B. Repair substrates to remove surface imperfections that could affect uniformity of texture and thickness of fireproofing system. Remove minor projections and fill voids that could telegraph through the finished work.
   C. Cover or otherwise protect other work that might be damaged by fallout or overspray of fireproofing system. Provide temporary enclosures as necessary to confine operations and maintain required environmental conditions.

3.03 INSTALLATION
   A. Comply with manufacturer's instructions for particular conditions of installation in each case.
B. Apply manufacturer’s recommended primer to required coating thickness.
C. Apply fireproofing to full thickness over entire area of each substrate to be protected. Apply coats at manufacturer’s recommended rate to achieve dry film thickness required for fire resistance ratings designated for each condition.
D. Apply intumescent fireproofing by spraying to maximum extent possible. If necessary, complete coverage by roller application or other method acceptable to manufacturer.
E. Achieve uniform finished appearance complying with approved mock-up.

3.04 FIELD QUALITY CONTROL
A. Perform field inspection and testing in accordance with Section 01 40 00.
   1. Arrange for testing of installed intumescent fireproofing by an independent testing laboratory using magnetic thickness gage, in accordance with SSPC-PA 2.
   2. Submit test reports promptly to Contractor and Architect.
B. Repair or replace fireproofing at locations where test results indicate fireproofing does not meet specified requirements.

3.05 CLEANING
A. Immediately after installation of fireproofing in each area, remove overspray and fallout from other surfaces and clean soiled areas.

3.06 PROTECTION
A. Protect installed intumescent fireproofing from damage due to subsequent construction activities, so fireproofing is without damage or deterioration at time of Substantial Completion.
B. Touch-up, repair or replace damaged products before Date of Substantial Completion.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Delegated design firestopping systems.
B. Firestopping of all penetrations, perimeters and interruptions to fire rated assemblies, whether indicated on drawings or not, and other openings indicated.
C. See drawings and listed appeals, if applicable, for additional firestopping requirements.
D. Sleeves with integral firestopping.

1.02 REFERENCE STANDARDS
F. FM 4991 - Approval of Firestop Contractors; Factory Mutual Research Corporation; 2001.
J. IAS AC291 Accreditation Criteria for Special Inspection Agencies
K. NFPA 221 Fire Walls and Fire Barriers
L. NFPA 251 Fire Tests of Building Construction and Materials
M. OHSU- Fire-Barrier Access Permit (BAP) Procedures.
N. IAS AC291

1.03 DEFINITIONS
A. "F" RATING: A rating usually expressed in hours indicating a specific length of time that a firestop system has been tested to withstand the passage of fire. A successful hose stream test is also required.
B. "T" RATING: A rating usually expressed in hours indicating the length of time that the temperature on the non-fire side of a fire-rated assembly does not exceed 325ºF above ambient temperature.
C. "L" RATING: Amount of air leakage through a penetration, measured in cubic feet per minute. The test is administered at ambient and 400ºF for validity due to variances in performance of firestop systems at different temperatures.

1.04 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Schedule of Firestopping: List each type of penetration.
C. Product Data: Provide data on product characteristics.
D. Manufacturer's Installation Instructions: Indicate preparation and installation instructions.
E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
F. Certificate from authority having jurisdiction indicating approval of materials used.
G. Qualification statements for installing mechanics.

H. Engineering Judgements
   1. Where there is no specific third party tested and classified firestop system available for a particular firestop configuration, the firestopping contractor shall obtain from the firestop manufacturer and Engineering Judgement (EJ) or Equivalent Fire resistance Rated Assembly (EFRRA) for submittal.

1.05 QUALITY ASSURANCE

A. Fire Testing: Provide firestopping assemblies of designs that provide the specified fire ratings when tested in accordance with methods indicated.
   1. Listing in the current-year classification or certification books of UL, FM, or ITS (Warnock Hersey) will be considered as constituting an acceptable test report.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum 10 years documented experience.
   1. Provide all project firestopping products from a single manufacturer.

C. Installer Qualifications: Company specializing in performing the work of this section and:
   1. A firm that has been approved by FM Global according to FM Global 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with its "Qualified Firestop Contractor Porgram Requirements."
      a. FM or UL Qualified installers shall submit certification (at bid time) showing certification from UL or FM that they have maintained their listing through their last two consecutive field audits.
   2. Able to show at least 10 satisfactorily completed projects of comparable size and type.
   3. Licensed or approved by authority having jurisdiction, where applicable.

D. Installing Mechanic's Qualifications: Trained and certified by firestopping manufacturer and able to provide evidence thereof.

E. 3rd Party inspector to meet the certification criteria set forth by IAS AC291.

F. Pre-Installation Conference: Include AHJ inspector and 3rd party inspector.

G. General contractor to hire 3rd party inspector to inspect all firestopping on the project, prior to bid to reserve funding for this quality control item.

H. All firestopping to be sourced from one manufacturer, but competitively bid.

I. All firestopping installation to be performed by one sub-contractor.

J. Electrical and low-voltage penetrations through fire rated construction not to exceed 2/3 manufacturer recommended maximum allowed fill rate of penetration - to allow for future expansion.

K. Provide Schedule of Firestopping to all trades prior to the start of work to guide the preparation of the joint, or penetration of all rated barriers.

1.06 MOCK-UP

A. Install one firestopping assembly representative of each fire rating design required on project.
   1. Where one design may be used for different penetrating items or in different wall constructions, install one assembly for each different combination.

B. If accepted, mock-up will represent minimum standard for the Work.

C. If accepted, mock-up may remain as part of the Work. Remove and replace mock-ups not accepted.
1.07 FIELD CONDITIONS
   A. Comply with firestopping manufacturer’s recommendations for temperature and conditions during and after installation. Maintain minimum temperature before, during, and for 3 days after installation of materials.
   B. Do not install work until work area is dry and moisture will not be present for at least 3 days.

PART 2 PRODUCTS
2.01 FIRESTOPPING - GENERAL REQUIREMENTS
   A. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Type required for tested assembly design.

2.02 MANUFACTURERS
   A. Provide products that comply with requirements from a single manufacturer, one of the following:
      2. Hilti, Inc.
      3. 3M Fire Protection Products Division

2.03 FIRESTOPPING SYSTEMS
   A. Firestopping: Any material meeting requirements.
      1. Fire Ratings: Use any system listed by UL or tested in accordance with ASTM E 814 that has F Rating equal to fire rating of penetrated assembly and minimum T Rating Equal to F Rating and that meets all other specified requirements.

2.04 MATERIALS
   A. Performance Criteria
      1. Provide products that upon curing do not re-emulsify, dissolve, leach, breakdown, or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water or other forms of moisture characteristic during and after construction.
      2. When intumescent products are used, provide products that do not contain sodium silicate or any other water soluble intumescent ingredient in the formulation.
      3. Provide firestop products that do not contain ethylene glycol.
      4. Provide firestop sealants sufficiently flexible to accommodate motion such as pipe vibration, water hammer, thermal expansion and other normal building movement without damage to the seal.
      5. Pipe insulation shall not be removed, cut away or otherwise interrupted through wall or floor openings. Provide products appropriately tested for the thickness and type of insulation utilized.
      6. Fire rated pathway devices shall be the preferred product and shall be installed in all locations where frequent cable moves, add-ons and changes will occur. Such devices shall be:
         a. Capable of retrofit around existing cables
         b. Designed such that two or more devices can be ganged together
         c. Maintenance free such that no action is required to activate the smoke and fire sealing mechanism
      7. When mechanical cable pathways are not practical, openings within walls and floors designed to accommodate voice, data and video cabling shall be provided with re-enterable products specifically designed for retrofit.
      8. Provide fire-resistive joint sealants sufficiently flexible to accommodate movement such as thermal expansion and other normal building movement without damage to the seal.
9. Provide fire-resistive joint sealants designed to accommodate a specific range of movement and tested for this purpose in accordance with a cyclic movement test criteria as outlined in Standards, ASTM E1966, or ANSI/ UL 2079.

10. Provide penetration firestop systems, fire-resistive joint systems, or perimeter fire barrier systems subjected to an air leakage test conducted in accordance with Standard, ANSI/ UL1479 for penetrations and ANSI/UL2079 for joint systems with published L-Ratings for ambient and elevated temperatures as evidence of the ability of firestop system to restrict the movement of smoke.

11. Provide T-Rating Collar Devices tested in accordance with ASTM E814 or ANSI/UL1479 for metallic pipe penetrations requiring T-Ratings per the applicable building code.

12. Provide a fire-rated grommet for all individual or small grouped cable applications up to 0.53 in. (14 mm).

13. Provide moisture-curing products where inclement weather or greater than transient water exposure is expected.

14. All penetrations for pipes, conduits, tubing or other building service elements shall be installed below the head-of-wall joint such that the distance between the top of the wall and the top of the penetrant is a minimum of 3" (76mm). No exceptions.

15. Provide fire rated pathway sleeves with integral firestopping to provided rated wall penetrations complying with tested assembly designs.

B. Firestopping Materials Acceptable for Use:

1. General: Use only firestopping products that have been tested for specific fire-resistance-rated construction conditions conforming to construction assembly type, penetrating item type or joint opening width and movement capabilities, annular space requirements, and fire-rating involved for each separate instance.
   a. Intumescent Sealants: Single component intumescent latex formulations containing no water soluble intumescent ingredients capable of expanding a minimum 8 times.
   b. Specified Technologies, Inc. (STI) SpecSeal Series LCI Intumescent Sealant
   c. Specified Technologies, Inc. (STI) SpecSeal Series LC Endothermic Sealant

2. Endothermic Sealants: Single component latex formulations that upon cure do not re-emulsify during exposure to moisture.
   a. Specified Technologies, Inc. (STI) SpecSeal Series LC Endothermic Sealant
   b. Specified Technologies, Inc. (STI) SpecSeal Series AS Elastomeric Spray
   c. Specified Technologies, Inc. (STI) SpecSeal Series ES Elastomeric Sealant

3. Elastomeric Sealants: Single component latex formulations that upon cure do not re-emulsify during exposure to moisture and accommodate minimum ±25 percent movement.
   a. Specified Technologies, Inc. (STI) SpecSeal Series AS Elastomeric Spray
   b. Specified Technologies, Inc. (STI) SpecSeal Series ES Elastomeric Sealant

4. Firestop Devices: Factory-assembled steel collars lined with intumescent material capable of expanding a minimum 30 times sized to fit specific outside diameter of penetrating item.
   a. Specified Technologies, Inc. (STI) SpecSeal Series SSC Firestop Collars
   b. Specified Technologies, Inc. (STI) SpecSeal Series LCC Firestop Collars

5. Fire Rated Cable Pathways: Gangable device modules capable of being retrofitted around existing cables and comprised of steel raceway with intumescent foam pads allowing 0 to 100 percent cable fill and requiring no additional action in the form of plugs, twisting closure, putty, pillow, or sealant to achieve fire and leakage ratings.
   a. Specified Technologies Inc. (STI) EZ-Path Fire Rated Pathway

6. Wall Opening Protective Materials: Intumescent, non-curing pads or inserts for protection of electrical switch and receptacle boxes to reduce horizontal separation to less than 24” (610 mm).
   a. Specified Technologies, Inc. (STI) SpecSeal Series SSP Firestop Putty Pads
   b. Specified Technologies, Inc. (STI) SpecSeal Series EP PowerShield Insert Pads

7. Firestop Putty: Intumescent, non-hardening, water resistant, butyl rubber based putties containing no solvents, inorganic fibers or silicone compounds,
SERA Architects, Inc.

Package 1 - PERMIT / CONSTRUCTION

NOTICE OF ALTERNATE BILLING CYCLE: The Contract allows the Owner to require the submission of billings or estimates in billing cycles other than 30-day cycles. Billings or estimates shall be submitted monthly ending on the last day of the month.

NOTICE OF EXTENDED CERTIFICATION PROVISION: The Contract will allow the Owner to certify billings and estimates within 20 days after the billings and estimates are received from the original contractor.

NOTICE OF EXTENDED PAYMENT PROVISION: The Contract will allow the Owner to make payment within 30 days after the date a billing or estimate is received.

a. Specified Technologies, Inc. (STI) SpecSeal Series SSP Firestop Putty

8. Wrap Strips: Single component intumescent elastomeric strips faced on both sides with a plastic film and capable of expanding a minimum 30 times,
   a. Specified Technologies, Inc. (STI) SpecSeal Series RED2 Wrap Strip
   b. Specified Technologies, Inc. (STI) SpecSeal Series BLU2 Wrap Strip

9. Mortar: Portland cement based dry-mix product formulated for mixing with water at Project site to form a non-shrinking, water-resistant, homogenous mortar,
   a. Specified Technologies, Inc. (STI) SpecSeal Series SSM Firestop Mortar

10. Silicone Sealants: Moisture curing, single component, silicone elastomeric sealant for horizontal surfaces (pourable or nonsag) or vertical surface (nonsag),
    a. Specified Technologies, Inc. (STI) SpecSeal SIL300 Silicone Firestop Sealant
    b. Specified Technologies, Inc. (STI) SpecSeal SIL300 SL Self-Leveling Silicone Firestop Sealant

11. All-Weather Coatings: Moisture curing, single component silicone copolymer elastomeric spray coatings for horizontal surfaces where greater water resistance is required or inclement weather is anticipated,
    a. Specified Technologies, Inc. (STI) SpecSeal FT305 Firestop Spray

12. Silicone Foam: Multicomponent, silicone-based liquid elastomers, that when mixed, expand and cure in place to produce a flexible, non-shrinking foam,
    a. Specified Technologies, Inc. (STI) Pensil 200 Silicone Foam

13. Composite Sheet: Intumescent material sandwiched between a galvanized steel sheet and steel wire mesh protected with aluminum foil capable of sustaining a minimum 2,500 lbs (1,134 kg) when subjected to load testing,
    a. Specified Technologies, Inc. (STI) SpecSeal CS Composite Sheet

14. Cast-In-Place Firestop Device: Single component molded firestop device installed on forms prior to concrete placement with totally encapsulated, tamper-proof integral firestop system and smoke sealing gasket,
    a. Specified Technologies, Inc. (STI) SpecSeal CD Cast-In Firestop Device

15. Fire-Rated HVAC Retaining Angles: Steel angle system with integral intumescent firestop gasket for use on steel HVAC ducts,
    a. Specified Technologies, Inc. (STI) SpecSeal FyreFlange Firestop Angles

16. Firestop Plugs: Re-enterable, foam rubber plug impregnated with intumescent material capable of expanding minimum 10 times with expansion beginning at 350°F (177°C) for use in blank openings and cable sleeves,
    a. Specified Technologies, Inc. (STI) SpecSeal Series FP Firestop Plug

17. Fire-Rated T Rating Collar Device: Louvered steel collar system with synthetic aluminized polymer coolant wrap installed on metallic pipes where T Ratings are required by applicable building code requirements,
    a. Specified Technologies, Inc. (STI) SpecSeal T-Collar Device

18. Fire-Rated Cable Grommet: Molded two-piece grommet made from plenum grade polymer with a foam inner core for sealing cable penetrations up to 0.53 in. (14 mm) diameter,
    a. Specified Technologies, Inc. (STI) Ready Firestop Grommet (RFG1 or RFG2)

C. Firestopping Sealants: Provide only products having lower volatile organic compound (VOC) content than required by South Coast Air Quality Management District Rule No.1168.

D. Provide paintable surface material where firestopping is exposed to view, excluding maintenance areas.

E. Pillow/Brick firestopping is not allowed.
PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify openings are ready to receive the work of this section.

3.02 PREPARATION
   A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter that could adversely affect bond of firestopping material.
   B. Remove incompatible materials that could adversely affect bond.
   C. Install backing materials to arrest liquid material leakage.

3.03 INSTALLATION
   A. Install materials in manner described in fire test report and in accordance with manufacturer's instructions, completely closing openings.
   B. Do not cover installed firestopping until inspected by authority having jurisdiction.
   C. Install labeling required by code.
   D. Identify penetration firestopping with preprinted vinyl metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches (150 mm) of firestopping edge and at intervals not exceeding 30 feet horizontally along wall or partition so labels will be visible to anyone seeking to remove penetrating items or firestopping. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
      1. The words "WARNING - FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS WITH PENETRATION FIRESTOPPING - DO NOT DISTURB. NOTIFY BUILDING MANAGEMENT OF ANY DAMAGE," with all letters a minimum of 1/2 inch in height.
      2. Contractor's name, address, and phone number.
      3. Designation of applicable testing and inspecting agency.
      4. Date of installation.
      5. Manufacturer's name.
      6. Installer's name.
   E. Label each rated wall assembly per applicable code requirements (including but not limited to concealed floor, floor-ceiling, or attic areas above finished ceilings).

3.04 CLEANING
   A. Clean adjacent surfaces of firestopping materials.

3.05 PROTECTION
   A. Clean adjacent surfaces of firestopping materials.
   B. Protect adjacent surfaces from damage by material installation.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Sealants and joint backing.

1.02 REFERENCE STANDARDS

1.03 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide data indicating sealant chemical characteristics.
   C. Manufacturer's Installation Instructions: Indicate special procedures.
   D. Preconstruction Field Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on preconstruction testing specified in "Quality Assurance" Article.
   E. Compatibility and Adhesion Test Reports: From sealant manufacturer, indicating the following:
      1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
      2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.
   F. Warranties: Special warranties specified in this Section.

1.04 QUALITY ASSURANCE
   A. Applicator Qualifications: Company specializing in performing the work of this section with minimum 10 years experience or approved by Manufacturer.
   B. Preconstruction Field-Adhesion Testing: Before installing elastomeric sealants, field test their adhesion to Project joint substrates as follows:
      1. Locate test joints where indicated on Project or, if not indicated, as directed by Architect.
      2. Conduct field tests for each application of elastomeric sealant and joint substrate indicated.
      3. Notify Architect seven days in advance of dates and times when test joints will be erected.
      4. Arrange for tests to take place with joint-sealant manufacturer's technical representative present.
      6. Report whether sealant in joint connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each type of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
      7. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

1.05 MOCK-UP
   A. Provide mock-up of sealant joints in conjunction with window, wall, and doors under provisions of Section 01 40 00.
   B. Construct mock-up with specified sealant types and with other components noted.
   C. Locate where directed.
   D. Mock-up may remain as part of the Work.
1.06 FIELD CONDITIONS
   A. Maintain temperature and humidity recommended by the sealant manufacturer during and after installation.

1.07 COORDINATION
   A. Coordinate the work with all sections referencing this section.

1.08 WARRANTY
   A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
   B. Correct defective work within a 10 year period after Date of Substantial Completion.
   C. Warranty: Include coverage for installed sealants and accessories which fail to achieve airtight seal, watertight seal, and non-bleeding, exhibit loss of adhesion or cohesion, or do not cure.

PART 2 PRODUCTS
2.01 SEALANTS
   A. Provide only products having lower volatile organic compound (VOC) content than required by South Coast Air Quality Management District Rule No.1168.
      1. VOC Content: Provide sealants and sealant primers that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
         a. Architectural Sealants: 250 g/L.
         b. Roofing Sealant: 300 g/L.
         c. Single Ply Membrane Sealer: 450 g/L.
         d. Other sealants: 420 g/L.
         e. Primers for Nonporous Substrates: 250 g/L.
         f. Primers for Porous Substrates: 775 g/L.
   B. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer, based on testing and field experience.
   C. Elastomeric Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied chemically curing sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.
   D. Stain-Test-Response Characteristics: Provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.
   E. Exterior Building Joint Sealant: Dow Corning 795, for vertical joints including:
      1. Panel joints
      2. Joints between products
      3. Joints in sheet metal fabrications
   F. Exterior Building Joint Sealant, non-bleeding: Dow Corning 756 SMS.
      1. Use in contact with stone or ceramic tile to assure no bleeding.
      2. Provide non-staining warranty
   G. Exterior Pavement Joint Sealant: Sonneborn SL-2, 2-part urethane
   H. Interior Horizontal Concrete Joint Sealant: Sonneborn Epolith-P, 2-part epoxy
   I. Interior Vertical Joint Sealant: Sonneborn Sonolac, 1-part acrylic
   J. Interior Acoustical Joint Sealant: Nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic rubber sealant formulated for sealing interior concealed joints to reduce transmission of airborne sound, complying with ASTM C919.
   K. Colors: Selected from full range except where custom color is specified.
2.02 ACCESSORIES
A. Primer: Non-staining type, recommended by sealant manufacturer to suit application.
B. Joint Cleaner: Non-corrosive and non-staining type, recommended by sealant manufacturer; compatible with joint forming materials.
C. Joint Backing: Round foam rod compatible with sealant; ASTM D 1056, sponge or expanded rubber; oversized 30 to 50 percent larger than joint width.
D. Bond Breaker: Pressure sensitive tape recommended by sealant manufacturer to suit application.

PART 3 EXECUTION
3.01 EXAMINATION
A. Verify that substrate surfaces are ready to receive work.
B. Verify that joint backing and release tapes are compatible with sealant.

3.02 PREPARATION
A. Remove loose materials and foreign matter that could impair adhesion of sealant.
B. Clean and prime joints in accordance with manufacturer's instructions.
C. Perform preparation in accordance with manufacturer's instructions and ASTM C1193.
D. Protect elements surrounding the work of this section from damage or disfigurement.

3.03 INSTALLATION
A. Perform work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.
B. Perform installation in accordance with ASTM C1193.
C. Install bond breaker where joint backing is not used.
D. Install sealant free of air pockets, foreign embedded matter, ridges, and sags.
E. Apply sealant within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.
F. Tool joints concave.

3.04 CLEANING
A. Clean adjacent soiled surfaces.

3.05 PROTECTION
A. Protect sealants until cured.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Non-fire-rated steel doors and frames.
B. Fire-rated steel doors and frames.
C. Thermally insulated steel doors.
D. Steel glazing frames.

1.02 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
B. Product Data: Materials and details of design and construction, hardware locations, reinforcement type and locations, anchorage and fastening methods, and finishes; and one copy of referenced grade standard.
C. Shop Drawings: Details of each opening, showing elevations, glazing, frame profiles, and identifying location of different finishes, if any.
   1. Schedule: Coordinated with other doors, frames, hardware, glazing, finishes and accessories.
D. Manufacturer's Certificate: Certification that products meet or exceed specified requirements.

1.03 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum five years documented experience.
B. Quality Standard: In addition to requirements specified, comply with ANSI/SDI A250.8, latest edition, "Recommended Specifications for Standard Steel Doors and Frames".
C. Maintain at the project site a copy of all reference standards dealing with installation.
D. 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 positive pressure according to NFPA 252 (neutral pressure at 40" above sill) or UL 10C.
   1. Oversize Fire-Rated Door Assemblies Construction: For units exceeding sizes of tested assemblies, attach construction label certifying doors are built to standard construction requirements for tested and labeled fire rated door assemblies except for size.
   2. Temperature-Rise Limit: Where indicated and at vertical exit enclosures (stairwell openings) and exit passageways, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F (250 deg C) above ambient after 30 minutes of standard fire-test exposure.
      a. Smoke "S" Label: Doors to bear "S" label, and include smoke and draft control gasketing applied to frame and on meeting stiles of pair doors.
D. Fire-Rated, Borrowed-Light Frame Assemblies: Assemblies complying with NFPA 80 that are listed and labeled, by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 257. Provide labeled glazing material.
E. Source Limitations: Obtain hollow metal doors and frames through one source from a single manufacturer wherever possible.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Store in accordance with NAAMM HMMA 840.
B. Protect with resilient packaging; avoid humidity build-up under coverings; prevent corrosion.
PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Steel Doors and Frames: Member of HMMA or SDI that produces products complying with requirements.

2.02 DOORS AND FRAMES
A. Requirements for All Doors and Frames:
   1. Door Top Closures: Flush with top of faces and edges.
   2. Door Edge Profile: Beveled on both edges.
   4. Glazed Lights: Non-removable stops on non-secure side; sizes and configurations as indicated on drawings.
   5. Hardware Preparation: In accordance with BHMA A156.115, with reinforcement welded in place, in addition to other requirements specified in door grade standard.
   6. Galvanizing all Units: All components hot-dipped zinc-iron alloy-coated (galvannealed), A60/ZF180.
   7. Finish: Factory primed, for field finishing.

B. Combined Requirements: If a particular door and frame unit is indicated to comply with more than one type of requirement, comply with all the specified requirements for each type; for instance, an exterior door that is also indicated as being sound-rated must comply with the requirements specified for exterior doors and for sound-rated doors; where two requirements conflict, comply with the most stringent.

2.03 STEEL DOORS
A. Exterior Doors Type ___:
   1. Grade: ANSI A250.8 Level 3, physical performance Level A, Model 2, seamless.
   2. Core: Polyurethane, foamed in place.
   3. Galvanizing: All components hot-dipped zinc-iron alloy-coated (galvannealed) in accordance with ASTM A653/A653M, with A60/ZF180 coating.

B. Interior Doors, Non-Fire-Rated:
   1. Grade: ANSI A250.8 Level 2, physical performance Level B, Model 2, seamless.
   2. Core: Polystyrene foam.
   3. Finish: Factory primed, for field finishing.

C. Interior Doors, Fire-Rated:
   1. Grade: ANSI A250.8 Level 2, physical performance Level B, Model 2, seamless.
   2. Fire Rating: As indicated on Door and Frame Schedule, tested in accordance with UL 10C ("positive pressure").
      a. Provide units listed and labeled by UL.
      b. Attach fire rating label to each fire rated unit.
   3. Smoke and Draft Control Doors (Indicated as "S" on Drawings): In addition to required fire rating, provide door assemblies tested in accordance with UL 1784 with maximum air leakage of 3.0 cfm per sq ft of door opening at 0.10 inch w.g. pressure at both ambient and elevated temperatures; with "S" label; if necessary, provide additional gasketing or edge sealing.

D. Energy Efficiency Hollow Metal Doors:
   1. General: Provide 1-3/4 inch doors of design specified, not less than thickness indicated; fabricated with smooth surfaces, without visible joints or seams on exposed faces unless otherwise indicated. Comply with ANSI/SDI A250.8 and ANSI/NAAMM HMMA 867.
   2. Exterior Doors: Face sheets fabricated of commercial quality hot-dipped zinc coated steel that complies with ASTM A924 A60. Provide doors complying with requirements indicated
HOLLOW METAL DOORS AND FRAMES

below by referencing ANSI/SDI A250.8 for level and model, ANSI/SDI A250.4 for physical performance level, and HMMA 867 for door construction.

a. Design: Flush panel.
   1) Roof Access Door Frame: 4-sided frame.

b. Core Construction: Foamed in place polyurethane and steel stiffened laminated core with no stiffener face welds, in compliance with HMMA 867 "Laminated Core".
   1) Provide 22 gauge steel stiffeners at 6 inches on-center internally welded at 5" on-center to integral core assembly, foamed in place polyurethane core chemically bonded to all interior surfaces. No stiffener face welding is permitted.
   2) Thermal properties to rate at a fully operable minimum U-Factor 0.29 and R-Value 3.4, including insulated door, thermal-break frame and threshold.
      (a) Kerf Type Frames: Thermal properties to rate at a fully operable minimum U-Factor 0.36 and R-Value 2.8, including insulated door, kerf type frame, and threshold.

c. Level/Model: Level 2 and Physical Performance Level A (Heavy Duty), Minimum 18 gauge (0.042 inch - 1.1-mm) thick steel, Model 2.

d. Vertical Edges: Vertical edges to be mechanically interlocked with hairline seam. Beveled Lock Edge, 1/8 inch in 2 inches (3 mm in 50 mm).

e. Top and Bottom Edges: Reinforce tops and bottoms of doors with a continuous steel channel not less than 16 gauge, extending the full width of the door and welded to the face sheet. Doors with an inverted top channel to include a steel closure channel, screwed attached, with the web of the channel flush with the face sheets of the door. Plastic or composite channel fillers are not acceptable.

f. Hinge Reinforcement: Minimum 7 gauge (3/16") plate 1-1/4" x 9".

g. Hardware Reinforcements: Fabricate according to ANSI/SDI A250.6 with reinforcing plates from same material as door face sheets.

2.04 STEEL FRAMES

A. General:
   1. Comply with the requirements of grade specified for corresponding door, except:
      a. Exterior Frames: Not less than 14 gage.
      b. Frames for Wood Doors: Comply with frame requirements specified in ANSI A250.8 for Level 2.
   2. Finish: Same as for door.
   3. Frame with Opening Wider than 48 inches: Increase material thickness by 2 gages.

B. Exterior Door Frames: Fully welded.
   1. Weatherstripping: Separate, see Section 08 71 00.

C. Interior Door Frames, Non-Fire-Rated: Fully welded type.

D. Interior Door Frames, Fire-Rated: Fully welded type.
   1. Fire Rating: Same as door, labeled.

E. Energy Efficiency Hollow Metal Frames:
   1. Thermal Break Frames: Subject to the same compliance standards and requirements as standard hollow metal frames, provide where indicated thermally broken frame profiles available for use in both masonry and drywall construction. Fabricate from minimum 16 gauge galvannealed steel, with positive 3/8" vinyl thermal break and integral vinyl weatherstripping. Thermal break frames available as knock down types only.
      a. Manufacturers Basis of Design:
         1) CECO Door Products - Thermal Break SQT and SRT Series.
         2) Curries Company - Thermal Break M and C Series.
3) Substitutions: See Section 01 60 00 - Product Requirements.

2. Weatherstripped Frames: Subject to the same compliance standards and requirements as standard hollow metal frames, provide where indicated weatherstripped profiles with 1/8" integral kerf formed into the frame soffit able to receive manufacturer's listed gasket material. Available for use in both masonry and drywall construction, with fire rating up to 3 hours complying with NFPA 105, UL 1784, and ASTM E-283 Test criteria.

F. Frames for Interior Glazing or Borrowed Lights: Construction and face dimensions to match door frames, and as indicated on drawings.

G. Transom Bars: Fixed, of profile same as jamb and head.

2.05 ACCESSORY MATERIALS

A. Glazing: As specified in Section 08 80 00, factory installed.

B. Removable Stops: Formed sheet steel, shape as indicated on drawings, mitered or butted corners; prepared for countersink style tamper proof screws.

C. Silencers: Resilient rubber, fitted into drilled hole; 3 on strike side of single door, 3 on center mullion of pairs, and 2 on head of pairs without center mullions.
   1. Do not prepare frames for silencers where weatherstripping or gasketting is indicated.

D. Temporary Frame Spreaders: Provide for all factory- or shop-assembled frames.

E. Galvanizing Repair Paint: Tnemec Series 135

2.06 FINISH MATERIALS

A. Primer: Rust-inhibiting, complying with ANSI A250.10, door manufacturer's standard, except silicone modified resin is not acceptable.

B. Galvanizing Touch-Up Paint: Zinc rich primer compatible with finish paint system.

C. Bituminous Coating: Asphalt emulsion or other high-build, water-resistant, resilient coating.
   1. Automotive undercoating.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that opening sizes and tolerances are acceptable.

3.02 PREPARATION

A. Coat inside of frames to be installed in masonry or to be grouted, with bituminous coating, prior to installation.

B. Coat inside of other frames with bituminous coating to a thickness of 1/16 inch.

3.03 INSTALLATION

A. Install in accordance with the requirements of the specified door grade standard and NAAMM HMMA 840.

B. In addition, install fire rated units in accordance with NFPA 80.

C. Coordinate frame anchor placement with wall construction.

D. Grout frames in masonry construction, using hand trowel methods; brace frames so that pressure of grout before setting will not deform frames.
   1. Coat interior of frame with undercoating.

E. Coordinate installation of hardware.

F. Coordinate installation of glazing.

G. Coordinate installation of electrical connections to electrical hardware items.

H. Touch up damaged factory finishes.
3.04 ADJUSTING

A. Adjust for smooth and balanced door movement.

END OF SECTION
PART 1  GENERAL

1.01  SECTION INCLUDES
A. Ceiling access door and frame units.
B. Access door and frame units, fire-rated, in wall and ceiling locations.

1.02  REFERENCE STANDARDS

1.03  DESIGN REQUIREMENTS
A. Fabricate floor access assemblies to support live load of 100 lb/sq ft with deflection not to exceed 1/180 of span.

1.04  SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide sizes, types, finishes, hardware, scheduled locations, and details of adjoining work.
C. Shop Drawings: Schedule of sizes and locations. Indicate exact position of all access door units.
D. Manufacturer’s Installation Instructions: Indicate installation requirements.
E. Project Record Documents: Record actual locations of all access units.

1.05  REGULATORY REQUIREMENTS
A. Conform to applicable code for fire rated access doors.
   1. Provide access doors of fire rating equivalent to the fire rated assembly in which they are to be installed.
B. Provide products listed and labeled by UL or ITS (Warnock Hersey) as suitable for the purpose specified and indicated.

1.06  PROJECT CONDITIONS
A. Coordinate the work with other work requiring access doors.

PART 2  PRODUCTS

2.01  ACCESS DOOR AND PANEL APPLICATIONS
A. Walls, Unless Otherwise Indicated:
   1. Size: 24 x 30 inches, unless otherwise indicated.
B. Fire and Smoke Rated Shaft Walls: See drawings for shaft wall fire and smoke ratings.
   1. Material: Steel.
      a. Frame: 16 gauge cold rolled steel with 1 inch flanges
      b. Door: 20 gauge double skin insulated sandwich panel.
      c. Hinge: Flush continuous piano hinge.
      d. Latch: Cylinder keyed self latching with interior latch release mechanism.
      e. Closer: Self-closing automatic closer.
      f. Gasketing: All 4 sides.
   2. Minimum Size: 24 inches by 30 inches, for personnel access and 16 x 16 inches for valve access, unless otherwise indicated.
      a. Access Door Size: Sufficient to allow access for all system components requiring maintenance panel size must be sufficient to repair the equipment.
      b. Label access to shut-offs. Label should read, "EMERGENCY _______ SHUT-OFF"
      c. 

SERA Architects, Inc.  Package 1 - PERMIT / CONSTRUCTION

NOTICE OF ALTERNATE BILLING CYCLE: The Contract allows the Owner to require the submission of billings or estimates in billing cycles other than 30-day cycles. Billings or estimates shall be submitted monthly ending on the last day of the month.

NOTICE OF EXTENDED CERTIFICATION PROVISION: The Contract will allow the Owner to certify billings and estimates within 20 days after the billings and estimates are received from the original contractor.

NOTICE OF EXTENDED PAYMENT PROVISION: The Contract will allow the Owner to make payment within 30 days after the date a billing or estimate is received.
2.02 MANUFACTURERS

2.03 WALL AND CEILING UNITS

A. Access Doors: Factory fabricated door and frame units, fully assembled units with corner joints welded, filled, and ground flush; square and without rack or warp; coordinate requirements with assemblies units are to be installed in.

1. Door Style: Single thickness with rolled or turned in edges.

2.04 ACCESS DOOR UNITS - WALLS

2.05 FABRICATION

A. Weld, fill, and grind joints to ensure flush and square unit.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that rough openings are correctly sized and located.

3.02 INSTALLATION

A. Install units in accordance with manufacturer's instructions.

B. Install frames plumb and level in openings. Secure rigidly in place.

C. Position units to provide convenient access to the concealed work requiring access.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Overhead coiling doors, operating hardware, non-fire-rated and exterior, electric operation.
   B. Wiring from electric circuit disconnect to operator to control station.

1.02 RELATED REQUIREMENTS
   A. Section 08 71 00 - Door Hardware: Cylinder cores and keys.
   B. Section 09 90 00 - Painting and Coating: Field paint finish.
   C. Section 28 31 00 - Fire Detection and Alarm: Fire alarm interconnection.
   D. Section 26 27 17 - Equipment Wiring: Power to disconnect.
   E. Section 26 05 34 - Conduit: Conduit from electric circuit to operator and from operator to control station.
   F. Section 26 05 34 - Conduit: Conduit from fire alarm system.

1.03 REFERENCE STANDARDS
   D. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2010.
   G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association; 2008.
   H. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association; 2011.

1.04 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide general construction, component connections and details, electrical equipment.
   C. Shop Drawings: Indicate pertinent dimensioning, anchorage methods, hardware locations, and installation details.
   D. Manufacturer’s Instructions: Indicate installation sequence and procedures, adjustment and alignment procedures.
   E. Maintenance Data: Indicate lubrication requirements and frequency and periodic adjustments required.

1.05 QUALITY ASSURANCE
   A. Products Requiring Electrical Connection: Listed and classified by testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.
OVERHEAD COILING DOORS

1.06 WARRANTY
   A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
   B. Correct defective Work within a two year period after Date of Substantial Completion.
   C. Provide one year service and maintenance agreement for installed system for one year owner’s consideration from Date of Substantial Completion.
      1. Examine system components monthly. Clean, adjust, and lubricate equipment.
      2. Include systematic examination, adjustment, and lubrication of elevator equipment. Maintain hydraulic fluid levels. Repair or replace parts whenever required. Use parts produced by the manufacturer of the original equipment.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. Overhead Coiling Doors:
      6. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 COILING DOORS
   A. Exterior Coiling Doors: Heavy Duty, Insulated, Type 304 Stainless steel slat curtain and components.
      1. Capable of withstanding positive and negative wind loads of 20 psf, without undue deflection or damage to components.
      2. Sandwich slat construction with insulated core of mineral wool type insulation; insulation 4.5 R-value: 0.50 BTU/hr sq ft deg F
      3. Nominal Slat Size: 2 inches wide x required length.
      4. Finish: No. 4.
      5. Guides: Angles; stainless steel.
      6. Hood Enclosure: Stainless steel
      7. Mounting: Surface mounted.
      8. Exterior lock and latch handle.
   B. Non-Fire-Rated Interior Coiling Doors: Perforated steel slat curtain.
      1. Single thickness slats.
      2. Nominal Slat Size: 2 inches wide x required length.
      4. Guides: Formed track; with factory powder coat steel.
      5. Hood Enclosure: Manufacturer's standard; with factory powder coat steel.
      7. Mounting: Surface mounted.
      8. Exterior lock and latch handle.
      9. Size: 8 feet wide by 7 feet high.

2.03 MATERIALS
   A. Curtain Construction: Interlocking slats.
      1. Slat Ends: Each slat fitted with end locks to act as wearing surface in guides and to prevent lateral movement.
      2. Curtain Bottom: Fitted with angles to provide reinforcement and positive contact in closed position.
OVERHEAD COILING DOORS

3. Weatherstripping: Moisture and rot proof, resilient type, located at jamb edges, bottom of curtain, and where curtain enters hood enclosure of exterior doors.

B. Steel Slats: Minimum 22 gage ASTM A653/A653M galvanized steel sheet.

C. Stainless Steel Slats: Minimum 22 gage steel conforming to ASTM A 666, Type 304,rollable temper.

D. Guide Construction: Continuous, of profile to retain door in place with snap-on trim, mounting brackets of same metal.

E. Steel Guides: ASTM A36/A36M steel angles, size as indicated, hot-dip galvanized per ASTM A 123/A 123M.

F. Steel Guides: Formed from galvanized steel sheet, 4 gage; 2 inch wide; complying with ASTM A653/A653M.

G. Stainless Steel Guides: ASTM A 666, Type 304,rollable temper.

H. Hood Enclosure: Internally reinforced to maintain rigidity and shape.
   1. Minimum 22 gage.
   2. Factory paint, custom color.

I. Hardware:
   1. Lock Cylinders: Specified in Section 08 71 00.
   2. Latching: Inside mounted, adjustable keeper, spring activated latch bar with feature to keep in locked or retracted position.
   3. Latch Handle: Interior and exterior handle.

J. Roller Shaft Counterbalance: Steel pipe and helical steel spring system, capable of producing torque sufficient to ensure smooth operation of curtain from any position and capable of holding position at mid-travel; with adjustable spring tension; requiring 25 lb nominal force to operate.

2.04 ELECTRIC OPERATION

A. Electric Operators:
   1. Mounting: Side mounted.
   2. Motor Enclosure:
      a. Exterior doors: NEMA MG 1 Type 4; open drip proof.
      b. Interior doors: NEMA MG 1 Type 1; open drip proof.
   5. Controller Enclosure: NEMA 250 Type 1.
   6. Opening Speed: 12 inches per second.

B. Interior Control Station: Standard three button (OPEN-STOP-CLOSE) momentary control for each operator.
   1. 24 volt circuit.
   2. Surface mounted.

C. Exterior Control Station: Standard key-operated (OPEN-STOP-CLOSE) momentary control for each operator.
   1. 24 volt circuit.
   2. Recessed.

D. Safety Edge: Located at bottom of curtain, full width, electro-mechanical sensitized type, wired to stop operator upon striking object, hollow neoprene covered.
E. Safety Edge: Located at bottom of curtain, full width, electro-mechanical sensitized type, wired to stop operator upon striking object, hollow neoprene covered.

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify that opening sizes, tolerances and conditions are acceptable.

3.02 INSTALLATION
A. Install units in accordance with manufacturer's instructions.
B. Use anchorage devices to securely fasten assembly to wall construction and building framing without distortion or stress.
C. Securely and rigidly brace components suspended from structure. Secure guides to structural members only.
D. Fit and align assembly including hardware; level and plumb, to provide smooth operation.
E. Coordinate installation of electrical service with Section 26 27 17 Division 26.
F. Complete wiring from disconnect to unit components.
G. Coordinate installation of sealants and backing materials at frame perimeter as specified in Section 07 90 05.
H. Install perimeter trim, closures, and gasketing.

3.03 TOLERANCES
A. Maintain dimensional tolerances and alignment with adjacent work.
B. Maximum Variation From Plumb: 1/16 inch.
C. Maximum Variation From Level: 1/16 inch.
D. Longitudinal or Diagonal Warp: Plus or minus 1/8 inch per 10 ft straight edge.

3.04 ADJUSTING
A. Adjust operating assemblies for smooth and noiseless operation.

3.05 CLEANING
A. Clean installed components.
B. Remove labels and visible markings.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Aluminum-framed curtain wall, with vision glazing and glass infill panels.
B. Aluminum doors and frames.
C. Transoms vents.
D. Column covers.
E. Perimeter sealant.
F. Field Quality Control Testing.

1.02 REFERENCE STANDARDS

A. AAMA CW-10 - Care and Handling of Architectural Aluminum From Shop to Site; American Architectural Manufacturers Association; 2012.
B. AAMA 503-08 (Voluntary Specification for Field Testing of Newly Installed Storefronts, Curtain Walls and Glazing Systems).
E. ASCE 7 - Minimum Design Loads for Buildings and Other Structures; American Society of Civil Engineers; 2011.

1.03 PERFORMANCE REQUIREMENTS

A. The delegated design curtain wall system shall be 2 ½ inches inside glazed and utilize the appropriate depth back member to meet project loads. An energy efficient fiberglass pressure plate will be used in lieu of a standard extruded aluminum pressure plate.
B. Design and size components to withstand the following load requirements without damage or permanent set:
   1. Positive Design Wind Load: 40 lbf/sq ft.
   2. Negative Design Wind Load: 40 lbf/sq ft.
   3. Member Deflection: Limit member deflection to 1/175 in any direction, and maximum of 3/4 inch, with full recovery of glazing materials.
   4. Measure performance by testing in accordance with ASTM E 330, using test loads equal to 1.5 times the design wind loads and 10 second duration of maximum pressure.
C. Seismic Loads: Design and size components to withstand seismic loads and sway displacement as calculated in accordance with building code.
D. Movement: Accommodate the following movement without damage to components or deterioration of seals:
ALUMINUM FRAMED CURTAIN WALL

1. Movement of curtain wall relative to perimeter framing.
2. Deflection of structural support framing, under permanent and dynamic loads.

E. Air Infiltration: Limit air infiltration through assembly to 0.06 cu ft/min/sq ft of wall area, measured at a reference differential pressure across assembly of 6.24 psf as measured in accordance with ASTM E 283.

F. Condensation Resistance Factor: CRF of 55 when measured in accordance with AAMA 1503.1.

G. Water Leakage: None, when measured in accordance with ASTM E 331 at a test pressure difference of 12 lbf/sq ft.

H. System Internal Drainage: Drain to the exterior by means of a weep drainage network any water entering joints, condensation occurring in glazing channel, and migrating moisture occurring within system.

I. Air and Vapor Seal: Maintain continuous air barrier and vapor retarder throughout assembly, primarily in line with inside pane of glazing and inner sheet of infill panel and heel bead of glazing compound.

J. Overall System U-Value: Not to exceed 0.35 including design basis glazing units.

K. Expansion/Contraction: Provide for expansion and contraction within system components caused by cycling temperature range of 170 degrees F over a 12 hour period without causing detrimental effect to system components, anchorages, and other building elements.

L. Design system to eliminate noises caused by wind and thermal movement, to prevent vibration harmonics, and to prevent "stack effect" in internal spaces.

M. Integration requirements with building envelope systems: manufacturer must allow weather barrier flashing components to extend into shoulder of curtain wall system to create a continuous 90 degree barrier against water penetration and to complete the air barrier.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide component dimensions, describe components within assembly, anchorage and fasteners, glazing and infill, internal drainage details and operable hardware.

C. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, affected related Work, expansion and contraction joint location and details, and field welding required.

D. Samples: Submit two samples 3 by 5 inches in size illustrating finished aluminum surface, glazing, infill panels, glazing materials.

E. Test Reports: Submit results of full-size mock-up testing. Reports of tests previously performed on the same design are acceptable.

F. Design Data: Provide framing member structural and physical characteristics and engineering calculations, and identify dimensional limitations; include load calculations at points of attachment to building structure.

1. Comply with Section 01 33 16 - Delegated Design Procedures.

G. Manufacturer’s Certificate: Certify that the products supplied meet or exceed the specified requirements.

H. Report of field testing for water leakage.

I. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.
1.05 QUALITY ASSURANCE
   A. Designer Qualifications: Design structural support framing components under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed at the State in which the Project is located.
   B. Manufacturer and Installer: Company specializing in manufacturing aluminum glazing systems with minimum 10 years of documented experience.

1.06 MOCK-UP
   A. See Section 01 40 00 Quality Requirements, for general requirements for mock-ups.
   B. Provide 100 square feet mock-up including all components occurring on project. Assemble to illustrate component assembly including glazing materials, weep drainage system, attachments, anchors, and perimeter sealant.
   C. Locate on-site where directed. Mock-up may remain as part of the Work.

1.07 PRE-INSTALLATION MEETING
   A. Convene one week before starting work of this section.

1.08 DELIVERY, STORAGE, AND HANDLING
   A. Handle products of this section in accordance with AAMA CW-10.
   B. Protect finished aluminum surfaces with wrapping. Do not use adhesive papers or sprayed coatings that bond to aluminum when exposed to sunlight or weather.

1.09 PROJECT CONDITIONS
   A. Coordinate the work with installation of firestopping components or materials.

1.10 FIELD CONDITIONS
   A. Do not install sealants when ambient temperature is less than 40 degrees F. Maintain this minimum temperature during and 48 hours after installation.

1.11 WARRANTY
   A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
   B. Correct defective Work within a five year period after Date of Substantial Completion.
   C. Provide 5 year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking.

PART 2 PRODUCTS
2.01 MANUFACTURERS
   B. Acceptable Manufacturers pending conformance to Design Basis requirements and requirements specified herein:
      1. EFCO Corporation; www.efcocorp.com
      3. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 CURTAIN WALL
   A. Aluminum-Framed Curtain Wall: Factory fabricated, factory finished aluminum framing members with infill, and related flashings, anchorage and attachment devices.
      1. Inside glazed, with pressure plate and mullion cover.
      a. Vents:
a. System Description: Concealed frame (structurally glazed), with operable awning windows integrated within curtain wall system by manufacturer. Performance requirements for whole system also apply to vents.

3. Door Frames: Reinforce as required to support loads imposed by door operation and for installing hardware.
   a. At exterior doors, provide compression weather stripping at fixed stops.

4. Hardware Installation: Factory install hardware to the greatest extent possible. Cut, drill, and tap for factory-installed hardware before applying finishes.

   a. Factory finish all surfaces that will be exposed in completed assemblies.
   b. Touch-up surfaces cut during fabrication so that no natural aluminum is visible in completed assemblies, including joint edges.
   c. Coat concealed metal surfaces that will be in contact with cementitious materials or dissimilar metals with bituminous paint.

6. Fabrication: Joints and corners flush, hairline, and weatherproof, accurately fitted and secured; prepared to receive anchors; fasteners and attachments concealed from view; reinforced as required for imposed loads.


8. System Internal Drainage: Drain to the exterior by means of a weep drainage network any water entering joints, condensation occurring in glazing channel, and migrating moisture occurring within system.

9. Air and Vapor Seal: Maintain continuous air barrier and vapor retarder throughout assembly, primarily in line with inside pane of glazing and inner sheet of infill panel and heel bead of glazing compound.

10. Perimeter Clearance: Minimize space between framing members and adjacent construction while allowing expected movement.

B. Structural Performance Requirements: Design and size components to withstand the following load requirements without damage or permanent set.

1. Design Wind Loads: Comply with the following:
   a. See structural notes for positive and negative design load requirements.
   b. Measure performance by testing in accordance with ASTM E330, using test loads equal to 1.5 times the design wind loads and 10 second duration of maximum pressure.
   c. Member Deflection: For spans less than 13 feet 6 inches, limit member deflection to flexure limit of glass in any direction, and maximum of 1/175 of span or 3/4 inch, whichever is less and with full recovery of glazing materials.
   d. Member Deflection: For spans over 13 feet 6 inches and less than 40 feet, limit member deflection to flexure limit of glass in any direction, and maximum of 1/240 of span plus 1/4 inch, with full recovery of glazing materials.

2. Seismic Loads: Design and size components to withstand seismic loads and sway displacement in accordance with the requirements of ASCE 7.

3. Movement: Accommodate the following movement without damage to components or deterioration of seals:
   a. Expansion and contraction caused by 180 degrees F surface temperature.
   b. Expansion/Contraction: Provide for expansion and contraction within system components caused by cycling temperature range of 170 degrees F over a 12 hour period without causing detrimental effect to system components, anchorages, and other building elements.
   c. Movement of curtain wall relative to perimeter framing.
   d. Deflection of structural support framing, under permanent and dynamic loads.
4. Design system to eliminate noises caused by wind and thermal movement, to prevent vibration harmonics, and to prevent "stack effect" in internal spaces.

C. Water Penetration Resistance: No uncontrolled water on indoor face when tested as follows:
   1. Test Pressure Differential: 12 lbf/sq ft.
   2. Test Method: AAMA 503 to full factory test pressure.

D. Air Leakage: Maximum of 0.06 cu ft/min/sq ft of wall area, when tested in accordance with ASTM E283 at 6.27 pounds per square foot pressure differential across assembly.

2.03 COMPONENTS
A. Aluminum-Framed Curtain Wall: Factory fabricated, factory finished aluminum framing members with infill, and related flashings, anchorage and attachment devices.
B. Aluminum Framing Members: Tubular aluminum sections, thermally broken with interior section insulated from exterior, drainage holes and internal weep drainage system.
C. System Description: concealed frame (structurally glazed), with operable awning and casement windows integrated within curtain wall system by manufacturer.
D. Glazing: As specified in Section 08 80 00.
E. Column Covers: Aluminum, 0.032 inch thick, full contact pressure bonded to __________ for flat surface, finish to match curtain wall framing members.

2.04 MATERIALS
C. Perimeter Sealant: Type exterior building sealant specified in Section 07 90 05.
D. Glazing Gaskets: Type to suit application to achieve weather, moisture, and air infiltration requirements.
E. Glazing Accessories: As specified in Section 08 80 00.

2.05 FINISHES
A. Superior Performance Organic Coating System: AAMA 2605 multiple coat, thermally cured polyvinylidene fluoride system.
B. Color: To be selected by Architect from manufacturer's custom range.
C. Touch-Up Materials: As recommended by coating manufacturer for field application.

2.06 FABRICATION
A. Fabricate components with minimum clearances and shim spacing around perimeter of assembly, yet enabling installation and dynamic movement of perimeter seal.
B. Accurately fit and secure joints and corners. Make joints flush, hairline, and weatherproof.
C. Prepare components to receive anchor devices. Fabricate anchors.
D. Coat concealed metal surfaces that will be in contact with cementitious materials or dissimilar metals with bituminous paint.
E. Arrange fasteners and attachments to conceal from view.
F. Reinforce framing members for imposed loads.
G. Finishing: Apply factory finish to all surfaces that will be exposed in completed assemblies.

PART 3 EXECUTION
3.01 EXAMINATION
A. Verify dimensions, tolerances, and method of attachment with other work.
B. Verify that wall openings and adjoining air and vapor seal materials are ready to receive work of this section.

C. Verify that anchorage devices have been properly installed and located.

3.02 INSTALLATION

A. Install wall system in accordance with manufacturer's instructions.

B. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.

C. Provide alignment attachments and shims to permanently fasten system to building structure.

D. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent work.

E. Provide thermal isolation where components penetrate or disrupt building insulation.

F. Install sill flashings. Turn up ends and edges; seal to adjacent work to form water tight dam.

G. Coordinate attachment and seal of perimeter air and vapor barrier materials.

H. Install firestopping at each floor slab edge.

I. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.

J. Install perimeter sealant in accordance with Section 07 90 05.

K. Touch-up minor damage to factory applied finish; replace components that cannot be satisfactorily repaired.

3.03 TOLERANCES

A. Maximum Variation from Plumb: 0.06 inches every 3 ft non-cumulative or 0.5 inches per 100 ft, whichever is less.

B. Maximum Misalignment of Two Adjoining Members Abutting in Plane: 1/32 inch.

C. Sealant Space Between Curtain Wall Mullions and Adjacent Construction: Maximum of 3/4 inch and minimum of 1/4 inch.

3.04 FIELD QUALITY CONTROL

A. Provide the services of the manufacturer's field representative to observe installation and make report.

B. See Section 01 40 00 - Quality Requirements, for independent testing and inspection requirements. Inspection will monitor quality of installation and glazing.

C. Test installed curtain wall for water leakage in accordance with AAMA 503 to factory full test pressure.

D. In-Place Testing Intallation: Demonstrating all common aspects applicable to Project. Include flashing and accessory products, Coordinated with flexible flashing and sill pans, initial units for in-place mock-ups. Coordinate Work in advance with all trades.

E. Test one curtain wall of each type, as directed by Architect.

F. If any curtain wall fails, test additional curtain walls at Contractor's expense.

G. Repair or remove Work that does not meet specified requirements, or that is damaged by testing.

1. Where repair does not produce system(s) that meet specified performance requirements, replace system(s) components with new components and re-test.

2. Obtain Architect's acceptance of corrective Work prior to executing it.

H. Cost of corrective Work and re-testing necessary to arrive at performance requirements are Contractor's responsibility.
1. Re-testing includes testing fees, Architect's fees, and Consultant's fees.
   a. Re-testing costs due to re-design by Architect will be paid by Owner.

3.05 MANUFACTURER'S FIELD SERVICES
   A. See Section 01 40 00 - Quality Requirements, for general requirements for manufacturer observation of installation.
   B. Provide curtain wall manufacturer's field surveillance of the installation. Monitor and report installation procedures, unacceptable conditions and provide copies to the architect and envelope consultant.

3.06 ADJUSTING
   A. Adjust operating sash for smooth operation.

3.07 CLEANING
   A. Remove protective material from pre-finished aluminum surfaces.
   B. Wash down surfaces with a solution of mild detergent in warm water, applied with soft, clean wiping cloths. Take care to remove dirt from corners. Wipe surfaces clean.

END OF SECTION
PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Door hardware. Owner furnished, contractor installed.

B. Related Sections:
   1. Section 08 11 00 - Metal Doors and Frames.
   2. Section 08 14 16 – Flush Wood Doors.
   3. Section 08 43 13 – Aluminum Framed Storefronts
   4. Division 26 – Electrical

C. Specific Omissions: Hardware for the following is specified or indicated elsewhere.
   1. Windows.
   2. Cabinets, including open wall shelving and locks.
   3. Signs
   4. Toilet accessories, including grab bars.

1.02 REFERENCES:

A. American National Standards Institute – ANSI 156.18 or BHMA A156.18– Materials and Finishes.
B. ANSI A117.1 – Specifications for making buildings and facilities usable by physically handicapped people.
C. BHMA A156.18 - Materials and Finishes; current edition.
F. ADA – Americans with Disabilities Act of 1990
G. BHMA – Builders Hardware Manufacturers Association
H. DHI – Door and Hardware Institute
I. NFPA – National Fire Protection Association
J. UL – Underwriters Laboratories
K. WHI – Warnock Hersey Incorporated
L. WDI – Wood Door Institute

1.03 SUBMITTALS & SUBSTITUTIONS

A. Hardware Schedule: Submit for approval six copies of schedule per Division 1. Organize vertically formatted schedule into “Hardware Sets” with index of doors and headings, indicating complete designations of every item required for each door or opening. Include following information:
   1. Type, style, function, size, quantity and finish of hardware items.
      a. Use BHMA Finish codes per ANSI A156.18.
   2. Name, part number and manufacturer of each item.
   3. Fastenings and other pertinent information.
   4. Location of hardware set coordinated with floor plans and door schedule.
   5. Explanation of abbreviations, symbols, and codes contained in schedule.
   6. Mounting locations for hardware.
   7. Door and frame sizes, materials, hand, rating, degrees of swing, and jamb depth.
   8. List of manufacturers used and their nearest representative with address and phone number.
   9. Catalog cuts.
10. Manufacturer’s technical data and installation instructions for electronic hardware.
11. Date of jobsite visit if existing conditions.
12. Provide point to point wiring and riser diagrams for each electric hardware application. Include electrical items provided by others where specified. Include a system description.

B. Schedules in coded or horizontal format are unacceptable. Submittals not conforming to the above requirements will be returned without review, for re-submittal.

C. Bid and submit manufacturer’s updated/improved item if scheduled item is discontinued.

D. See section 01 33 00- Submittal Procedures, for submittal procedures.

E. Make substitution requests in accordance with Division 1. Include product data and indicate benefit to the Project. Furnish operating samples on request.
   1. Items listed with no substitute manufacturers have been requested by Owner to meet existing standard.

F. Cylinders: Provide interchangeable core cylinders with factory installed keyed construction cores (Schlage ICC).
   1. Cylinder cores: Primus cores provided by Owner.
   2. Provide 10 construction keys and one control key.
   3. Permanent Keys and keying: Provided by Owner.
   4. Return temporary construction cores to hardware supplier after permanent cores are installed.

G. Closeout Submittals: Furnish 2 copies of the as-built/as-installed hardware schedule with closeout documents including wiring diagrams, manufacturers installation instructions, and suppliers final inspection report.

1.04 REFERENCES
   A. BHMA A156.18 - Materials and Finishes; current edition.

1.05 QUALITY ASSURANCE:
   A. Supplier Qualifications:
      1. Owner furnished.
   B. Hardware: New, free of defects, blemishes and excessive play. Obtain each kind of hardware (latch and locksets, exit devices, hinges and closers) from one manufacturer.
   C. Exit Doors: Operable from inside with single motion without the use of a key or special knowledge or effort.
   D. Notify Architect of any code conflicts before ordering material.
   E. Fire-Rated Openings: In compliance with NFPA 80. Hardware UL10C/UBC-7-2 (positive pressure) compliant for given type/size opening and degree of label. Provide proper latching hardware, non-flaming door closers, approved-bearing hinges, plus resilient and required intumescent seals. Furnish openings complete.
      1. Note: scheduled seals may exceed selected door manufacturer’s requirements. See 2.6.E for clarification.
   F. Pre-Installation Meetings: Initiate and conduct with supplier, installer, and related trades through Architect. Coordinate materials and techniques, and sequence complex mechanical and electrical hardware items and systems installation. Convene at least two weeks prior to commencement of related work.
      1. Confirm that Supplier has supplied necessary riser and point to point wiring diagrams for complex electric hardware systems.
1.06 DELIVERY, STORAGE AND HANDLING:
A. Delivery: coordinate delivery to appropriate locations (shop or field).
B. Acceptance at Site: Items individually packaged in manufacturers’ original containers, complete with proper fasteners and related pieces. Clearly mark packages to indicate contents, locations in hardware schedule and door numbers.
C. Storage: Provide locked storage area for hardware, protect from moisture, sunlight, paint, chemicals, etc.

1.07 PROJECT CONDITIONS:
A. Where exact types of hardware specified are not adaptable to finished shape or size of members requiring hardware, provide suitable types having as nearly as practical as the same operation and quality as type specified, subject to Architect’s approval.

1.08 SEQUENCING AND COORDINATION:
A. Coordinate with concrete.
B. Reinforce walls.
C. Coordinate finish floor materials and floor-mounted hardware.
D. Conduit and raceways as needed for electrical, electronic and electro-pneumatic hardware items. Fire/life-safety system interfacing. Point-to-point wiring diagrams plus riser diagrams to related trades.
E. Furnish manufacturer templates to door and frame fabricators.
F. Use hardware consultant to check Shop Drawings for doors and entrances to confirm that adequate provisions will be made for proper hardware installation.
   1. Confirm that door manufacturers furnish necessary UBC-7-2 compliant seal packages.

1.09 WARRANTY:
A. Part of respective manufacturers’ regular terms of sale. Provide manufacturers’ warranties:
   1. Closers: Ten years mechanical, 2 years electrical
   2. Exit Devices: Three years mechanical, 1 year electrical.
   3. Hinges: Life of Building.
   4. Locksets: Five years
   5. Other Hardware: Two years.

1.10 COMMISSIONING:
A. Test door hardware operation with climate control system and stairwell pressurization system both at rest and while in full operation.
B. Test electrical, electronic and electro-pneumatic hardware systems for satisfactory operation.
C. Test hardware interfaced with fire/life-safety system for proper operation and release.

1.11 MAINTENANCE:
A. Tools: After final adjustment of door hardware turn over to Owner tools. Furnished during construction used for installation and adjustment.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:
A. Listed below are specified manufacturers and acceptable alternates:

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<tr>
<th>ITEM</th>
<th>MANUFACTURER</th>
<th>ACCEPTABLE SUB</th>
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<tbody>
<tr>
<td>Hinges</td>
<td>(IVE) Ives</td>
<td>McKinney, Stanley</td>
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<td>Pivots</td>
<td>(IVE) Ives</td>
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<tr>
<td>Locks</td>
<td>(SCH) Schlage</td>
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## Finish Hardware

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<tr>
<th>Item</th>
<th>Manufacturer 1</th>
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<td>Push/Pull Latches</td>
<td>(GLY) Glynn Johnson</td>
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<tr>
<td>Push/Pull Plates</td>
<td>(IVE) Ives</td>
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<td>Push/Pull Sets</td>
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<td>Pocket Door Pulls</td>
<td>(TRI) Trimco</td>
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<td>Flush Pull</td>
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<td>(LCN) LCN</td>
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B. Provide hardware items required to complete the work in accordance with these specifications and manufacturers’ instructions.
1. Include items inadvertently omitted from this specification. Note these items in submittal for review.
2. Where scheduled item is now obsolete, bid and furnish manufacturers updated item at no additional cost to the project.

## 2.02 Hanging Means:

A. Conventional Hinges: Hinge open widths minimum, but, of sufficient throw to permit maximum door swing. Steel or stainless steel pins and concealed bearings.
1. Three hinges per leaf to 7 foot, 0 inch height. Add one for each additional 30 inches in height, or any fraction thereof.
2. Heavy weight hinges on doors over 36” in width and doors with exit devices, 4 ¼ x 4 ½.
4. Non-ferrous material exteriors and at doors subject to corrosive atmospheric conditions.
5. Provide shims and shimming instructions for proper door adjustment.

## 2.03 Locksets, Latchsets, Deadbolts:

A. Locksets and Latchsets:
1. Schlage ND series.
2. Latchbolts: 1/2 inch throw at single doors and non-rated pairs, 5/8” at rated pairs.
3. Lever Trim: Rhodes design.
4. Strikes: ANSI 1-1/4” x 4-7/8” x 3/32” (10-025), lips of sufficient length to clear trim and protect clothing. Where pairs of door occur with flat bar astragal, provide lip length that allows installation of astragal without modification to strike.

2.04 EXIT DEVICES/PANIC HARDWARE
A. General features:
1. Independent lab-tested 1,000,000 cycles.
3. 3/4” throw deadlocking latch-bolts.
4. No exposed screws to show through glass doors.
5. Non-handed basic device design with center case interchangeable with all functions, no extra parts required to effect change of function.
6. Releasable with 32 lb. maximum pressure under 250 lb. load to the door.

B. Specific features:
2. Lever Trim: Breakaway type, forged brass or bronze escutcheon min .130” thickness, match lockset lever design.
3. Fire-Labeled Devices: UL label indicating “Fire Exit Hardware”. Provide rim exit devices at pair and single openings unless otherwise scheduled. Provide surface vertical rod exit devices at cross corridor pairs where wall mounted magnetic hold opens are scheduled.
4. Electrically Operated Devices: Single manufacturer source for electric latch retraction devices, electrically controlled trim, power transfers, power supplies, monitoring switches and controls.
5. Removable Mullions: Removable with single turn of building key. Securely reinstalled without need for key. Furnish storage brackets for securely stowing the mullion away from the door when removed.

2.05 CLOSERS
A. Surface Closers:
1. Full rack-and-pinion type cylinder with removable non-ferrous cover and cast iron body.
3. Plates, brackets and special templating when needed for interface with particular header, door and wall conditions and neighboring hardware.
4. Opening pressure: Exterior doors 8.5 lb., interior doors 5 lb., labeled fire doors-minimum required to close and latch door.
5. Separate adjusting valves for closing speed, latching speed and backcheck, fourth valve for delayed action where scheduled.
6. Heavy duty arms (EDA) for doors scheduled with parallel arm units.

1. Self-contained low-voltage power supply, terminal strip and sequencing for incorporation of electric hardware with system operation.

2.06 OTHER HARDWARE
A. Flush Bolts: Low operating force design.
B. Kick Plates: Four beveled edges, .050 inches minimum thickness, height and width as scheduled. Sheet-metal screws of bronze or stainless steel to match other hardware.

C. Door Stops: Provide stops to protect walls, casework or other hardware.
   1. Unless otherwise noted in Hardware Sets, provide wall type with appropriate fasteners. Where wall type cannot be used, provide floor type. If neither can be used, provide overhead type.

D. Thresholds: As scheduled and per details. Substitute products: certify that the products equal or exceed specified material’s thickness. Proposed substitutions: submit for approval.
   1. Exteriors: Set in full bed of butyl-rubber or polyisobutylene mastic sealant complying with requirements in Division 7 “Thermal and Moisture Protection”. Non-ferrous ¼ inch fasteners and lead expansion shield anchors, or Red-Head #SFS-1420 (or approved equivalent) Flat Head Sleeve Anchors (SS/FHSL).
   2. Sound control openings: Set in bed of mastic sealant.

E. Fasteners: Generally, exposed screws to be Phillips or Robertson drive. Pinned TORX drive at high security areas. Flat head sleeve anchors (FHS) may be slotted drive. Sheet metal and wood screws: full-thread. Sleeve nuts: full length to prevent door compression.

F. Silencers: Interior hollow metal frames, 3 for single doors, 4 for pairs of doors. Omit where adhesive mounted seal occurs. Leave no unfilled/uncovered pre-punched silencer holes.

2.07 FINISH:

A. Generally BHMA 626 Satin Chromium.
   1. Areas using BHMA 626 to have push-plates, pulls and protection plates of BHMA 630, Satin Stainless Steel, unless otherwise noted.

B. Door closers: factory powder coated to match other hardware, unless otherwise noted.

C. Aluminum items: match predominant adjacent material. Seals to coordinate with frame color.

2.08 KEYING REQUIREMENTS:

A. Key System: Existing Schlage Primus Key System. Cylinder cores, keys and keying provided by Owner.

B. Interchangeable Core cylinders at all cylinders, with keyed construction cores installed.

C. Permanent cores: furnished by Owner.

D. Permanent keys and cores: furnished by Owner.

PART 3 - EXECUTION

3.01 ACCEPTABLE INSTALLERS:

A. Factory trained, certified, and carries a factory-issued card certifying that person as a “Certified Installer”. Alternative: can demonstrate suitably equivalent competence and experience.

3.02 PREPARATION:

A. Ensure that walls and frames are square and plumb before hardware installation.

B. Clarify placement if new hardware is to be installed near existing doors/hardware scheduled to remain.

C. Mounting Heights: Locate hardware units at heights indicated in DHI’s recommended locations unless otherwise indicated or required to comply with governing regulations.

D. Existing frames and doors scheduled to receive new hardware: carefully remove existing hardware, tag and bag, and turn over to Owner.
   1. Patch and fill wood frames and doors with solid wood stock or dowel material before cutting for new hardware. Do not reuse existing screw holes - fill and re-pilot.
2. Metal doors/frames: Weld or fasten with screws: filler pieces in existing hardware cut-outs and mortises not scheduled for re-use by new hardware. Leave surfaces smooth - no applied patches.

3.03 INSTALLATION
   A. Install hardware per manufacturer’s instructions and recommendations. Do not install surface-mounted items until finishes have been completed on substrate. Set units level, plumb and true to line and location. Adjust and reinforce attachment substrate for proper installation and operation.
   1. Gaskets: install jamb-applied gaskets before closers, overhead stops, rim strikes, etc. Install sweeps across bottoms of doors before astragals, cope sweeps around bottom pivots, trim astragals to tops of sweeps.
   2. When hardware is to be attached to existing metal surface and insufficient reinforcement exists, use RivNuts, NutSerts or similar anchoring device for screws.
   B. Locate floor stops not more than 4 inches from the wall.
   C. Drill pilot holes for fasteners in wood doors and/or frames.
   D. Lubricate and adjust existing hardware scheduled to remain. Carefully remove and give to Owner items not scheduled for reuse.

3.04 ADJUSTING
   A. Adjust and check for proper operation and function. Replace units, which cannot be adjusted to operate freely and smoothly.
   1. Hardware damaged by improper installation or adjustment methods to be repaired or replaced to Owner’s satisfaction.
   B. Inspection: Use hardware supplier. Include suppliers with closeout documents.
   C. Follow-up inspection: Installer to provide letter of agreement to Owner that approximately 6 months after substantial completion, installer will visit Project with representatives of the manufacturers of the locking devices and door closers to accomplish following:
      1. Re-adjust hardware.
      2. Evaluate maintenance procedures and recommend changes or additions, and instruct Owner’s personnel.
      3. Identify items that have deteriorated or failed.

3.05 DEMONSTRATION:
   A. Demonstrate electrical, electronic and pneumatic hardware systems, including adjustment and maintenance procedures.

3.06 PROTECTION/CLEANING:
   A. Cover installed hardware, protect from paint, cleaning agents, weathering, carts/barrows, etc. Remove covering materials and clean hardware just prior to substantial completion.
   B. Clean adjacent wall, frame and door surfaces soiled from installation/reinstallation process.

3.07 SCHEDULE OF FINISH HARDWARE
   A. See door schedule in drawings for hardware set assignments.

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**DOOR HARDWARE SCHEDULE**

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DOOR HARDWARE SCHEDULE

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*WEATHERSTRIP BY DOOR/FRAME MANUFACTURER*

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*AUTO OPERATOR AND POWER SUPPLY REQUIRE 110VAC. MOUNT OPERATOR BUTTONS WITHIN 5 FEET OF DOOR*

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**UNIVERSITY OF OREGON ERB MEMORIAL UNION**

**PROJECT NO. 11045**

**CRAFT CENTER – PACKAGE 1**

**2013.12.20**

**SECTION 08 71 00**

**DOOR HARDWARE SCHEDULE**

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**ACCESS CONTROL - WORK OF DIVISION 28**

**POWER SUPPLY BY OTHERS**

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### HW SET: 16

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**ACCESS CONTROL - WORK OF DIVISION 28**

**POWER SUPPLY BY OTHERS**

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**SERA Architects Inc.**

Package 1 – PERMIT / CONSTRUCTION

**NOTICE OF ALTERNATE BILLING CYCLE:** The Contract will allow the Owner to require the submission of billings or estimates in billing cycles other than 30-day cycles. Billing or statements shall be submitted monthly ending on the last day of the month.

**NOTICE OF EXTENDED CERTIFICATION PROVISION:** The Contract will allow the Owner to certify billings and estimate within 20 days after the billings and estimates are received from the original contractor.

**NOTICE OF EXTENDED PAYMENT PROVISION:** The Contract will allow the Owner to make payment within 30 days after the date a billing or estimate is received.
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Glass.
   B. Glazing compounds and accessories.

1.02 DEFINITIONS
   A. ASHRAE NFRC 2001 Terms and abbreviations:
      1. U-Value = U-Factor, winter.
      2. VTL = Visible Light Transmittance.
      3. SHGC = Solar Heat Gain Coefficient.
   B. Safety Glazing: Laminated glass complying with ASTM C 1172, and testing requirements of 16 CFR 1201, Category II or tempered glass complying with ASTM C 1048, and testing requirements of CPSC 16 CFR 1201.
   C. Glazing conditions requiring safety glazing by code or local authority having jurisdiction.

1.03 PERFORMANCE REQUIREMENTS
   A. Provide glass and glazing materials for continuity of building enclosure vapor retarder and air barrier:
      1. In conjunction with vapor retarder and joint sealer materials described in other sections.
      2. To maintain a continuous air barrier and vapor retarder throughout the glazed assembly from glass pane to heel bead of glazing sealant.
   B. Select type and thickness of all glass and glass units to withstand dead loads and wind loads acting normal to plane of glass at design pressures calculated in accordance with building code.
      1. Use the procedure specified in ASTM E 1300 to determine glass type and thickness.
      2. Limit center-of-glass deflection to the smallest of the following:
         a. The displacement associated with the structural capacity of the glazing unit.
         b. L/100, where L is the shortest side dimension of the unit measured in inches.
         c. 3/4 inch.
      3. Thermal Loading: Design glass to resist thermal loads at service including those induced by differential shading within individual lites.
   C. Safety Glazing: Provide safety glazing of type indicated at glazing conditions where shown and where additionally required by authorities having jurisdiction.
   D. Heat Strengthening and Tempering: Flatness for 6mm glass panels shall not exceed 0.0030 inches for localized deformation.

1.04 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data on Glass Types: Provide structural, physical and environmental characteristics, size limitations, special handling or installation requirements.
   C. Product Data on Glazing Compounds: Provide chemical, functional, and environmental characteristics, limitations, special application requirements. Identify available colors of exposed materials for selection by Architect.
   D. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.
      1. Delegated Design Data: See Section 01 33 16.
   E. Samples: Submit two samples 12 by 12 inch in size of glass and plastic units, showing coloration and design.
F. Samples: Submit 8 inch long bead of glazing sealant, selected or available color.
G. Manufacturer’s Certificates: Certify that products meet or exceed specified requirements.
H. Installer’s Qualifications.
I. Sample Warranties.

1.05 QUALITY ASSURANCE
B. Safety Glazing Labeling: Where safety glazing labeling is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer’s name, type of glass, thickness, and safety glazing standard with which glass complies.
C. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.
D. Source Limitations for Glass: Obtain ultraclear float glass tinted float glass coated float glass laminated glass and insulating glass from single source from single manufacturer for each glass type.
E. IGU Fabricator: Company whose location, equipment, and processes are certified by the coated glass manufacturer.
F. Installer Qualifications: Company specializing in performing the work of this section with minimum 10 years documented experience.
   1. A qualified installer who employs glass installers for this Project who are certified under the National Glass Association’s Certified Glass Installer Program.

1.06 MOCK-UP
A. See Section 01 40 00 - Quality Requirements, for additional mock-up requirements.
B. Provide mockup of glazing system including glass and air barrier and vapor retarder seal.
C. Locate where directed.
D. Mockup may remain as part of the Work.

1.07 PRE-INSTALLATION MEETING
A. Convene meeting prior to fabrication of glazing units and coordinate with meetings for glazing framing systems work.

1.08 FIELD CONDITIONS
A. Do not install glazing when ambient temperature is less than 50 degrees F.
B. Maintain minimum ambient temperature before, during and 24 hours after installation of glazing compounds.

1.09 WARRANTY
A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
B. Sealed Insulating Glass Units: Provide a ten (10) year warranty to include coverage for seal failure, interpane dusting or misting, deterioration of coatings(s); and to provide for replacement of failed units. Deterioration of coated glass is defined as peeling, cracking, or related defects developed from normal use that are not associated with breakage or with actions in violation of written guidance from the manufacturer. Warranty to cover all costs associated with full replacement of failed units.
C. Laminated Glass Units: Provide manufacturer’s standard form in which laminated-glass manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that
are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by ASTM C 1172 Standard Specification for Laminated Architectural Flat Glass. Warranty to cover all costs associated with full replacement of failed units.

PART 2 PRODUCTS

2.01 GENERAL GLASS REQUIREMENTS

A. Glass Thickness: Where glass thickness is indicated, it is a minimum. Provide glass lites in thicknesses as needed to comply with requirements indicated.
   1. Minimum Glass Thickness for Exterior Lites: Not less than [6.0] mm.
   2. Thickness of Tinted Glass: Provide same thickness for each tint color indicated throughout Project.

B. Strength: Where float glass is indicated, provide annealed float glass, Kind HS heat-treated float glass, or Kind FT heat-treated float glass as needed to comply with "Performance Requirements" Article. Where heat-strengthened glass is indicated, provide Kind HS heat-treated float glass or Kind FT heat-treated float glass as needed to comply with "Performance Requirements" Article. Where fully tempered glass is indicated, provide Kind FT heat-treated float glass.

C. Exposed Edges of Glass: Ground and polished.

D. IGU Performance Properties:
   1. U-Factors (Winter): Center-of-glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. x h x deg F.
      a. IGU must meet minimum code requirements for U-Value of 0.30.
   2. Solar Heat-Gain Coefficient (SHGC), Visible Light Transmittance (VLT), and Ultraviolet Transmittance (UVT): Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.
      a. IGU must meet minimum code requirements for SHGC of 0.40.
   3. Visible Light Reflectance: Center-of-glazing values, according to NFRC 300.
   4. Sound Transmission Class, STC, when tested per ASTM E 90.
   5. Assure that edge seal is compatible with glazing system.

2.02 GLASS MATERIALS

A. Float Glass: ASTM C1036, Type I, transparent flat, Class 1 clear, Quality Q3 (glazing select), unless otherwise indicated.
   1. Float Glass Manufacturers:
      e. Substitutions: Refer to Section 01 60 00 - Product Requirements.

B. Heat-Strengthened and Fully Tempered Float Glass: ASTM C 1048; Type I; Quality-Q3; of class, kind and condition indicated; horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed.
   1. Maximum roll wave distortion from top to bottom of wave as measured using calibrated industry accepted equipment: 0.005 inch.
   2. Structurally Butt Glazed Glass: Delegated design for thickness and span, and bright flat polished edges joined verticall with silicone sealant, and at perimeter, stopped into hollow metal frame.
      a. Operational Loads: Designed to withstand imposed human impact pressure under normal traffic without damage, racking, sagging, or deflection.
C. Uncoated Tinted Float Glass: Class 2, complying with other requirements specified, manufacturer, product, and color as scheduled.

2.03 LAMINATED GLASS UNITS
A. Laminated Glass: Float glass, heat strengthened float glass, or fully tempered float glass laminated in accordance with ASTM C1172. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.
   1. Laminated Safety Glass: Comply with 16 CFR 1201 test requirements for Category II.
   2. Plastic Interlayer: Polyvinyl butyral, 0.030 inch thick, unless otherwise indicated, or required by performance requirements.
   3. Where fully tempered is specified or required, provide glass that has been tempered by the tong-less horizontal method.

2.04 SEALED INSULATING GLASS UNITS
A. Fabricator/Manufacturers: Certified by coated glass manufacturer.
B. Sealed Insulating Glass Units: Types as indicated.
   1. Durability: Certified by an independent testing agency to comply with ASTM E2190.
   2. Edge Spacers: Aluminum, clear anodized finish, bent and soldered corners.
   3. Edge Seal: Glass to elastomer with supplementary silicone sealant.
   4. Purge interpane space with dry hermetic air.
   5. Glass: Comply with applicable requirements in "Glass Products" Article as indicated by designations in "Insulating-Glass Types" Article.

2.05 GLAZING COMPOUNDS
A. Manufacturers:
   5. Substitutions: Refer to Section 01 60 00 - Product Requirements.
B. Butyl Sealant: Single component; ASTM C 920, Grade NS, Class 12-1/2, Uses M and A; Shore A hardness of 10 to 20; black color; non-skinning.
C. Silicone Sealant: Single component; neutral curing; capable of water immersion without loss of properties; non-bleeding, non-staining; ASTM C 920, Type S, Grade NS, Class 100/50 selected color.

2.06 GLAZING ACCESSORIES
A. Setting Blocks: EPDM, 80 to 90 Shore A durometer hardness, ASTM C 864 Option I. Length of 0.1 inch for each square foot of glazing or minimum 4 inch x width of glazing rabbet space minus 1/16 inch x height to suit glazing method and pane weight and area.
B. Spacer Shims: EPDM, 50 to 60 Shore A durometer hardness, ASTM C 864 Option I. Minimum 3 inch long x one half the height of the glazing stop x thickness to suit application, self adhesive on one face.
C. Glazing Tape: Preformed butyl compound with integral resilient tube spacing device; 10 to 15 Shore A durometer hardness; coiled on release paper; black color.
   1. Manufacturers:
      c. Substitutions: Refer to Section 01 60 00 - Product Requirements.
D. Glazing Gaskets: Resilient silicone extruded shape to suit glazing channel retaining slot; ASTM C 864 Option I; selected color.
E. Glazing Clips: Manufacturer's standard type.

2.07 LAMINATED GLASS TYPES

A. Glass Type LG#1: Clear laminated glass.
   1. Outer and Inner Ply: 3-mm heat strengthened float glass.
   2. Unit Thickness: 6.0 mm.
   3. Interlayer Thickness: 0.030- inch.
   4. Provide safety glazing labeling.

B. Glass Type LG#2: Clear laminated glass.
   1. Outer Ply: 3-mm fully-tempered coated float glass.
      a. Coating: Scratch resistant coating on No. 1 surface.
   2. Inner Ply: 3-mm fully-tempered coated float glass.
      a. Coating: Scratch resistant coating on No. 4 surface.
   3. Unit Thickness: 6.0 mm.
   4. Interlayer Thickness: 0.030- inch.
   5. Provide safety glazing labeling.
   6. Application: Entry doors and as indicated.

2.08 INSULATED GLASS UNIT TYPES

A. Glass Type IGU#1: High-performance, low-e-coated, solar control clear insulating glass.
   1. Overall Unit Thickness: 1 inch (25 mm).
   2. Thickness of Each Glass Lite: 1/4 inch (6.0 mm).
   3. Outdoor Lite: Float glass, except heat-strengthened float glass where required, and fully tempered float glass where required or as indicated.
      a. Low-E Coating: Sputtered on second surface.
   4. Interspace Content: Air.
   5. Indoor Lite: Float glass, except heat-strengthened float glass where required, and fully tempered float glass where indicated.
   6. Visible Light Transmittance: 60 to 65 percent.
   7. Winter Nighttime U-Factor: 0.30 maximum.
   8. Solar Heat Gain Coefficient: 0.27 to 0.30.
   9. Provide safety glazing labeling where required.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that openings for glazing are correctly sized and within tolerance.

B. Verify that surfaces of glazing channels or recesses are clean, free of obstructions that may impede moisture movement, weeps are clear, and ready to receive glazing.

3.02 PREPARATION

A. Clean contact surfaces with solvent and wipe dry.

B. Prime surfaces scheduled to receive sealant.

C. Install sealants in accordance with ASTM C1193 and GANA Sealant Manual.

D. Install sealant in accordance with manufacturer's instructions.

3.03 INSTALLATION - EXTERIOR DRY METHOD (GASKET GLAZING)

A. Place setting blocks at 1/4 points with edge block no more than 6 inches from corners.

B. Rest glazing on setting blocks and push against fixed stop with sufficient pressure on gasket to attain full contact.

C. Install removable stops without displacing glazing gasket; exert pressure for full continuous contact.
3.04 INSTALLATION - INTERIOR BUTT GLAZED METHOD (SEALANT ONLY)

A. Provide glass edge with flat polish to remove sharp corners and prepare for proper sealant adhesion.
B. Temporarily brace glass in position for duration of glazing process. Mask edges of glass at adjoining glass edges and between glass edges and framing members.
C. Temporarily secure a small diameter non-adhering foamed rod on back side of joint.
D. Apply sealant to open side of joint in continuous operation; thoroughly fill the joint without displacing the foam rod. Tool the sealant surface smooth to concave profile.
E. Permit sealant to cure then remove foam backer rod. Apply sealant to opposite side, tool smooth to concave profile.
F. Remove masking tape.

3.05 INSTALLATION - INTERIOR DRY METHOD (TAPE AND TAPE)

A. Cut glazing tape to length and set against permanent stops, projecting 1/16 inch (1.6 mm) above sight line.
B. Place setting blocks at 1/4 points with edge block no more than 6 inches from corners.
C. Rest glazing on setting blocks and push against tape for full contact at perimeter of pane or unit.
D. Place glazing tape on free perimeter of glazing in same manner described above.
E. Install removable stop without displacement of tape. Exert pressure on tape for full continuous contact.
F. Knife trim protruding tape.

3.06 INSTALLATION - INTERIOR WET/DRY METHOD (TAPE AND SEALANT)

A. Cut glazing tape to length and install against permanent stops, projecting 1/16 inch (1.6 mm) above sight line.
B. Place setting blocks at 1/4 points with edge block no more than 6 inches from corners.
C. Rest glazing on setting blocks and push against tape to ensure full contact at perimeter of pane or unit.
D. Install removable stops, spacer shims inserted between glazing and applied stops at 24 inch intervals, 1/4 inch below sight line.
E. Fill gaps between pane and applied stop with clear silicone type sealant to depth equal to bite on glazing, to uniform and level line.
F. Trim protruding tape edge.

3.07 MANUFACTURER'S FIELD SERVICES

A. Glass and Glazing product manufacturers to provide field surveillance of the installation of their products.
B. Monitor and report installation procedures and unacceptable conditions.

3.08 CLEANING

A. Remove glazing materials from finish surfaces.
B. Remove labels after Work is complete.
C. Clean glass and adjacent surfaces.
D. Smoke Removal Targets: Install in accordance with approved shop drawings and direction of authorities having jurisdiction.
3.09 PROTECTION

A. After installation, mark pane with an 'X' by using removable plastic tape or paste; do not mark heat absorbing or reflective glass units.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Louvers, frames, and accessories.

1.02 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide data describing design characteristics, maximum recommended airflow velocity, design free area, materials and finishes.
   C. Shop Drawings: Indicate louver layout plan and elevations, opening and clearance dimensions, tolerances; head, jamb and sill details; blade configuration, screens, blankout areas required, and frames.
   D. Samples: Submit two samples 2 by 2 inches in size illustrating finish and color of exterior and interior surfaces.
   E. LEED Submittals: Complete LEED Checklist and Tracking Form, Section 01 33 00, and other data for the following LEED Credits. Requirements and definitions are located in Section 01 35 15 and Section 01 60 00.
      2. Credit MR 5: List products that are extracted, harvested or recovered as well as manufactured within 500 straight-line miles of Project Site, or percent of regional material by weight. Include address and distance of material source and product manufacture. Product cost data.
      3. Credit EQ 4.1: Manufacturers’ product data for adhesives and sealants, including printed statement of VOC content.
   F. Test Reports: Independent agency reports showing compliance with specified performance criteria.
   G. Manufacturer’s Certificate: Certify that products meet or exceed specified requirements.

1.03 QUALITY ASSURANCE
   A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with minimum 3 years of documented experience.

1.04 WARRANTY
   A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
   B. Provide twenty year manufacturer warranty against distortion, metal degradation, and failure of connections.
      1. Finish: Include coverage against degradation of exterior finish.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. Wall Louvers:
      5. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 LOUVERS
   A. Louvers: Factory fabricated and assembled, complete with frame, mullions, and accessories; AMCA Certified under AMCA 511.
1. Wind Load Resistance: Design to resist positive and negative wind load of 25 psf without damage or permanent deformation.
2. Intake Louvers: Design to allow maximum of 0.01 oz/sq ft water penetration at calculated intake design velocity based on design air flow and actual free area, when tested in accordance with AMCA 500-L.
3. Drainable Blades: Continuous rain stop at front or rear of blade aligned with vertical gutter recessed into both jambs of frame.
4. Screens: Provide insect screens at intake louvers and bird screens at exhaust louvers.

B. Stationary Louvers: Horizontal blade, extruded aluminum construction, with intermediate mullions matching frame.
   1. Free Area: 50 percent, minimum.
   2. Blades: Drainable.
   3. Frame: 4 inches deep, channel profile; corner joints mitered and, with continuous recessed caulking channel each side.
   4. Metal Thickness: Frame 0.081 inch; blades 0.081 inch.
   5. Finish: Polyvinylidene fluoride coating; finish welded units after fabrication.
   6. Color: Custom, to match approved sample.

2.03 MATERIALS
B. Bird Screen: Interwoven wire mesh of steel, 0.063 inch diameter wire, 1/2 inch open weave, diagonal design.
C. Insect Screen: 18 x 16 size aluminum mesh.
D. Polyvinylidene Fluoride Coating: Minimum 70 percent Kynar 500/Hylar 500 resin, two coat finish, complying with AAMA 2605.

2.04 ACCESSORIES
A. Blank-Off Panels: Same material as louver, painted black on exterior side; provide where duct connected to louver is smaller than louver frame, sealing off louver area outside duct.
B. Screens: Frame of same material as louver, with reinforced corners; removable, screw attached; installed on inside face of louver frame.
C. Fasteners and Anchors: Stainless steel.
D. Flashings: Of same material as louver frame, formed to required shape, single length in one piece per location.
E. Sealant: Exterior building joint type, as specified in Section 07 90 05.

PART 3 EXECUTION
3.01 EXAMINATION
A. Verify that prepared openings and flashings are ready to receive work and opening dimensions are as indicated on shop drawings.

3.02 INSTALLATION
A. Install louver assembly in accordance with manufacturer's instructions.
B. Install louvers level and plumb.
C. Install flashings and align louver assembly to ensure moisture shed from flashings and diversion of moisture to exterior.
D. Secure louver frames in openings with concealed fasteners.
E. Install perimeter sealant and backing rod in accordance with Section 07 90 05.
3.03 CLEANING
   A. Strip protective finish coverings.
   B. Clean surfaces and components.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Performance criteria for gypsum board assemblies.
B. Delegated design metal framing for interior partitions, ceilings and soffits.
C. Resilient sound isolation components.
D. Metal channel ceiling framing.
E. Acoustic insulation.
F. Gypsum wallboard.
G. Joint treatment and accessories.

1.02 DEFINITIONS

A. Wet Areas: Toilet room, bath room, shower, janitor closet, laundry room, walls within indicated distance behind or adjacent to a sink, trash room, recycle room, and exterior; see construction assemblies on drawings for diagrams indicating distances.
B. Steel Thickness: Minimum base metal thickness per SSMA.

1.03 SYSTEM DESCRIPTION

A. Acoustic Attenuation for Interior Partitions Indicated as Acoustic: STC of value indicated in Drawings calculated in accordance with ASTM E 413, based on tests conducted in accordance with ASTM E 90.
B. Imposed Loads:

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Shop Drawings: Indicate special details associated with fireproofing and acoustic seals.
C. Product Data: Provide data on metal framing, gypsum board, glass mat faced gypsum board, accessories, and joint finishing system.
D. Product Data: Provide manufacturer's data on partition head to structure connectors, showing compliance with requirements.
E. Samples: Submit two samples of predecorated gypsum board, 12 by 12 inches in size, illustrating finish color and texture.
F. Samples: Submit two samples of gypsum board finished with proposed texture application, 12 by 12 inches in size, illustrating finish color and texture.

1.05 QUALITY ASSURANCE

A. Perform in accordance with ASTM C 754, ASTM C 840. Comply with requirements of GA-600 for fire-rated assemblies. Comply with more stringent recommendations of Northwest Wall and Ceiling Bureau (NWCB).
   1. Maintain one copy of standards at project site.
B. Provide acoustically rated assemblies in compliance with listings for ratings indicated.
C. Installer Qualifications: Company specializing in performing gypsum board application and finishing, with minimum 5 years of documented experience.
D. Copies of Documents at Site: Maintain at the project site a copy of each referenced document that prescribes execution requirements.

1.06 REGULATORY REQUIREMENTS

A. Conform to applicable code for fire rated assemblies as indicated on drawings.
B. Brace and restrain ceilings as required by building code and AHJ.
PART 2 PRODUCTS

2.01 GYPSUM BOARD ASSEMBLIES

A. Provide completed assemblies complying with ASTM C840 and GA-216.
   1. See PART 3 for finishing requirements.

B. Interior Partitions General: Interior partitions must continue and completely close to underside of structure as opposed to stopping at ceiling height.

C. Interior Partitions Indicated as Acoustic: Provide completed assemblies with the following characteristics:
   1. Acoustic Attenuation: STC of 45-49 calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90.

D. Shaft Walls at HVAC Shafts: Provide completed assemblies with the following characteristics:
   1. Air Pressure Within Shaft: Sustained loads of 5 lbf/sq ft with maximum mid-span deflection of L/240.
   2. Acoustic Attenuation: STC of 35-39 calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90.

2.02 METAL FRAMING MATERIALS

A. Manufacturers - Metal Framing, Connectors, and Accessories: Member of SSMA or GA. Subject to compliance with requirements, provide cold-formed metal framing by one of the following:
   5. Scafco Corporation: www.scafco.com
   8. Substitutions: See Section 01 60 00 - Product Requirements.

B. Interior Non-Loadbearing Framing System Components: ASTM C 645; galvanized sheet steel, of size and properties necessary to comply with ASTM C 754 for the spacing indicated, with maximum deflection of wall framing of L/240 at 5 psf, except L/360 at 5 psf for ceramic tile and L/720 at 5 psf for stone tile or stone veneer.
   1. Studs: "C" shaped with flat or formed webs with knurled faces.
   2. Runners: U shaped, sized to match studs.
   3. Ceiling Channels: C shaped.
   4. Furring: Hat-shaped sections, minimum depth of 7/8 inch or as indicated.
   5. Resilient Furring Channels: 1/2 inch depth, for attachment to substrate through one leg only.
      a. Manufacturers - Resilient Furring Channels:
         1) Same manufacturer as other framing materials.
      6. Resilient Channel: Assymetric-shaped channel with face connected to single flange by single leg with alternating slots, 1/2 inch deep.

C. Exterior Non-Loadbearing Studs and Furring for Application of Gypsum Board: As specified in Section 09 22 16.

D. Loadbearing Studs for Application of Gypsum Board: As specified in Section 05 40 00.

E. Ceiling Hangers: Type and size as specified in ASTM C754 for spacing required.

F. Partition Head To Structure Connections: Provide track fastened to structure with legs of sufficient length to accommodate deflection, for friction fit of studs cut short and screwed to secondary deflection channel set inside but unattached to top track.
G. Partition Head to Structure Connections: Provide mechanical anchorage devices that accommodate deflection using slotted holes, screws and anti-friction bushings, preventing rotation of studs while maintaining structural performance of partition.

1. Structural Performance: Maintain lateral load resistance and vertical movement capacity required by applicable code, when evaluated in accordance with AISI North American Specification for the Design of Cold-Formed Steel Structural Members.


3. Deflection and Firestop Track:
   a. Provide mechanical anchorage devices as described above that accommodate deflection while maintaining the fire-rating of the wall assembly.
   b. Acceptable Products:
      1) “Posi Clip” by Fire Trak Corporation.
      2) “The System” by Metal-Lite, Inc.

4. Provide top track preassembled with connection devices spaced to fit stud spacing indicated on drawings; minimum track length of 12 feet.

2.03 BOARD MATERIALS

A. Manufacturers - Gypsum-Based Board:
   10. Substitutions: See Section 01 60 00 - Product Requirements.

B. Gypsum Wallboard: Paper-faced gypsum panels as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
   1. Application: Use for vertical surfaces and ceilings, unless otherwise indicated.
   2. Glass-mat-faced gypsum panels as defined in ASTM C1658/C1658M, suitable for paint finish, of the same core type and thickness may be substituted for paper-faced board.
   3. Unfaced fiber-reinforced gypsum panels as defined in ASTM C1278/C1278M, suitable for paint finish, of the same core type and thickness may be substituted for paper-faced board.
   4. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
      a. Mold-resistant board is required whenever board is being installed before the building is enclosed and conditioned.
      b. Mold-resistant board is required at all locations.
      c. Mold-resistant board is required __________.
   5. At Assemblies Indicated with Fire-Rating: Use type required by indicated tested assembly; if no tested assembly is indicated, use Type X board, UL or WH listed.
   6. Thickness:
      c. Where indicated on Drawings: 1/4 inch.
      d. Multi-Layer Assemblies: Thicknesses as indicated on drawings.
   7. Paper-Faced Products:
      a. American Gypsum; EagleRoc Regular Gypsum Wallboard and FireBloc Type X Gypsum Wallboard.
b. CertainTeed Corporation; ProRoc Brand Gypsum Board.
c. CertainTeed Corporation; ProRoc Brand Abuse Resistant Gypsum Board.
e. Lafarge North America Inc; Regular Drywall and Firecheck Type X and Type C.
g. Pacific Coast Building Products, Inc; PABCO Regular Gypsum Wallboard and PABCO Flame Curb.
h. Temple-Inland Building Product by Georgia-Pacific, LLC; Gypsumboard and Gypsum Board Fire Resistant Panels Type X and Type TGC.
i. USG Corporation; Sheetrock Brand Gypsum Panels.
j. Substitutions: See Section 01 60 00 - Product Requirements.

8. Mold-Resistant Paper-Faced Products:
   a. American Gypsum; M-Bloc.
   b. CertainTeed Corporation; ProRoc Brand Moisture & Mold Resistant Gypsum Board.
   c. Lafarge North America Inc; Mold Defense Drywall.
   d. Lafarge North America Inc; Protecta AR 100 Type X with Mold Defense.
   e. National Gypsum Company; Gold Bond Brand XP Gypsum Board.
   f. National Gypsum Company; Gold Bond Hi-Abuse Brand XP Wallboard.
   g. Pacific Coast Building Products, Inc; PABCO Mold Curb Gypsum Wallboard.
   h. Temple-Inland Building Product by Georgia-Pacific, LLC; ComfortGuard Mold Resistant Gypsum Board.
   i. USG Corporation; Sheetrock Brand Mold Tough Gypsum Panels.
   j. USG Corporation; Sheetrock Brand Mold Tough Gypsum Panels AR.
   k. 
   l. Substitutions: See Section 01 60 00 - Product Requirements.

9. Glass-Mat-Faced Products:
   a. Georgia-Pacific Gypsum; DensArmor Plus.
   b. Georgia-Pacific Gypsum LLC; DensArmor Plus Abuse Guard.
   c. Substitutions: See Section 01 60 00 - Product Requirements.

10. Unfaced Products:
    a. USG Corporation; Fiberock Aqua-Tough Interior Panels.
    b. USG Corporation; Fiberock Brand Panels--Abuse-Resistant.
    c. Substitutions: See Section 01 60 00 - Product Requirements.

C. Impact-Rated Wallboard: Tested to Level 3 soft-body and hard-body impact in accordance with ASTM C1629.
   1. Application: High-traffic areas indicated.
   2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
   3. Paper-Faced Type: Gypsum wallboard as defined in ASTM C1396/C1396M.
   4. Unfaced Type: Interior fiber-reinforced gypsum panels as defined in ASTM C1278/C1278M.
   5. Type: Fire-resistance rated Type X, UL or WH listed.
   8. Products:
      b. USG Corporation; Fiberock Brand Panels--VHI Abuse-Resistant.
      c. Substitutions: See Section 01 60 00 - Product Requirements.

D. Backing Board For Wet Areas: One of the following products:
   1. Application: Surfaces behind tile, wet areas as defined, and including tub and shower surrounds, shower ceilings, kitchen area, and mop sink.
2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.

3. ANSI Cement-Based Board: Non-gypsum-based; aggregated Portland cement panels with glass fiber mesh embedded in front and back surfaces complying with ANSI A118.9 or ASTM C1325.
   a. Thickness: 1/2 inch.
   b. Products:
      1) Custom Building Products; Wonderboard.
      2) National Gypsum Company; PermaBase Brand Cement Board.
      3) National Gypsum Company; PermaBase Flex Brand Cement Board.
      4) USG Corporation; Durock Brand Cement Board.
      5) Substitutions: See Section 01 60 00 - Product Requirements.

4. ASTM Cement-Based Board: Non-gypsum-based, cementitious board complying with ASTM C1288.
   a. Thickness: 1/2 inch.
   b. Products:
      1) James Hardie Building Products, Inc; Hardibacker Cement Board.
      2) Substitutions: See Section 01 60 00 - Product Requirements.

5. Glass-Mat-Faced Board: Coated glass mat water-resistant gypsum backing panel as defined in ASTM C1178.
   a. Standard Type: Thickness 1/2 inch.
   b. Fire-Resistant Type: Type X core, thickness 5/8 inch.
   c. Products:
      1) Georgia-Pacific Gypsum; DensShield Tile Backer.
      2) National Gypsum Company; Gold Bond eXP Tile Backer.
      3) Temple-Inland Building Product by Georgia-Pacific, LLC; GreenGlass Tile Backer.
      4) Substitutions: See Section 01 60 00 - Product Requirements.

E. Backing Board For Non-Wet Areas: Water-resistant gypsum backing board as defined in ASTM C1396/C1396M; sizes to minimum joints in place; ends square cut.
   1. Application: Vertical surfaces behind thinset tile, except in wet areas.
   2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
   3. Type: Regular and Type X, in locations indicated.
   4. Type X Thickness: 5/8 inch.
   5. Type C Thickness: 1/2 inch.
   6. Regular Board Thickness: 1/2 inch.
   8. Products:
      a. American Gypsum; AquaBloc ("Greenboard").
      b. American Gypsum; M-Bloc.
      c. CertainTeed Corporation; ProRoc Brand Moisture Resistant Gypsum Board ("Greenboard").
      d. CertainTeed Corporation; ProRoc Brand Moisture & Mold Resistant Gypsum Board.
      e. Georgia-Pacific Gypsum; ToughRock Mold-Guard Gypsum Board ("Greenboard").
      f. Georgia-Pacific Gypsum; DensShield Tile Backer.
      g. Lafarge North America Inc; Watercheck ("Greenboard").
      h. Lafarge North America Inc; Mold Defense Drywall.
      i. National Gypsum Company; Gold Bond Brand XP Gypsum Board.
      j. Pacific Coast Building Products, Inc; PABCO Water Curb ("Greenboard").
      k. Pacific Coast Building Products, Inc; PABCO Mold Curb Gypsum Wallboard.
      l. Temple-Inland Building Product by Georgia-Pacific, LLC; Water-Resistant Gypsum Board ("Greenboard").
m. Temple-Inland Building Product by Georgia-Pacific, LLC; ComfortGuard WR.
 n. USG Corporation; Sheetrock Brand Mold Tough Gypsum Panels.
o. Substitutions: See Section 01 60 00 - Product Requirements.

F. Ceiling Board: Special sag-resistant gypsum ceiling board as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
   1. Application: Ceilings, unless otherwise indicated.
   2. Thickness: 1/2 inch.
   4. Products:
      a. American Gypsum; Interior Ceiling Board.
      b. CertainTeed Corporation; ProRoc Interior Ceiling.
      c. Georgia-Pacific Gypsum; ToughRock CD Ceiling Board.
      d. Lafarge North America Inc; Sagcheck.
      e. National Gypsum Company; High Strength Brand Ceiling Board.
      f. Pacific Coast Building Products, Inc; PABCO Ceiling Board.
      g. Temple-Inland Building Products by Georgia-Pacific, LLC; Span24 Ceiling Board.
      h. USG Corporation; Sheetrock Brand Sag-Resistant Interior Gypsum Ceiling Board.
i. Substitutions: See Section 01 60 00 - Product Requirements.

2.04 ACCESSORIES
A. Acoustic Insulation: ASTM C665; preformed glass fiber, friction fit type, unfaced. Thickness: 3-1/2 inches.
   1. Green Guard label, and without formaldehyde.
B. Acoustic Sealant: As specified in Section 07 90 05.
C. Finishing Accessories: ASTM C1047, galvanized steel or rolled zinc, unless otherwise indicated.
   1. Types: As detailed or required for finished appearance.
   2. Special Shapes: In addition to conventional cornerbead and control joints, provide U-bead at exposed panel edges.
   3. Manufacturers - Finishing Accessories:
      a. Same manufacturer as framing materials.
      c. Substitutions: See Section 01 60 00 - Product Requirements.
D. Joint Materials: ASTM C475 and as recommended by gypsum board manufacturer for project conditions.
   1. Tape: 2 inch wide, creased paper tape for joints and corners, except as otherwise indicated.
   3. Chemical hardening type compound at wet areas.
E. Gypsum board reveal molding: Fry Reglet DRM-625-50
   1. 5/8 inch by ½ inch reveal
   2. Aluminum shall be extruded alloy 6063 T5, with chemical conversion coating
   3. Clear anodized finish
F. Screws for Attachment to Steel Members Less Than 0.03 inch In Thickness, to Wood Members, and to Gypsum Board: ASTM C1002; self-piercing tapping type; cadmium-plated for exterior locations.
G. Screws for Attachment to Steel Members From 0.033 to 0.112 Inch in Thickness: ASTM C954; steel drill screws for application of gypsum board to loadbearing steel studs.
H. Screws: ASTM C 1002; self-piercing tapping type, anticorrosive-coated at wet areas.
I. Screws: ASTM C 954; steel drill screws for application of gypsum board to 40 mil and greater steel studs, anticorrosive-coated.


K. Staples For Attachment of Base Ply of Two-Ply Assembly to Wood Members: Flattened galvanized wire type as specified in ASTM C840.

L. Anchorage to Substrate: Tie wire, nails, screws, and other metal supports, of type and size to suit application; to rigidly secure materials in place.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that project conditions are appropriate for work of this section to commence.

3.02 FRAMING INSTALLATION

A. Metal Framing: Install in accordance with ASTM C754 and manufacturer's instructions.

B. Suspended Ceilings and Soffits: Space framing and furring members as indicated.
   1. Level ceiling system to a tolerance of 1/1200.
   2. Laterally brace and vertically constrain entire suspension system.
   3. Install bracing as required at exterior locations to resist wind uplift.

C. Studs: Space studs at 16 inches on center, unless indicated otherwise.
   1. Extend partition framing to structure where indicated and to ceiling in other locations.
   2. Partitions Terminating at Ceiling: Attach ceiling runner securely to ceiling track in accordance with manufacturer's instructions.
   3. Partitions Terminating at Structure: Attach extended leg top runner to structure, maintain clearance between top of studs and structure, and brace both flanges of studs with continuous bridging.
   4. Partitions Terminating at Structure: Attach top runner to structure, maintain clearance between top of studs and structure, and connect studs to track using specified mechanical devices in accordance with manufacturer's instructions; verify free movement of top of stud connections; do not leave studs unattached to track.
   5. Provide not less than 43 mil thick studs supporting wall cabinets and similar high wall loads. Refer to casework specification for design load.
   6. Provide not less than 54 mil thick studs supporting plumbing fixtures, counter tops and similar low wall-hanging loads. In addition to dead load, support 300 pound live load located anywhere on supported item.

D. Openings: Reinforce openings as required for weight of doors or operable panels, using not less than double 33 mil studs at jamb.

E. Standard Wall Furring: Install at concrete walls scheduled to receive gypsum board, not more than 4 inches from floor and ceiling lines and abutting walls. Secure in place on alternate channel flanges at maximum 24 inches on center.
   1. Orientation: Horizontal.
   2. Spacing: As indicated.

F. Acoustic Furring: Install resilient channels at maximum 24 inches on center, unless indicated otherwise.
   1. Locate joints over framing members.
   2. Orient open leg facing up to receive gypsum board.

G. Furring for Fire Ratings: Install as required for fire resistance ratings indicated and to GA-600 requirements.

H. Blocking: Install wood blocking for support of:
   1. Framed openings.
2. Wall mounted cabinets.
3. Plumbing fixtures.
4. Toilet partitions.
5. Toilet accessories.
6. Wall-mounted door hardware.
7. Wall-mounted television.

I. Blocking: Install blocking for support of plumbing fixtures, toilet partitions, wall cabinets, wood frame openings, toilet accessories, hardware, and other items as indicated. Comply with Section 06 10 00 for wood blocking with kerf for flange return.
1. Metal Blocking (where approved): Continuous 6 inch 43 mil track with legs cut at supports.

### 3.03 ACOUSTIC ACCESSORIES INSTALLATION

A. Acoustic Insulation: Place tightly within spaces, around cut openings, behind and around electrical and mechanical items within partitions, and tight to items passing through partitions.

B. Acoustic Sealant: Install in accordance with manufacturer's instructions.
1. Place one bead continuously on substrate before installation of perimeter framing members.
2. Place continuous bead at perimeter of each layer of gypsum board.
3. In non-fire-rated construction, seal around all penetrations by conduit, pipe, ducts, and rough-in boxes.

### 3.04 BOARD AND GLASS MAT FACED BOARD INSTALLATION

A. Comply with most stringent of NWCB, ASTM C 840, GA-216, and manufacturer's instructions. Install to minimize butt end joints, especially in highly visible locations.

B. Single-Layer Non-Rated: Install gypsum board parallel to framing, with ends and edges occurring over firm bearing.
1. Exception: Tapered edges to receive joint treatment at right angles to framing.

C. Double-Layer Non-Rated: Use gypsum board for first layer, placed perpendicular to framing or furring members, with ends and edges occurring over firm bearing. Place second layer parallel to framing or furring members. Offset joints of second layer from joints of first layer.

D. Cementitious Backing Board: Install over steel framing members and plywood substrate where indicated, in accordance with ANSI A108.11 and manufacturer's instructions.

E. Installation on Metal Framing: Use screws for attachment of all gypsum board.

F. Installation on Wood Framing: For rated assemblies, comply with requirements of listing authority. For non-rated assemblies, install as follows:
2. Double-Layer Application: Install base layer using screws or nails. Install face layer using adhesive.

G. Air Barrier Seal: Continuously seal joint between gypsum board and top plate of exterior walls. Provide continuous perimeter sealant joint and sealant joint at all penetrations of uppermost ceiling. Seal other joints and gaps to assure complete and continuous air seal.
1. Refer to Section 07 27 00 for continuous air and weather barrier system.
2. Refer to building section drawings for additional information.

H. Attach gypsum board to resilient channels between framing members.

I. Moisture Protection: Treat cut edges and holes in moisture resistant gypsum board and exterior gypsum soffit board with sealant.

### 3.05 INSTALLATION OF TRIM AND ACCESSORIES

A. Control Joints: Place control joints consistent with lines of building spaces and as indicated.
1. Not more than 30 feet apart on walls and ceilings over 50 feet long.
B. Corner Beads: Install at external corners, using longest practical lengths.

C. Edge Trim: Install at locations where gypsum board abuts dissimilar materials and as indicated.

3.06 JOINT TREATMENT


B. Finish gypsum board in accordance with levels defined in ASTM C840, as follows:
   1. Level 5: Walls and ceilings to receive semi-gloss or gloss paint finish and other areas specifically indicated.
      a. All locations receiving epoxy paint.
   2. Level 2: In utility areas, behind cabinetry, and on backing board to receive tile finish.
   3. Level 0: Temporary partitions and surfaces indicated to be finished in later stage of project.

C. Finish all gypsum board in accordance with ASTM C 840/NWCB Level 4 smooth, except where level 5 is indicated.

D. Tape, fill, and sand exposed joints, edges, and corners to produce smooth surface ready to receive finishes.
   1. Feather coats of joint compound so that camber is maximum 1/32 inch.
   2. Taping, filling, and sanding is not required at surfaces behind adhesive applied ceramic tile and fixed cabinetry.
   3. Taping, filling and sanding is not required at base layer of double layer applications.

E. Where Level 5 finish is indicated, spray apply high build drywall surfacer over entire surface after joints have been properly treated; achieve a flat and tool mark-free finish.

F. Fill and finish joints and corners of cementitious backing board as recommended by manufacturer.

3.07 TOLERANCES

A. Maximum Variation of Finished Gypsum Board Surface from True Flatness: 1/8 inch in 10 feet in any direction.
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Suspended metal grid ceiling system.
   B. Acoustical units.
   C. Suspended wood components.
   D. Supplementary acoustical insulation above ceiling.

1.02 PERFORMANCE REQUIREMENTS
   A. Submit design data in compliance with Section 01 33 16 when required by AHJ.
   B. Seismic Design Requirements: Provide ceilings designed and installed to withstand the effects of earthquake motions according to the following:
      1. IBC Seismic Design Category for Project Site: D, E, or F, severe.
      2. Alternate methods approved by authority having jurisdiction (AHJ).
      3. Edge Molding Design: Face of molding less than 1 inch wide and concealed clip.
      4. Provide rigidly braced system.
   C. Fire-Test-Response Characteristics: Provide acoustical panel ceilings that comply with the following requirements:
      1. Fire-Resistance Characteristics: Where indicated, provide acoustical panel ceilings identical to those of assemblies tested for fire resistance per ASTM E 119 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
         a. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another testing and inspecting agency.
         b. Identify materials with appropriate markings of applicable testing and inspecting agency.
      2. Surface-Burning Characteristics: Provide acoustical panels with the following surface-burning characteristics complying with ASTM E 1264 for Class A materials as determined by testing identical products per ASTM E 84:
         a. Smoke-Developed Index: 450 or less.

1.03 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Shop Drawings: Indicate grid layout and related dimensioning.
   C. Product Data: Provide data on suspension system components.
   D. Samples: Submit two full size samples illustrating material and finish of acoustical units.
   E. Manufacturer's Installation Instructions: Indicate special procedures.
   F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
      1. See Section 01 60 00 - Product Requirements, for additional provisions.
      2. Extra Ceiling Materials: Quantity equivalent to 5 percent of each type and color.

1.04 FIELD CONDITIONS
   A. Maintain uniform temperature of minimum 60 degrees F, and maximum humidity of 40 percent prior to, during, and after acoustical unit installation.

1.05 PROJECT CONDITIONS
   A. Sequence work to ensure acoustical ceilings are not installed until building is enclosed, sufficient heat is provided, dust generating activities have terminated, and overhead work is completed, tested, and approved.
   B. Install acoustical units after interior wet work is dry.
PART 2 PRODUCTS

2.01 ACOUSTICAL UNITS

A. Manufacturers:
   4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Acoustical Units - General: comply with ASTM E 1264, Class A.
   1. Antimicrobial Fungicide and Bactericide Treatment: Provide acoustical panels treated with manufacturer’s standard antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D 3273 and evaluated according to ASTM D 3274 or ASTM G 21.

C. Acoustical Panels Type ACT-1: Painted mineral fiber, ASTM E 1264 Type III, with the following characteristics:
   1. Size: 24 x 24 inches.
   2. Thickness: 3/4 inches.
   3. Composition: Wet felted.
   4. Light Reflectance: 0.86 percent, determined as specified in ASTM E1264.
   5. NRC Range: 0.70 to ____, determined as specified in ASTM E1264.
   7. Edge: Beveled Tegular.
   9. Suspension System: Exposed grid Type ACT-1.

D. Wood Ceiling Cloud Type WCC-1: With the following characteristics:
   1. Species: Douglas Fir.
   2. Grade: Select, clear vertical grain.
   4. Profile: Tongue and groove.
   5. Cloud Perimeter:
      a. Species: Douglas Fir.
      b. Grade: Select, clear vertical grain.
      c. Size: 3/4 x 6 inches.
      d. Profile: Square exterior edge with tongue on interior edge to fit groove on all 3/4 x 4 cloud perimeter edges.

2.02 SUSPENSION SYSTEM(S)

A. Acoustical Ceiling Suspension System(s):
   1. Suspension Systems - General: ASTM C 635; die cut and interlocking components, with stabilizer bars, clips, splices, perimeter moldings, and hold down clips as required.
   2. Exposed Steel Suspension System Type ACT-1: Formed steel, commercial quality cold rolled; heavy-duty.
      a. Profile: Tee; 9/16 inch wide face.
      b. Construction: Double web.
      c. Finish: White painted.

B. Wood Cloud Suspension System(s):
   1. Metal Suspension System Standard: Provide manufacturer’s standard direct-hung metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635.
2. Finishes and Colors, General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Provide manufacturer's standard factory-applied finish for type of system indicated.
   a. High-Humidity Finish: Comply with ASTM C 635 requirements for "Coating Classification for Severe Environment Performance" where high-humidity finishes are indicated.

3. Attachment Devices: Size for five times the design load indicated in ASTM C 635, Table 1, "Direct Hung," unless otherwise indicated.
   a. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated, and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing per ASTM E 1190, conducted by a qualified testing and inspecting agency.

4. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
   b. Size: Select wire diameter so its stress at three times hanger design load (ASTM C 635, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.106-inch-diameter wire.

5. Seismic Struts: Manufacturer's standard compression struts designed to accommodate seismic forces.

6. Seismic Clips: Manufacturer's standard seismic clips designed and spaced to secure wood strip panels in-place.

7. Hold-Down Clips: Where indicated, provide manufacturer's standard hold-down clips spaced 24 inches o.c. on all cross tees.

2.03 ACCESSORIES

A. Support Channels and Hangers: Galvanized steel; size and type to suit application, seismic requirements, and ceiling system flatness requirement specified.

B. Perimeter Moldings: Same material and finish as grid.
   1. At Exposed Grid: Provide L-shaped molding for mounting at same elevation as face of grid.
   2. L-Shaped Molding: Less than 1 inch wide exposed face. Provide concealed seismic clip approved by AHJ.

C. Acoustical Insulation: Specified in Section 07 21 00.
   1. Thickness: 6 inch.
   2. Size: To fit acoustical suspension system.

D. Acoustical Sealant For Perimeter Moldings: Specified in Section 07 90 05.

E. Gasket For Perimeter Moldings: Closed cell rubber sponge tape.

F. Touch-up Paint: Type and color to match acoustical and grid units.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that layout of hangers will not interfere with other work.
3.02 INSTALLATION - SUSPENSION SYSTEM

A. Install suspension system in accordance with ASTM C 636, ASTM E 580, and manufacturer’s instructions and as supplemented in this section.

B. Rigidly secure system, including integral mechanical and electrical components, for maximum deflection of 1:360.

C. Install after major above-ceiling work is complete. Coordinate the location of hangers with other work.

D. Hang suspension system independent of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.

E. Where ducts or other equipment prevent the regular spacing of hangers, reinforce the nearest affected hangers and related carrying channels to span the extra distance.

F. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability.

G. Support fixture loads using supplementary hangers located within 6 inches of each corner, or support components independently.

H. Do not eccentrically load system or induce rotation of runners.

I. Perimeter Molding: Install at intersection of ceiling and vertical surfaces and at junctions with other interruptions.
   1. Use longest practical lengths.
   2. Overlap and rivet corners.

3.03 INSTALLATION - ACOUSTICAL UNITS

A. Install acoustical units in accordance with manufacturer’s instructions.

B. Fit acoustical units in place, free from damaged edges or other defects detrimental to appearance and function.

C. Fit border trim neatly against abutting surfaces.

D. Install units after above-ceiling work is complete.

E. Install acoustical units level, in uniform plane, and free from twist, warp, and dents.

F. Cutting Acoustical Units:
   1. Cut to fit irregular grid and perimeter edge trim.
   2. Make field cut edges of same profile as factory edges.
   3. Finish cuts to match factory finish.
   4. Double cut and field paint exposed reveal edges.

G. Where round obstructions occur, provide preformed closures to match perimeter molding.

3.04 TOLERANCES

A. Maximum Variation from Flat and Level Surface: 1/8 inch in 10 feet.

B. Maximum Variation from Plumb of Grid Members Caused by Eccentric Loads: 2 degrees.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Resilient sheet flooring.
B. Resilient base.
C. Installation accessories.

1.02 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data on specified products, describing physical and performance characteristics; including sizes, patterns and colors available; and installation instructions.
C. Shop Drawings: Indicate seaming plan, if applicable.
D. Selection Samples: Submit manufacturer's complete set of color samples for Architect's initial selection.
E. Verification Samples: Submit two samples, 12 by 12 inch in size illustrating color and pattern for each resilient flooring product specified.
F. Concrete Testing Standard: Submit a copy of ASTM F710.
G. Certification: Prior to installation of flooring, submit written certification by flooring manufacturer and adhesive manufacturer that condition of sub-floor is acceptable.
H. Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning.

1.03 DELIVERY, STORAGE, AND HANDLING
A. Protect roll materials from damage by storing on end.

1.04 FIELD CONDITIONS
A. Maintain temperature in storage area between 55 degrees F and 90 degrees F.
B. Store materials for not less than 48 hours prior to installation in area of installation at a temperature of 70 degrees F to achieve temperature stability. Thereafter, maintain conditions above 55 degrees F.

1.05 WARRANTY
A. Provide current, detailed manufacturer's 5 year limited warranty for each flooring product as applicable, including limited wear, defect and conductivity.

PART 2 PRODUCTS

2.01 SHEET FLOORING
A. Rubber Sheet Flooring: 100 percent rubber composition, color and pattern through total thickness:
   1. Critical Radiant Flux (CRF): Minimum 0.45 watt per square centimeter, when tested in accordance with ASTM E 648 or NFPA 253.
   2. VOC Content: Certified as Low Emission by one of the following:
   3. Total Thickness: 0.078 inch (2.0 mm) minimum.
   5. Design: Flat.
   7. Manufacturers:
RESILIENT FLOORING

2.02 ACCESSORIES
B. Primer: Type for use with the flooring usage, and substrate conditions, as recommended by flooring membrane manufacturer.
C. Leveler: Type for use with the flooring usage, and substrate conditions, as recommended by flooring membrane manufacturer.
D. Patch: Type for use with the flooring usage, and substrate conditions, as recommended by flooring membrane manufacturer.
E. Adhesives: Type for use with the flooring usage, and substrate conditions, as recommended by flooring membrane manufacturer.

2.03 RESILIENT BASE
A. Resilient Base: ASTM F1861, Type TS rubber, vulcanized thermoset; PVC free, top set Style B, Cove, and as follows:
   1. Critical Radiant Flux (CRF): Minimum 0.45 watt per square centimeter, when tested in accordance with ASTM E 648 or NFPA 253.
   2. Height: 3.5 inch.
   3. Thickness: 0.125 inch thick.
   5. Length: Roll.
   6. Color: Color as selected from manufacturer's standards.
   7. Manufacturers:
      d. Substitutions: See Section 01 60 00 - Product Requirements.

2.04 ACCESSORIES
A. Primers, Adhesives, and Seaming Materials: Waterproof; types recommended by flooring manufacturer.
   1. Provide only products having lower volatile organic compound (VOC) content than required by the more stringent of the South Coast Air Quality Management District Rule No.1168 and the Bay Area Air Quality Management District Regulation 8, Rule 51.
   2. VOC Content: Comply with requirements in Section 01 60 00.
B. Moldings, Transition and Edge Strips: Same material as flooring.
   1. Reducer at rubber flooring: Johnsonite SSR-63-B, color Burnt Umber.

PART 3 EXECUTION
3.01 EXAMINATION
A. Verify that surfaces are flat to tolerances acceptable to flooring manufacturer, free of cracks that might telegraph through flooring, clean, dry, and free of curing compounds, surface hardeners, and other chemicals that might interfere with bonding of flooring to substrate.
1. Specified required experience makes it incumbent upon flooring installer as ultimate source of product compatibility to notify the Contractor of potential incompatibility issues with adhesive and substrate prior to installation.

B. Verify that sub-floor surfaces are smooth and flat within the tolerances specified for that type of work and are ready to receive resilient flooring.

C. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive resilient base.

D. Verify that sub-floor surfaces are dust-free and free of substances that could impair bonding of adhesive materials to sub-floor surfaces.

E. Verify that concrete sub-floor surfaces are dry enough and ready for resilient flooring installation by testing for moisture emission rate and alkalinity in accordance with ASTM F710; obtain instructions if test results are not within limits recommended by resilient flooring manufacturer and adhesive materials manufacturer.

F. Verify that concrete sub-floor surfaces are ready for resilient flooring installation by testing for moisture emission rate and alkalinity; obtain instructions if test results are not within the following limits:
   1. Moisture emission rate: Not greater than 3 lb per 1000 sq ft per 24 hours when tested using calcium chloride moisture test kit for 72 hours, or in-situ relative humidity test performed in accordance with requirements of ASTM F 2170.

G. Verify that required floor-mounted utilities are in correct location.

3.02 SHEET FLOORING

A. Lay flooring with joints and seams parallel to longer room dimensions, to produce minimum number of seams. Lay out seams to avoid widths less than 1/3 of roll width; match patterns carefully at seams.

B. Double cut sheet; provide heat welded seams.

3.03 RESILIENT BASE

A. Fit joints tightly and make vertical. Maintain minimum dimension of 18 inches between joints.

B. Miter internal corners. At external corners, "V" cut back of base strip to 2/3 of its thickness and fold. At exposed ends, use premolded units.

C. Install base on solid backing. Bond tightly to wall and floor surfaces.

D. Scribe and fit to door frames and other interruptions.

3.04 CLEANING

A. Remove excess adhesive from base, and wall surfaces without damage.

B. Clean in accordance with manufacturer's instructions.

3.05 SCHEDULE

A. Resilient Base (RB):
   1. RB-1:
      a. Design Basis Manufacturer: Roppe
      b. Product: Pinnacle PVC free rubber base
      c. Size: 3.5 inch high
      d. Color: 174 Smoke
      e. Notes: Standard Toe

B. Rubber Flooring (RF):
   1. RF-1:
      a. Design Basis Manufacturer: Nora Systems Inc.
RESILIENT FLOORING

b. Product: Noraplan Senica, Article 17001.
c. Type: Sheet rubber.
d. Thickness: 2.0 mm.
e. Style: Smooth.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Surface preparation.
B. Field application of paints, stains, varnishes, and other coatings.
C. Surfaces to be finished are indicated in this section and on the Drawings.
D. Surfaces to receive high performance coating are indicated in Section 09 96 00.

1.02 RELATED REQUIREMENTS

A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.
B. Section 05 51 00 - Metal Stairs: Shop-primed items.
C. Section 09 96 00 - High-Performance Coatings.
D. Section 22 05 53 - Identification for Plumbing Piping and Equipment: Painted identification.
E. Section 26 05 53 - Identification for Electrical Systems: Painted identification.

1.03 REFERENCE STANDARDS


1.04 DEFINITIONS

A. Gloss and Sheen Levels: As defined by MPI except this specification uses common names defined below rather than numbered levels:
   1. Flat: Gloss Level 1
   2. Velvet: Gloss Level 2
   3. Eggshell: Gloss Level 3
   4. Satin: Gloss Level 4
   5. Semi-gloss: Gloss Level 5
   6. Gloss: Gloss Level 6
   7. High Gloss: Gloss Level 7

1.05 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide complete list of all products to be used, with the following information for each:
   1. Manufacturer's name, product name and/or catalog number, and general product category (e.g. "alkyd enamel").
   2. MPI product number (e.g. MPI #47).
   3. Cross-reference to specified paint system(s) product is to be used in; include description of each system (copy of relevant MPI Manual page is acceptable).
C. Schedule of Paints: List each coating and finish system for all surfaces that require paint. List special washes, surface preparation, sealers, primers, intermediate coats and final coats.
   1. Identify each material by the manufacturer's catalog number and general classification.
   2. List dry film thickness for each coat in each finish system.
   3. Identify minimum total dry film thickness for each system.
D. Certification by listed Manufacturer’s Representative that products comply with Contract Documents and are compatible with applicable substrates and with each other.

E. Certification: By manufacturer that all paints and coatings do not contain any of the prohibited chemicals specified; GreenSeal GS-11 certification is not required but if provided shall constitute acceptable certification.

F. Samples: Submit three paper "drop" samples, 8-1/2 by 11 inches in size, illustrating range of colors available for each finishing product specified.
   1. Where sheen is specified, submit samples in only that sheen.
   2. Where sheen is not specified, submit each color in each sheen available.

G. Maintenance Data: Submit data on cleaning, touch-up, and repair of painted and coated surfaces.

1.06 QUALITY ASSURANCE

   2. Certified testing reports for all GS-11 requirements by independent testing agency may be accepted in lieu of GreenSeal Label.

B. Acceptable Manufacturers and Manufacturer's Representative: Direct employee of Manufacturer who is authorized by Manufacturer to perform duties specified in this Section:
   1. Benjamin Moore & Company: Randy E. Tessman, CSI CDT
   2. Glidden Professional: Terry Decker, CSI, CDT, LEED AP.
   3. Miller Paint Company: Amy Tacke, CSI, LEED AP, IIDA.
   4. PPG Architectural Finishes: Raymond V. Nicholson, CSI CDT
   5. Rodda/Cloverdale: Jeff McIntyre, CSI CDT.
   6. Sherwin-Williams: Brian Keil, CSI, CCPR
   7. Yolo Colorhouse, LLC: DJ Widmer

1.07 MOCK-UP

A. See Section 01 40 00 - Quality Requirements, for general requirements for mock-up.
B. Provide wall panel, 10 feet long by 10 feet wide, illustrating coating color, texture, and finish.
C. Provide door and frame assembly illustrating coating color, texture, and finish.
   1. Provide mock-up illustrating each coating color, texture, and finish of assemblies and 10 lineal feet for trims.
D. Locate where directed.
E. Mock-up may remain as part of the Work.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.
B. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.
C. Paint Materials: Store at minimum ambient temperature of 45 degrees F and a maximum of 90 degrees F, in ventilated area, and as required by manufacturer's instructions.

1.09 FIELD CONDITIONS

A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.
B. Follow manufacturer’s recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.
C. Do not apply exterior coatings during rain or snow, or when relative humidity is outside the humidity ranges required by the paint product manufacturer.

D. Minimum Application Temperatures for Latex Paints: 45 degrees F for interiors; 50 degrees F for exterior; unless required otherwise by manufacturer’s instructions.

E. Minimum Application Temperature for Varnish Finishes: 65 degrees F for interior or exterior, unless required otherwise by manufacturer’s instructions.

F. Provide lighting level of 80 ft candles measured mid-height at substrate surface.

1.10 EXTRA MATERIALS

A. See Section 01 60 00 - Product Requirements, for additional provisions.

B. Supply 1 gallon of each color; store where directed.

C. Label each container with color in addition to the manufacturer’s label.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturers are listed in Part 1, Quality Assurance.
   1. Substitution Requests for Manufacturer will not be accepted.
   2. Submit Substitution Requests for paint systems by acceptable Manufacturer per Section 01 60 00.

B. Provide all paint and coating products used in any individual system from the same manufacturer; no exceptions.
   1. Coordinate shop applied metal primers and intermediate coats with work in Division 05.

C. Provide all paint and coating products from the same manufacturer to the greatest extent possible.

D. In the event that a single manufacturer cannot provide all specified products, minor exceptions will be permitted provided approval by Architect is obtained using the specified procedures for substitutions.
   1. Substitution of other products by the same manufacturer is preferred over substitution of products by a different manufacturer.

2.02 MATERIALS - GENERAL

A. Volatile Organic Compound (VOC) Content and minimum quality:
   1. Provide coatings that comply with the most stringent requirements specified in the following:
      a. Green Seal Standards GS-11 and GC-03, South Coast Air Quality Management District Rule 1113, specifically:
         1) Opaque Topcoats, Flat: 50 g/L, maximum.
         2) Opaque Topcoats, Nonflat: 150 g/L, maximum.
         3) Anti-Corrosive paint: 250 g/L, maximum.
         4) Floor coating: 100 g/L, maximum.
         5) Clear varnish: 350 g/L, maximum.
         6) Sanding sealer: 275 g/L, maximum.
         7) Waterproofing sealer: 250 g/L, maximum.
         8) Other sealers: 200 g/L, maximum.
         9) Stains: 250 g/L, maximum.
   2. Determination of VOC Content: Testing and calculation in accordance with 40 CFR 59, Subpart D (EPA Method 24), inclusive of colorants added to a tint base and exclusive of water added at project site; or other method acceptable to authorities having jurisdiction.

B. Chemical Content: The following compounds are prohibited:
1. Aromatic Compounds: In excess of 1.0 percent by weight of total aromatic compounds (hydrocarbon compounds containing one or more benzene rings).

   1. Provide Manufacturer's highest quality product in MPI category.
   2. Provide ready mixed paints and coatings, except field-catalyzed coatings.
   3. Provide materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
   4. Products in containers with GreenSeal Label.

D. Accessory Materials: Sealers, paint thinners and other materials not specifically indicated but required to achieve the finishes specified; commercial quality.

E. Patching Material: Latex filler.

F. Fastener Head Cover Material: Latex filler.

2.03 PAINT SYSTEMS

A. Provide Premium Grade systems (2 top coats) as defined in MPI Architectural Painting Specification Manual, except as otherwise indicated.
   1. Where a specified paint system does not have a Premium Grade, provide Custom Grade system.

B. Where sheen is not specified or more than one sheen is specified, sheen will be selected during Submittals by Architect from the manufacturer’s full line.

C. Provide colors as directed by Architect.

2.04 EXTERIOR PAINT SYSTEMS

A. Concrete Sealer:
   1. ____: EXT 3.2G Sealer, Clear: MPI #104.

B. Cementitious Fireproofing and Intumescent Mastic Fireproofing:
   1. PT: EXT 3.3F Polyurethane over epoxy MPI #77, 77, and 72; or as recommended by fireproofing manufacturer.

C. Structural Steel and Metal Fabrications:
   1. PT: EXT 5.1L Pigmented Polyurethane (over inorganic zinc rich primer and high build epoxy): Epoxy Primer MPI #19, Epoxy MPI #108, Polyurethane #72.

2.05 INTERIOR PAINT SYSTEMS

A. Concrete Vertical and Overhead Surfaces:
   1. INT 3.1M Institutional Low Odor/VOC: Institutional Low Odor/VOC MPI #145, gloss level 3.

B. Galvanized Metal, Not Chromate Passivated:
   1. Applications include but are not limited to doors, frames, railings, and piping.
   2. INT 5.3K W.B. Light Industrial Coating: Waterborne Primer MPI #134, W.B. Light Industrial Coating MPI #110, gloss level 5.

C. Woodwork (Not Floors or Stairs):
   1. Applications include but are not limited to paneling, partitions, casework, cabinets, and trim:
   2. STN or CLR: WB Clear Polyurethane over stain (system not listed by MPI): Stain where indicated and 3 coats polyurethane, or three coats of tinted WB polyurethane.
      a. Basis of Design: Timber Pro UV, Crystal Urethane, non-yellowing, 145 g/L VOC.
      b. Stain: Manufacturer's compatible product, color selected from full range.
SERA Architects, Inc. Package 1 - PERMIT / CONSTRUCTION

NOTICE OF ALTERNATE BILLING CYCLE: The Contract allows the Owner to require the submission of billings or estimates in billing cycles other than 30-day cycles. Billings or estimates shall be submitted monthly ending on the last day of the month.

NOTICE OF EXTENDED CERTIFICATION PROVISION: The Contract will allow the Owner to certify billings and estimates within 20 days after the billings and estimates are received from the original contractor.

NOTICE OF EXTENDED PAYMENT PROVISION: The Contract will allow the Owner to make payment within 30 days after the date a billing or estimate is received.

3. INT 6.4T Institutional Low Odor/VOC: Latex Primer MPI #39, Institutional Low Odor/VOC MPI #147, gloss level 5.

D. Plaster and Gypsum Board:
   1. Applications include but are not limited to walls, ceilings, soffits, and bulkheads.

PART 3 EXECUTION

3.01 SCOPE -- SURFACES TO BE FINISHED

A. Paint all exposed surfaces except where indicated not to be painted or to remain natural; the term "exposed" includes areas visible through permanent and built-in fixtures when they are in place.

B. Paint the surfaces described in PART 2, indicated on the Drawings, and as follows:
   1. If a surface, material, or item is not specifically mentioned, paint in the same manner as similar surfaces, materials, or items, regardless of whether colors are indicated or not.
   2. Paint surfaces behind movable equipment and furnishings the same as similar exposed surfaces.
   3. Paint surfaces to be concealed behind permanently installed fixtures, equipment, and furnishings, using primer only, prior to installation of the permanent item.
   4. Paint back sides of access panels and removable and hinged covers to match exposed surfaces.
   5. Paint interior surfaces of air ducts and convector and baseboard heating cabinets with flat, nonspecular black paint where visible through registers, grilles, or louvers.
   6. Paint dampers exposed behind louvers, grilles, and convector and baseboard cabinets to match face panels.

C. Do Not Paint or Finish the Following Items:
   1. Items fully factory-finished unless specifically noted; factory-primed items are not considered factory-finished.
   2. Items indicated to receive other finish.
   3. Items indicated to remain naturally finished.
   4. Fire rating labels, equipment serial number and capacity labels, and operating parts of equipment.

3.02 EXAMINATION

A. Verify that surfaces are ready to receive Work as instructed by the product manufacturer.

B. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.

C. Test shop-applied primer for compatibility with subsequent cover materials; report incompatible primer conditions and submit recommended changes for Architect's approval.

D. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces are below the following maximums:
   1. Plaster and Gypsum Board: 12 percent.
   2. Masonry, Concrete, and Concrete Unit Masonry: 12 percent.
   3. Interior Wood: 15 percent, measured in accordance with ASTM D4442.
   4. Concrete Floors: 8 percent.

E. Measure the ph factor of concrete, masonry, and mortar before starting any finishing process, using the method specified in MPI Architectural Painting Manual.
   1. Report results in writing to Architect before starting work.
   2. If results of test indicates need for remedial action, provide written description of remedial action. If a different primer or paint systems is required, state the total cost of the change.
SERA Architects, Inc.

Do not proceed with remedial action or change without receiving written authorization from Architect.

3.03 PREPARATION

A. Prepare surfaces as specified in MPI Architectural Painting Specification Manual and as follows for the applicable surface and coating; if multiple preparation treatments are specified, use as many as necessary for best results; where the Manual references external standards for preparation (e.g. SSPC standards), prepare as specified in those standards; comply with coating manufacturer's specific preparation methods or treatments, if any.

B. Coordinate painting work with cleaning and preparation work so that dust and other contaminants do not fall on newly painted, wet surfaces.

C. Surface Appurtenances: Prior to preparing surfaces or finishing, remove electrical plates, hardware, light fixtures, light fixture trim, escutcheons, machined surfaces, fittings, and similar items already installed that are not to be painted.
   1. If removal is impractical or impossible because of the size or weight of the item, provide surface-applied protection before preparation and finishing.
   2. After completing painting in each space or area, reinstall items removed using workers skilled in the trades involved.

D. Surfaces: Correct defects and clean surfaces which affect work of this section. Remove or repair existing coatings that exhibit surface defects.

E. Marks: Seal with shellac those which may bleed through surface finishes.

F. Impervious Surfaces: Remove mildew by scrubbing with solution of tetra-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.

G. Concrete, Cement Plaster and Unit Masonry Surfaces to be Painted: Remove dirt, loose mortar, scale, salt or alkali powder, and other foreign matter. Remove oil and grease with a solution of tri-sodium phosphate; rinse well and allow to dry. Remove stains caused by weathering of corroding metals with a solution of sodium metasilicate after thoroughly wetting with water. Allow to dry.

H. Gypsum Board Surfaces to be Painted: Fill minor defects with filler compound. Spot prime defects after repair.

I. Plaster Surfaces to be Painted: Fill hairline cracks, small holes, and imperfections with latex patching plaster. Make smooth and flush with adjacent surfaces. Wash and neutralize high alkali surfaces.

J. Uncoated Steel and Iron Surfaces to be Painted: Remove grease, mill scale, weld splatter, dirt, and rust. Where heavy coatings of scale are evident, remove by hand wire brushing or sandblasting; clean by washing with solvent. Apply a treatment of phosphoric acid solution, ensuring weld joints, bolts, and nuts are similarly cleaned. Prime paint entire surface; spot prime after repairs.

K. Shop-Primed Steel Surfaces to be Finish Painted: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces. Re-prime entire shop-primed item.

L. Interior Wood Items to Receive Opaque Finish: Wipe off dust and grit prior to priming. Seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after primer has dried; sand between coats. Back prime concealed surfaces before installation.

3.04 APPLICATION

A. Apply products in accordance with manufacturer's instructions and as specified or recommended by MPI Manual, using the preparation, products, sheens, textures, and colors as indicated.
   1. Remove, refinish, or repaint work not complying with requirements.
B. Do not apply finishes over dirt, rust, scale, grease, moisture, scuffed surfaces, or other conditions detrimental to formation of a durable coating film; do not apply finishes to surfaces that are not dry.

C. Use applicators and methods best suited for substrate and type of material being applied and according to manufacturer's instructions.
   1. Brush Application: Use brushes best suited for the type of material applied; use brush of appropriate size for the surface or item being painted; produce results free of visible brush marks.
   2. Roller Application: Use rollers of carpet, velvet back, or high-pile sheep's wool as recommended by manufacturer for material and texture required.
   3. Spray Application: Use airless spray equipment with orifice size as recommended by manufacturer for material and texture required.
   4. Where application method is listed in the MPI Manual for the paint system that application method is required; otherwise any application method recommended by manufacturer for material used and objects to be painted is acceptable.

D. Minimum Coating Thickness: Apply paint materials no thinner than manufacturer's recommended spreading rate; provide total dry film thickness of entire system as recommended by manufacturer.
   1. Number of coats and film thickness required are the same regardless of application method.
   2. If undercoats, stains, or other conditions show through final coat of paint, apply additional coats until paint film is of uniform finish, color, and appearance.
   3. Give special attention to ensure edges, corners, crevices, welds, and exposed fasteners receive dry film thickness equivalent to that of flat surfaces.

E. Apply finish to completely cover surfaces with uniform appearance without brush marks, runs, sags, laps, ropiness, holidays, spotting, cloudiness, or other surface imperfections.
   1. Before applying finish coats, apply a prime coat of material recommended by manufacturer, unless the surface has been prime coated by others; where evidence of suction spots or unsealed areas in first coat appear, recoat primed and sealed surfaces to ensure finish coat with no burn through or other defects due to insufficient sealing.
   2. Apply first coat to surface that has been cleaned, pretreated, or otherwise prepared as soon as practical after preparation and before subsequent surface deterioration.
   3. Do not apply succeeding coats until the previous coat has cured as recommended by manufacturer.
   4. Do not recoat until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and application of another coat will not cause the undercoat to lift or lose adhesion.
   5. If manufacturer's instructions recommend sanding to produce a smooth, even surface, sand between coats.
   6. Before applying next coat vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.
   7. Pigmented (Opaque) Finishes on Doors, Frames, Trim: Provide smooth, opaque surface of uniform finish, color, appearance, and coverage.
   8. Transparent Finishes: Smooth, glass-like.
   9. Stippled Finish on Walls, Ceilings, Soffits: Roll and redistribute paint to even, fine texture; leave no evidence of rolling, such as laps, irregularity in texture, skid marks, or other surface imperfections; back roll final coat to achieve a uniform surface.

3.05 CLEANING AND PROTECTION

A. Collect waste material which may constitute a fire hazard, place in closed metal containers, and remove daily from site.
B. At the end of each workday, remove empty cans, rags, rubbish, and other discarded paint materials from site.

C. Protect other work, whether being painted or not, against damage by painting. Correct damage by cleaning, repairing or replacing, and repainting as approved by Architect.

D. Provide "Wet Paint" signs to protect newly painted finishes. Remove temporary protective wrappings provided by others to protect their work after completing painting operations.

E. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces. Comply with procedures specified in MPI Manual.

3.06 SCHEDULE

A. PT-1
   1. Location: General Wall Color
   2. Manufacturer: Benjamin Moore
   3. Color: Brilliant White

B. PT-2
   1. Location: Wall and Ceiling at Craft Center
   2. Manufacturer: Parker Paint ColorLife CL
   3. Color: 3232W Tinman

C. PT-3
   1. Not Used

D. PT-4
   1. Not Used

E. PT-5
   1. Not Used

F. PT-6
   1. Not Used

G. PT-7
   1. Not Used

H. PT-8
   1. Location: Craft Center Corridor
   2. Manufacturer: Parper Paint ColorLife CL
   3. Color: Capricorn, Semi-Gloss Sheen

I. PT-9
   1. Not used.

J. PT-10
   1. Not used.

K. PT-11
   1. Not used.

L. PT-12
   1. Not used.

M. PT-13
   1. Not used.

N. PT-14
   1. Not used.

O. PT-15
   1. Not Used
NOTICE OF ALTERNATE BILLING CYCLE: The Contract allows the Owner to require the submission of billings or estimates in billing cycles other than 30-day cycles. Billings or estimates shall be submitted monthly ending on the last day of the month.

NOTICE OF EXTENDED CERTIFICATION PROVISION: The Contract will allow the Owner to certify billings and estimates within 20 days after the billings and estimates are received from the original contractor.

NOTICE OF EXTENDED PAYMENT PROVISION: The Contract will allow the Owner to make payment within 30 days after the date a billing or estimate is received.

P. PT-16
   1. Not Used

Q. PT-17
   1. Not Used

R. PT-18
   1. Not Used

S. PT-20
   1. Not Used

T. PT-21
   1. Location: Structural Steel
   2. Manufacturer: TBD
   3. Color: TBD

U. PT-22
   1. Not Used

V. EPT-1
   1. Location: General Wall Color - Epoxy Paint to match PT-1
   2. Manufacturer: Benjamin Moore
   3. Color: Brilliant White

W. EPT-2
   1. Location: Craft Center Dark Room
   2. Manufacturer: Parker Paint Colorlife CL 3175A
   3. Color: Lead

X. STN-1
   1. Location: Craft Center Stain at Concrete Floor
   2. Application: Concrete Floor
   3. Manufacturer: TBD

Y. STN-2
   1. Location: Craft Center Accent at Studio Door 1
   2. Application: Baltic Birch wall panels and concrete floor
   3. Manufacturer: TBD

Z. STN-3
   1. Location: Craft Center Accent at Studio Door 2
   2. Application: Baltic Birch wall panels and concrete floor
   3. Manufacturer: TBD
   4. Color: TBD

AA. STN-4
   1. Location: Craft Center Accent at Studio Door 3
   2. Application: Baltic Birch wall panels and concrete floor
   3. Manufacturer: TBD
   4. Color: TBD

AB. STN-5
   1. Location: Craft Center Accent at Studio Door 4
   2. Application: Baltic Birch wall panels and concrete floor
   3. Manufacturer: TBD
4. Color: TBD

END OF SECTION
PART 1  GENERAL

1.01  SECTION INCLUDES
   A. Surface preparation and application of high-performance coating systems on the following substrates:
      1. Section 05 12 00 Architectural Steel
      2. Section 05 50 00 Architectural Steel Fabrications.
   B. Section includes option for Section 05 05 13 - Shop Applied Metal Coatings for thermally fused shop finish in lieu of liquid coatings.

1.02  RELATED SECTIONS
   A. Division 5 Sections for shop priming of metal substrates with primers specified in this Section.
   B. Division 9 painting Sections for special-use coatings and general field painting.

1.03  SUBMITTALS
   A. Product Data: For each product indicated.
   B. Samples for Verification: For each type of coating system and in each color and gloss of finish coat indicated.
      1. Samples on ¼ inch thick steel plate, 8 by 12 inches.
      2. Step coats on Samples to show each coat required for system.
      3. Label each coat of each Sample.
      4. Label each Sample for location and application area.
   C. Product List: For each product indicated. Cross-reference products to coating system and locations of application areas. Use same designations indicated on Drawings and in schedules.

1.04  QUALITY ASSURANCE
   A. Master Painters Institute (MPI) Standards:

1.05  DELIVERY, STORAGE, AND HANDLING
   A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
      1. Maintain containers in clean condition, free of foreign materials and residue.
      2. Remove rags and waste from storage areas daily.

1.06  PROJECT CONDITIONS
   A. Apply coatings only when temperature of surfaces to be coated and surrounding air temperatures are between 55 and 90 deg F.
   B. Do not apply coatings in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 2  PRODUCTS

2.01  HIGH-PERFORMANCE COATINGS, GENERAL
   A. Material Compatibility:
      1. Provide materials for use within each coating system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
      2. Provide products of same manufacturer for each coat in a coating system.
   B. Chemical Components of Interior Paints and Coatings: Provide products that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24) and the following chemical restrictions:
1. Flat Paints and Coatings: VOC content of not more than 50 g/L.
2. Nonflat Paints and Coatings: VOC content of not more than 150 g/L.
3. Anticorrosive Coatings: VOC content of not more than 250 g/L.
4. Stains: VOC content of not more than 250 g/L.
5. Aromatic Compounds: Paints and coatings shall not contain more than 1.0 percent by weight of total aromatic compounds (hydrocarbon compounds containing 1 or more benzene rings).
6. Restricted Components: Paints and coatings shall not contain any of the following:
   a. Acrolein.
   b. Acrylonitrile.
   c. Antimony.
   d. Benzene.
   e. Butyl benzyl phthalate.
   f. Cadmium.
   g. Di (2-ethylhexyl) phthalate.
   h. Di-n-butyl phthalate.
   i. Di-n-octyl phthalate.
   j. 1,2-dichlorobenzene.
   k. Diethyl phthalate.
   l. Dimethyl phthalate.
   m. Ethylbenzene.
   n. Formaldehyde.
   o. Hexavalent chromium.
   p. Isophorone.
   q. Lead.
   r. Mercury.
   s. Methyl ethyl ketone.
   t. Methyl isobutyl ketone.
   u. Methylene chloride.
   v. Naphthalene.
   w. Toluene (methylbenzene).
   x. 1,1,1-trichloroethane.
   y. Vinyl chloride.

C. Coordinate selection of shop primer with selection of intermediate and top coatings. Product shall comply with requirements in this Section.

2.02 GLAZE COATING FOR STEEL

A. 3-Coat System:
   1. Zinc-rich epoxy primer, 2.5 to 3.0 dry film mils.
   2. High-build epoxy intermediate coat, 4.0 to 6.0 dry mils.
   3. Pigmented aliphatic urethane top coat, 2.0 to 3.0 mils dry film thickness.

B. Color: Match Architect’s sample.

C. Gloss: Semi-gloss, MPI GL-5.

D. Performance Requirements: AAMA 2605.

E. Warranty: Remove and replace defective coating system within 5 year warranty period.

F. Design Basis: Tnemec system as follows:
   1. Primer: 90-97
   3. Top: Series 73
G. Acceptable Manufacturers, include but are not limited to the following pending conformance to Design Basis requirements and requirements specified herein:
   1. Benjamin Moore.
   2. Carboline.
   3. PPG Architectural Finishes, Inc.
   5. Tnemec.

2.03 SHOP FINISHING
   A. Prepare and apply primers in shop.
   B. Optional Shop Finish: Thermally fused 3-coat system comparable to specified liquid system.
      1. Provide same dry film thicknesses, color and gloss.
      2. Submit system for approval per Section 01 60 00, Substitution Request.
   C. Deliver lintels individually wrapped in recyclable protective covering.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of work.
      1. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
      2. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.
      3. Coating application indicates acceptance of surfaces and conditions.

3.02 PREPARATION
   A. Comply with manufacturer’s written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated, but not less than specified.
   B. Remove plates, machined surfaces, and similar items already in place that are not to be coated. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and coating.
      1. After completing coating operations, reinstall items that were removed; use workers skilled in the trades involved.
   C. Clean substrates of substances that could impair bond of coatings, including dirt, oil, grease, and incompatible paints and encapsulants.
   D. Coordination of shop-applied prime coats with high-performance coatings is critical.
      1. Remove incompatible primers and reprime substrate with compatible primers as required to produce coating systems indicated.
   E. Steel Substrates: Remove rust and loose mill scale.
      1. Blast clean according to SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
      2. Field Touch-up: SSPC-SP 3 “Power tool cleaning.”

3.03 PREPARATION OF HOT-DIP GAVANIZED STEEL FOR PAINTING AND COATING
   A. Eliminate the use of post-galvanizing treatments detrimental to paint and coating adhesion.
   B. Prepare galvanized surfaces for painting and coating by removing zinc oxide and zinc hydroxide conforming to theo surface preparation techniques and guidelines under ASTM D 6386.
   C. Application of paint and coatings must be performed within the timeline provided for under ASTM D 6386.
3.04 APPLICATION

A. Apply high-performance coatings according to manufacturer’s written instructions.
   1. Use applicators and techniques suited for coating and substrate indicated.
   2. Coat surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, coat surfaces behind permanently fixed equipment or furniture with prime coat only.

B. Comply with additional requirements in Division 05 for steel preparation and priming.

C. Apply primer to steel as soon as possible after surface preparation, same day and within 8 hours.

D. Apply subsequent coats within Manufacturer’s recommended recoat time for previous coat.
   1. Comply with Manufacturer’s recommended surface preparation when recoat time is exceeded.

E. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of the same material are to be applied. Tint undercoats to match color of finish coat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

F. If undercoats or other conditions show through final coat, apply additional coats until cured film has a uniform coating finish, color, and appearance.

G. Apply coatings to produce surface films without cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Produce sharp glass lines and color breaks.

3.05 FIELD QUALITY CONTROL

A. Owner reserves the right to invoke the following procedure at any time and as often as Owner deems necessary during the period when coatings are being applied:
   1. Owner will engage the services of a qualified testing agency to sample coating material being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
   2. Testing agency will perform tests for compliance with specified requirements.
   3. Owner may direct Contractor to stop applying coatings if test results show materials being used do not comply with specified requirements. Contractor shall remove noncomplying coating materials from Project site, pay for testing, and recoat surfaces coated with rejected materials. Contractor will be required to remove rejected materials from previously coated surfaces if, on recoating with complying materials, the two coatings are incompatible.

3.06 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from coating operation. Correct damage by cleaning, repairing, replacing, and recoating, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Chalkboards.

1.02 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide manufacturer's data on chalkboard, markerboard, tackboard, tackboard surface covering, trim, and accessories.
   C. Shop Drawings: Indicate wall elevations, dimensions, joint locations, special anchor details.
   D. Samples: Submit two samples 2 by 2 inch in size illustrating materials and finish, color and texture of chalkboard, markerboard, tackboard, tackboard surfacing, and trim.
   E. Manufacturer's printed installation instructions.
   F. Maintenance Data: Include data on regular cleaning, stain removal.

1.03 WARRANTY
   A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
   B. Provide 20 year warranty for chalkboard and markerboard to include warranty against discoloration due to cleaning, crazing or cracking, and staining.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. Visual Display Boards:
      4. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 VISUAL DISPLAY BOARDS
   A. Chalkboards: Chalkboard enamel on hardboard.
      2. Hardboard Face Sheet Thickness: 1/4 inch.
      3. Height: 48 inches.
      4. Length: 8 feet, in one piece.
      5. Frame: Extruded aluminum, with concealed fasteners.

2.03 MATERIALS
   A. Hardboard for Chalk Surface: AHA A135.4, Tempered type.
   B. Adhesives: Type used by manufacturer.

2.04 ACCESSORIES
   A. Temporary Protective Cover: Sheet polyethylene, 8 mil thick.
   B. Mounting Brackets: Concealed.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that field measurements are as indicated.
   B. Verify that internal wall blocking is ready to receive work and positioning dimensions are as indicated on shop drawings.

3.02 INSTALLATION
   A. Install boards in accordance with manufacturer's instructions.
B. Secure units level and plumb.

3.03 CLEANING

A. Clean board surfaces in accordance with manufacturer’s instructions.

B. Cover with protective cover, taped to frame.

C. Remove temporary protective cover at date of Substantial Completion.

END OF SECTION
PART 1  GENERAL

1.01  SECTION INCLUDES

A. Interior signage:
   1. Room and door signs.
   2. Interior directional and informational signs.
   3. Emergency evacuation maps.
   4. Plaque.

1.02  REFERENCE STANDARDS


1.03  SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Manufacturer's printed product literature for each type of sign, indicating sign styles, font, foreground and background colors, locations, overall dimensions of each sign.
C. Signage Schedule: Provide information sufficient to completely define each sign for fabrication, including room number, room name, other text to be applied, sign and letter sizes, fonts, and colors.
   1. When room numbers to appear on signs differ from those on the drawings, include the drawing room number on schedule.
   2. When content of signs is indicated to be determined later, request such information from Owner through Architect at least 2 months prior to start of fabrication; upon request, submit preliminary schedule.
   3. Submit for approval by Owner through Architect prior to fabrication.
D. Samples: Submit two samples of each type of sign, of size similar to that required for project, illustrating sign style, font, and method of attachment.
E. Manufacturer's Installation Instructions: Include installation templates and attachment devices.

1.04  QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.

1.05  DELIVERY, STORAGE, AND HANDLING

A. Package signs as required to prevent damage before installation.
B. Package room and door signs in sequential order of installation, labeled by floor or building.

PART 2  PRODUCTS

2.01  SIGNAGE APPLICATIONS

A. Accessibility Compliance: All signs are required to comply with ADA Standards for Accessible Design and ANSI/ICC A 117.1 and applicable building codes, unless otherwise indicated; in the event of conflicting requirements, comply with the most comprehensive and specific requirements.
B. All Signage Types: Unless otherwise indicated:
   1. Character Font, Case, Colors: Provide sign type and characteristics matching existing campus standards.
   2. Character Color: Contrasting color.
C. Room and Door Signs: Provide a sign for every doorway, whether it has a door or not, not including corridors, lobbies, and similar open areas.
SIGNAGE

1. Sign Type: Provide sign types matching existing campus standards.
   a. Sign type to have the following requirements:
      1) 1/16 inch Thick Acrylic over Double-Sided Foam Tape Spacer over 1/16 inch Thick Black ABS Backer
      2) 1/32 inch Tactile Text & Graphics
      3) Grade 2 Braille
      4) Double-Sided Foam Tape Mount (Standard)
      5) Insert Slot is located at Spacer Layer.
      6) A paper insert is used.

2. Provide "tactile" signage, with letters raised minimum 1/32 inch and Grade II braille.

3. Office Doors: Identify with room numbers to be determined later, not the numbers shown on the drawings; in addition, provide "window" section for replaceable occupant name.

4. Conference and Meeting Rooms: Identify with room numbers to be determined later, not the numbers shown on the drawings; in addition, provide "window" section with sliding "In Use/Vacant" indicator.

5. Service Rooms: Identify with room names and numbers to be determined later, not those shown on the drawings.

6. Rest Rooms: Identify with pictograms, the names "MEN" and "WOMEN", room numbers to be determined later, and braille.

D. Interior Directional and Informational Signs:
   1. Sign Type: Provide sign types matching existing campus standards.
   2. Where suspended, ceiling mounted, or projecting from wall signs are indicated, provide two-sided signs with same information on both sides.

E. Emergency Evacuation Maps:
   1. Allow for one map per elevator lobby.
   2. Map content to be provided by Owner.
   3. Use clear plastic panel silk-screened on reverse, in brushed aluminum frame, screw-mounted.

2.02 ACCESSORIES

A. Concealed Screws: Stainless steel, galvanized steel, chrome plated, or other non-corroding metal.

B. Exposed Screws: Chrome plated.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that substrate surfaces are ready to receive work.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install neatly, with horizontal edges level.

C. Locate signs where indicated:
   1. Room and Door Signs: Locate on wall at latch side of door with centerline of sign at 60 inches above finished floor.
   2. If no location is indicated obtain Owner's instructions.

D. Protect from damage until Substantial Completion; repair or replace damage items.

END OF SECTION
PART 1  GENERAL
1.01  SECTION INCLUDES
   A. Corner guards.

1.02  SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Indicate physical dimensions, features, anchorage details, and rough-in measurements.
   C. Samples: Submit two sections of bumper rail, 24 inch long, illustrating component design, configuration, color and finish.
   D. Manufacturer's Instructions: Indicate special procedures, perimeter conditions requiring special attention.

1.03  PROJECT CONDITIONS
   A. Coordinate the work with wall or partition sections for installation of concealed blocking or anchor devices.

PART 2  PRODUCTS
2.01  MANUFACTURERS
   A. Stainless Steel Corner Guards:
      4. Substitutions: See Section 01 60 00 - Product Requirements.

2.02  COMPONENTS
   A. Stainless Steel Corner Guards - Surface Mounted:
      1. Material: Type 304 stainless steel; 16 gauge.
      2. Size: 3-1/2 x 3-1/2 x 48 inches.
      3. Corner: 1/8 inch radius.
      4. Attachment: Stainless steel flat head screws of appropriate size, type, and spacing for attachment condition.

2.03  FABRICATION
   A. Fabricate components free of sharp edges and burrs.
   B. Pre-drill holes for attachment.

PART 3  EXECUTION
3.01  EXAMINATION
   A. Verify that rough openings, concealed blocking, and anchors are correctly sized and located.
   B. Verify that field measurements are as indicated on Drawings.

3.02  INSTALLATION
   A. Install components in accordance with manufacturer's instructions, level and plumb, secured rigidly in position to wall framing members only.

3.03  TOLERANCES
   A. Maximum Variation From Required Height: 1/4 inch.
   B. Maximum Variation From Level or Plane For Visible Length: 1/4 inch.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Fire extinguishers.
   B. Fire extinguisher cabinets.
   C. Fire extinguisher brackets
   D. Accessories.

1.02 REFERENCE STANDARDS
   A. Factory Mutual Global; FM Approvals, LLC, portable fire extinguisher approval.

1.03 PERFORMANCE REQUIREMENTS
   A. Conform to NFPA 10.
   B. Provide extinguishers classified and labeled by Underwriters Laboratories Inc. for the purpose specified and indicated.

1.04 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Shop Drawings: Indicate cabinet physical dimensions.
   C. Product Data: Provide extinguisher operational features.
   D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
   E. Maintenance Data: Include test, refill or recharge schedules and re-certification requirements.

1.05 FIELD CONDITIONS
   A. Do not install extinguishers when ambient temperature may cause freezing of extinguisher ingredients.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. Fire Extinguishers (Must be FM Approved):
      1. Amerex Corp; amerex-fire.com.
   B. Fire Extinguisher Cabinets and Accessories:
      4. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 FIRE EXTINGUISHERS
   A. Fire Extinguishers - General: Comply with product requirements of NFPA 10 and applicable codes, whichever is more stringent.
   B. Dry Chemical Type Fire Extinguishers: Cast steel tank, with pressure gage.
      1. Class A:B:C.
      2. Size: UL Label, 2A-10BC.
      3. Finish: Baked enamel, red color.
   C. Wet Chemical Type Fire Extinguishers: Stainless steel tank, with pressure gage.
2.03 FIRE EXTINGUISHER CABINETS

A. Application: Extinguishers in public areas, recreation areas, and residence halls are to be housed in cabinets.
B. Box Metal: Formed primed steel sheet; 0.036 inch thick base metal.
C. Cabinet Configuration: Semi-recessed type.
   1. Sized to accommodate accessories.
   2. Form cabinet enclosure and door stiles with right angle inside corners and seams. Form perimeter trim with radius edges and corners.
D. Door: 0.036 inch thick stainless steel, reinforced for flatness and rigidity; latch. Hinge doors for 180 degree opening with continuous piano hinge. Provide nylon catch.
E. Door Glazing: Plastic, clear, 1/8 inch thick acrylic. Set in resilient channel gasket glazing.
F. Cabinet Mounting Hardware: Appropriate to cabinet. Pre-drill for anchors.
G. Weld, fill, and grind components smooth.
H. Finish of Cabinet Interior: White enamel.

2.04 ACCESSORIES

A. Extinguisher Brackets: Formed steel, chrome-plated.
   1. For wall mounting fire extinguisher without a cabinet.
B. Seismic bracket for extinguisher.
C. Extinguisher Theft Alarm: Battery operated alarm, 10 second delay for disarming, activated by opening cabinet door.
D. Cabinet Signage: Manufacturer's standard red block letters, "FIRE EXTINGUISHER."

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.
B. Verify rough openings for cabinet are correctly sized and located.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.
B. Secure rigidly in place.
C. Place extinguishers in cabinets.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Metal lockers.
   B. Locker units with hinged doors.
   C. Metal tops and filler panels.

1.02 REFERENCE STANDARDS

1.03 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Manufacturer's published data on locker construction, sizes and accessories.
   C. Shop Drawings: Indicate locker plan layout, numbering plan and combination lock code.
   D. Manufacturer's Installation Instructions: Indicate component installation assembly.

1.04 MOCK-UP
   A. Provide mock-up of one full size locker, 4 tier with sloped top, in selected colors.
   B. Locate where directed.
   C. Mock-up may remain as part of the Work.

1.05 DELIVERY, STORAGE, AND HANDLING
   A. Protect locker finish and adjacent surfaces from damage.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. Metal Lockers:

2.02 LOCKER APPLICATIONS
   A. Student Lockers: Six tier metal lockers, free-standing with matching closed base.
      1. Width: 15 inches.
      2. Depth: 18 inches.
      3. Height: 18 inches.
      4. Locking: Padlock hasps, for padlocks provided by Owner.
      5. Provide sloped top.

2.03 METAL LOCKERS
   A. Lockers: Factory assembled, made of formed sheet steel, ASTM A653/A653M SS Grade 33/230, with G60/Z180 coating, stretcher leveled; metal edges finished smooth without burrs; baked enamel finished inside and out.
      1. Color: To be selected by Architect; allow for contrasting colors for locker bodies and doors.
   B. Locker Body: Formed and flanged; with steel stiffener ribs; electric spot welded.
      1. Body and Shelves: 24 gage, 0.024 inch.
   C. Frames: Formed channel shape, welded and ground flush, welded to body, resilient gaskets and latching for quiet operation.
      1. Door Frame: 16 gage, 0.060 inch, minimum.
D. Doors: Hollow double pan, sandwich construction, 1-3/16 inch thick; welded construction, channel reinforced top and bottom with intermediate stiffener ribs, grind and finish edges smooth.
   1. Door Outer Face: 18 gage, 0.048 inch, minimum.
   2. Door Inner Face: 20 gage, 0.036 inch, minimum.
   3. Form recess for operating handle and locking device.
   4. Provide louvers in door face, top and bottom, for ventilation.

E. Hinges: Two for doors under 42 inches high; three for doors over 42 inches high; weld securely to locker body and door.
   1. Hinge Thickness: 14 gage, 0.075 inch.

F. Sloped Top: 20 gage, 0.036 inch, with closed ends.

G. Trim: 20 gage, 0.036 inch.

H. Number Plates: Provide oval shaped brass plates. Form numbers 1 inch high of block font style with ADA designation, in contrasting color.

2.04 MATERIALS
   A. Sheet Steel: ASTM A 653/A 653M SS Grade 33/230, with G60/Z180 coating, stretcher leveled; to the following minimum thicknesses:
      1. Body and Shelf: 24 gage, 0.024 inch.
      2. Door Outer Face: 18 gage, 0.048 inch.
      3. Door Inner Face: 20 gage, 0.036 inch.
      4. Door Frame: 16 gage, 0.060 inch.
      5. Hinges: 14 gage, 0.075 inch.
      6. Base: 20 gage, 0.036 inch.
      7. Sloping Top: 20 gage, 0.036 inch.
      8. Trim: 20 gage, 0.036 inch.
   B. Accessories For Each Locker: Two single prong wall hooks, coat hanger bar.
   C. Finish: C Paint locker units 11 custom colors to be selected.

2.05 FINISHING
   A. Clean, degrease, and neutralize metal; prime and finish with one coat of baked enamel.
   B. Paint locker bodies and doors in same colors.
   C. Paint locker units 1 custom color, as selected.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that prepared bases are in correct position and configuration.

3.02 INSTALLATION
   A. Install in accordance with manufacturer's instructions.
   B. Install lockers plumb and square.
   C. Place and secure on prepared base.

3.03 CLEANING
   A. Clean locker interiors and exterior surfaces.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Blackout curtain with front and rear light trap valances.
B. Extruded aluminum curtain track.
C. Accessories.

1.02 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data indicating properties of track and curtain, component dimensions, accessories and other design characteristics.
C. Shop Drawings: Indicate layout dimensions, attachment and termination details.
1. For radiused tracks and single and double cutain configurations located within a dimensionally restricted area, show minimum dimensions of track for spacings and overlaps required for full blackout installation.
D. Maintenance Data: Include cleaning instructions, stain removal procedures and track adjustments.

1.03 WARRANTY
A. Five (5) years from the date of Substantial Completion; curtain material shall be free of defects in workmanship and material.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Blackout Curtain and Track:
1. Blackout Curtains; blackoutcurtains.com
3. PLS Group; www.plsys.net
4. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 CURTAIN AND TRACK
A. Curtain: Sewn flat with 15 percent fullness; French-style seams displaying no raw edges, with grommets on 6 inch centers at top and bottom edge weighted and overlapping with floor approximately 2 inches.
1. Fabric: Non-toxic flame-resistant synthetic fiber blend,
2. Backing: Opaque, double-vinyl black color laminated.
3. Curtain outside vertical edges have Velcro quick seal strips for light-trap overlaps and light-tight attachment to walls.
B. Track with Valances:
1. Extruded aluminum box-channel track, 1-1/4 x 7/8 inches, slotted on underside for carriers, with Velcro strips mounted both sides for valances to be attached at a maximum of 18 inches on center.
   a. Mounting: Surface to underside of ceiling.
2. Light Trap Valances:
   a. Track mounted front and rear.
   b. Material: Same as curtain with a sewn-on Velcro strips for track mounting.

2.03 ACCESSORIES
A. Curtain hooks formed to ride in carriers.
1. rustproof wire.

B. Hook carriers:
   1. Non-wearing nylon wheels.

C. Track end caps

D. Snap-outs

E. Track section sleeve type connectors.

PART 3 EXECUTION

3.01 PREPARATION

   A. Verify substrates are ready to receive Work.

3.02 INSTALLATION

   A. Install curtain and track system in accordance with manufacturer’s written installation instructions.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Front projection screen assemblies.

1.02 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Manufacturer's catalog cuts and descriptive information on each product to be used, including:
      1. Preparation instructions and recommendations.
      2. Storage and handling requirements and recommendations.
      3. Installation methods.
   C. Shop Drawings: For custom installations, indicate dimensions, verified field measurements, mounting details, and interface with adjacent construction.
   D. Samples: For screen fabrics, submit two 4 by 4 in size.
   E. Operation and Maintenance Data: Provide manufacturer's operation and maintenance instructions.
   F. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.03 QUALITY ASSURANCE
   A. Manufacturer Qualifications: Experienced in manufacturing products specified in this section.
   B. Installer Qualifications: Experienced in installation of the work of this section.

1.04 DELIVERY, STORAGE, AND HANDLING
   A. Deliver projection screens to project site in manufacturer's original unopened packaging. Inspect for damage and size before accepting delivery.
   B. Store in a protected, clean, dry area with temperature maintained above 50 degrees F. Stack according to manufacturer's recommendations.
   C. Acclimate screens to building temperatures for 24 hours prior to installation, or in accordance with manufacturer's recommendations.

1.05 FIELD CONDITIONS
   A. Maintain interior of building between 60 degrees F and 75 degrees F during and after installation of projection screens.

1.06 WARRANTY
   A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
   B. Provide five year manufacturer warranty for projection screen assembly.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   E. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 FRONT PROJECTION SCREENS
   A. Front Projection Screens: Factory assembled unless otherwise indicated.

C. Masking Borders: White, four sides.

D. Extra Drops: White; 20 inches.

E. Concealed-in-Ceiling Screen Cases: Steel; integral roller brackets.
   1. Door Slat: Self trim; self-closing and -opening.
   2. Case Finish: Baked enamel.
   4. End Caps: Steel; finished to match case.

F. Provide mounting hardware, brackets, supports, fasteners, and other mounting accessories required for a complete installation, in accordance with manufacturer’s recommendations for specified substrates and mountings.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that substrate is finished and ready to accept screen installation.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

C. Verify that openings for recessed screens are correctly sized.

D. Do not install projection screens until climate control systems are in place and interior painting and other finishes are completed.

3.02 PREPARATION

A. Coordinate screen installation with installation of projection systems.

B. Coordinate installation with adjacent construction and fixtures, including ceilings, walls, lighting, fire suppression, and registers and grilles.

3.03 INSTALLATION

A. Install in accordance with manufacturer’s instructions, using manufacturer’s recommended hardware for relevant substrates.

B. Do not field cut screens.

C. Install screens in mountings as specified and as indicated on drawings.

D. Install plumb and level.

E. Adjust projection screens and related hardware in accordance with manufacturer’s instructions for proper placement and operation.

3.04 PROTECTION

A. Protect installed products until completion of project.

B. Touch up, repair, or replace damaged products before Substantial Completion.

END OF SECTION
PART 1 - GENERAL

1.01 SECTION INCLUDES
   A. Manually operated roller shades.
      1. Roller shades - partial transparency for visual privacy.

1.02 REFERENCE STANDARDS
   B. NFPA 70 - National Electrical Code.
   D. WCMA A100.1 - Safety of Corded Window Covering Products; Window Covering Manufacturers Association; 2007. (ANSI/WCMA A101.1)

1.03 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: For each type of product indicated, include:
      1. Styles, material descriptions, construction details, dimensions of individual components, profiles, features, finishes and operating instructions.
      2. Preparation instructions and recommendations, mounting details and installation methods.
      3. Storage and handling requirements and recommendations.
   C. Shop Drawings: Manufacturer's data sheets on each product to be used, including: location and extent of roller shades. Include elevations, sections, details, and dimensions not shown in Product Data. Show installation details, mountings, attachments to other work, operational clearances, and relationship to adjoining work.
   D. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
      1. Ceiling suspension system members and attachment to building structure.
      2. Ceiling-mounted or penetrating items including light fixtures, air outlets and inlets, speakers, sprinklers, recessed shades, and special moldings at walls, column penetrations, and other junctures of acoustical ceilings with adjoining construction.
      3. Shade mounting assembly and attachment.
      4. Size and location of access to shade operator and adjustable components.
      5. Minimum Drawing Scale: 1/4 inch = 1 foot.
   E. Selection Samples: For each finish product specified, one set of shade cloth options and aluminum finish color samples representing manufacturer's full range of available colors and patterns.
   F. Samples for Verification:
      1. For the following products:
         a. Shade Material: Not less than 12-inch square section of fabric, from dye lot used for the Work, with specified treatments applied. Show complete pattern repeat. Mark top and face of material.
         b. Valance: Full-size unit, not less than 12 inches long.
   G. Window Treatment Schedule: For roller shades using same designations indicated on Drawings and include opening sizes and key to typical mounting details.
   H. Maintenance Data: Include methods for maintaining roller shades, precautions regarding cleaning materials and methods, instructions for operating hardware and controls, in maintenance manuals.
1.04 QUALITY ASSURANCE
A. Manufacturer Qualifications: Obtain roller shades through one source from a single manufacturer with a minimum of five years experience in manufacturing products comparable to those specified in this section.
B. Installer Qualifications: Installer trained and certified by the manufacturer with a minimum of five years experience installing products comparable to those specified in this section.
C. Fire-Test-Response Characteristics: Passes NFPA 701 small and large-scale vertical burn. Materials tested shall be identical to products proposed for use.
D. Product Standard: Provide roller shades complying with WCMA A 100.1.

1.05 DELIVERY, STORAGE, AND HANDLING
A. Deliver shades in factory packages, marked with manufacturer and product name, fire-test-response characteristics, and location of installation using same designations indicated on Drawings and in a window treatment schedule.

1.06 PROJECT CONDITIONS
A. Environmental Limitations: Do not install roller shades until construction and wet and dirty finish work in spaces, including painting, is complete and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
B. Field Measurements: Where roller shades are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operable glazed units' operation hardware throughout the entire operating range. Notify Contracting Officer of discrepancies. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1.07 WARRANTY
A. Roller Shade Hardware, Chain and Shadecloth (except EcoVeilä): Manufacturer's standard non-depreciating twenty-five year limited warranty.
   1. EcoVeil standard non-depreciating 10-year limited warranty.
B. Roller Shade Installation: One year from date of Substantial Completion, not including scaffolding, lifts or other means to reach inaccessible areas.

PART 2 - PRODUCTS
2.01 MANUFACTURERS
A. Manually Operated Roller Shades:
   1. Basis of Design:
   2. Acceptable manufacturers pending conformance to basis of Design requirements:
      b. Solarfective Products Limited; www.solarfective.com
      c. Nysan Shading Systems Ltd.; www.nysan.com
      d. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 COMPONENTS
A. Shade Band Material: Fiberglass and acrylic blend.
   1. Fabric Width: As indicated on Drawings.
   2. Pattern: Mesh
   3. Style: EcoVeil by MechoShade or equivalent.
   4. Colors: As selected.
   6. Material Openness Factor: 3 percent.
   7. Material UV Blockage: 85 percent.
ROLLER SHADES

8. **Bottom Hem:** Straight.

B. **Rollers:**
   1. Electrogalvanized or epoxy primed steel or extruded-aluminum tube of diameter and wall thickness required to support and fit internal components of operating system and the weight and width of shade band material without sagging.
   2. Designed to be easily removable from support brackets.
   3. Removable spline fitting integral channel in tube manufacturer's standard method for attaching shade material.
   4. Provide capacity for one roller shade band(s) per roller, unless otherwise indicated on Drawings.
   5. Installations with a single row of aligned rollers are either regular or reverse roll. Installations with a double row of queued or overlapping rollers can be same roll or opposite. Coordinate direction of roll with fascia and pocket design.
   6. **Direction of Roll:** Regular, from back of roller.

C. **Standard Headbox Installation:**
   1. **Fascia:** L-shaped, formed-steel sheet or extruded aluminum; long edges returned or rolled; continuous panel concealing front and bottom of shade roller, brackets, and operating hardware and operators; length as indicated on Drawings; removable design for access.
   2. **Top/Back Cover:** L-shaped; material and finish to match fascia; combining with fascia and end caps to form a six-sided headbox enclosure sized to fit shade roller and operating hardware inside.

D. **Bottom Bar:** Steel or extruded aluminum, with plastic or metal capped ends. Provide exposed-to-view, external-type bottom bar with concealed weight bar as required for smooth, properly balanced shade operation.

E. **Mounting:** As indicated on Drawings, mounting permitting easy removal and replacement without damaging roller shade or adjacent surfaces and finishes.

F. **Shade Operation:** Manual; with continuous-loop bead-chain, clutch, and cord tensioner and bracket lift operator.
   1. **Position of Clutch Operator:** As indicated on Drawings.
   2. **Position of Clutch Operator:** Left side of roller, as determined by hand of user facing shade from inside, unless otherwise indicated on Drawings.
   3. **Clutch:** Capacity to lift size and weight of shade; sized to fit roller or provide adaptor.
   4. **Lift-Assist Mechanism:** Manufacturer's standard spring assist for balancing roller shade weight and lifting heavy roller shades.
   5. **Loop Length:** Length required to make operation convenient from floor level.
   6. **Bead Chain:** Stainless steel.
   7. **Cord Tensioner Mounting:** Wall.

2.03 **ACCESSORIES**

A. **Fascia:**
   1. Continuous removable extruded aluminum fascia that attaches to shade mounting brackets without the use of adhesives, magnetic strips, or exposed fasteners.
   2. **Fascia shall be able to be installed across two or more shade bands in one piece.**
   3. **Fascia shall fully conceal brackets, shade roller and fabric on the tube.**
   4. **Provide bracket / fascia end caps where mounting conditions expose outside of roller shade brackets.**
   5. **Notching of Fascia for manual chain shall not be acceptable.**
2.04 FABRICATION

A. Product Description: Roller shade consisting of a roller, a means of supporting the roller, a flexible sheet or band of material carried by the roller, a means of attaching the material to the roller, a bottom bar, and an operating mechanism that lifts and lowers the shade.

B. Concealed Components: Noncorrodible or corrosion-resistant-coated materials.
   1. Lifting Mechanism: With permanently lubricated moving parts.

C. Unit Sizes: Obtain units fabricated in sizes to fill window and other openings as follows, measured at 74 deg F:
   1. Shade Units Installed between (Inside) Jambs: Edge of shade not more than 1/4 inch from face of jamb. Length equal to head to sill dimension of opening in which each shade is installed.

D. Installation Brackets: Designed for easy removal and reinstallation of shade, for supporting fascia, roller, and operating hardware and for hardware position and shade mounting method indicated.

E. Installation Fasteners: No fewer than two fasteners per bracket, fabricated from metal noncorrosive to shade hardware and adjoining construction; type designed for securing to supporting substrate; and supporting shades and accessories under conditions of normal use.

F. Finish: Color-Coat metal components exposed to view. Apply manufacturer's standard baked finish complying with manufacturer's written instructions for surface preparation including pretreatment, application, baking, and minimum dry film thickness.

G. Finish: Clear anodized aluminum metal components exposed to view. Apply manufacturer's standard anodic finish complying with manufacturer's written instructions for surface preparation including pretreatment.

H. Colors of Metal and Plastic Components Exposed to View: Matching or coordinating with shade band color, unless otherwise indicated.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that openings are ready to receive the work.

B. Ensure structural blocking and supports are correctly placed.

C. Examine conditions for compliance with requirements for installation tolerances, operational clearances, and other conditions affecting performance.

D. Do not begin installation until substrates have been properly prepared.

E. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.03 COORDINATION

A. Coordinate requirements for distance between roller shades and glass with clearances between shade perimeter and surrounding construction, glass type, and placement of heating/cooling air supplies to avoid heat buildup and possible damage to glass. Generally retain option for 2 inches (50 mm) in paragraph below. See Evaluations and GANA's "Glazing Manual."
3.04 INSTALLATION
   A. Install shades in accordance with manufacturer's instructions.
   B. Install level, plumb, and aligned with adjacent units, and located so shade band is not closer than 2 inches to interior face of glass and allow clearances for window operation hardware.

3.05 ADJUSTING
   A. Adjust and balance shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

3.06 CLEANING AND PROTECTION
   A. Clean shade surfaces after installation, according to manufacturer's written instructions.
   B. Protect installed products until completion of project.
   C. Touch-up, repair or replace damaged products before Substantial Completion.

3.07 SCHEDULE
   A. RS-1:
      1. Basis of Design Manufacturer: Mechoshade
      2. Product: Manually operating roller shades
      3. Shadecloth: EcoVeil 1550 series, 100% Thermoplastic Olefin (3% open)
      4. Color: 1569 Silver Birch
      5. Anodized aluminum fascia
      6. See Alternate Section 01 23 00.

END OF SECTION
PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS
A. All work under this Section shall comply with the requirements of General Conditions, Supplemental Conditions, Special Conditions and Division 01 - General Requirements, and shall include all Fire Protection Sections specified herein.

1.2 SCOPE OF THIS SECTION
A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to, the following:
   1. Compliance with all codes and standards applicable to this jurisdiction
   2. Shop Drawings for Equipment
   3. Coordination Documents
   4. Record Drawings
   5. Start-up Service and Building Commissioning
   6. Instruction, Maintenance, and O & M Manuals
   7. Work associated with Delivery, Storage, and Handling of products
   8. Work associated with provision of Temporary Facilities
   9. Preparation of Posted Operating Instructions
   10. Meeting Project Safety and Indemnity requirements
   11. Proper Cleaning and Closing
   12. Supplying proper Warranty information
   13. Supply specified Guarantee documentation
   14. Design and provision of Supports and Anchors
   15. Pipe Portals
   16. Access Panels and Doors
   17. Identification Markers
   18. Coordination of Electrical requirements for equipment provided

1.3 DESCRIPTION OF WORK
A. The Contract Documents, including Specifications and Construction Drawings, are intended to provide all material and labor to install complete fire protection systems for the building.
B. The Contractor shall refer to the architectural interior details, floor plans, elevations, and the structural and other Contract Drawings and he shall coordinate his work with that of the other trades to avoid interference. The plans are diagrammatic and show generally the locations of the equipment and risers and are not to be scaled; all dimensions and existing conditions shall be checked at the building.
C. The Contractor shall comply with the project closeout requirements as detailed in General Requirements of Division 01.
D. Where project involves interface with existing building and site systems, effort has been made to note existing utilities and services. However, the Contractor should thoroughly familiarize themselves with existing conditions and be aware that in some cases information is not available as to concealed conditions, which exist in portions of the existing building affected by this work.

1.4 DESCRIPTION OF BID DOCUMENTS
A. Specifications:
   1. Specifications, in general, describe quality and character of materials and equipment.
   2. Specifications are of simplified form and include incomplete sentences.
1.5 DEFINITIONS

A. "Above Grade": Not buried in the ground and not embedded in concrete slab on ground.
B. "Actuating" or "Control" Devices: Automatic sensing and switching devices such as thermostats, pressure, float, electro-pneumatic switches and electrodes controlling operation of equipment.
C. "Below Grade": Buried in the ground or embedded in concrete slab on ground.
D. "Concealed": Embedded in masonry or other construction, installed in furred spaces, within double partitions or hung ceilings, in trenches, in crawl spaces, or in enclosures. In general, any item not visible or directly accessible.
E. "Connect": Complete hook-up of item with required service.
F. "Exposed": Not installed underground or "concealed."
G. "Furnish": To supply equipment and products as specified.
H. "Indicated," "Shown" or "Noted": As indicated, shown or noted on Drawings or Specifications.
I. "Install": To erect, mount and connect complete with related accessories.
J. "Motor Controllers": Manual or magnetic starters (with or without switches), individual push buttons or hand-off-automatic (HOA) switches controlling the operation of motors.
K. "Piping": Pipe, tube, fittings, flanges, valves, controls, strainers, hangers, supports, unions, traps, drains, insulation, and related items.
L. "Provide": To supply, install and connect as specified for a complete, safe and operationally ready system.
M. "Reviewed," "Satisfactory" or "Directed": As reviewed, satisfactory, or directed by or to Architect/Engineer/Owner.
N. "Rough-In": Provide all indicated services in the necessary arrangement suitable for making final connections to fixture or equipment.
O. "Shall": An exhortation or command to complete the specified task.
P. "Similar" or "Equal": Of base bid manufacture, equal in materials, weight, size, design, and efficiency of specified products.
Q. "Supply": To purchase, procure, acquire and deliver complete with related accessories.
R. "Typical" or "Typ": Exhibiting the qualities, traits, or characteristics that identify a kind, class, number, group or category. Of or relating to a representative specimen. Application shall apply to all other similarly identified on plan or detail.
S. "Will": A desire to complete the specified task. Allows some flexibility in application as opposed to "Shall."
T. "Wiring": Raceway, fittings, wire, boxes and related items.
U. "Work": Labor, materials, equipment, apparatus, controls, accessories, and other items required for proper and complete installation.

1.6 RELATED WORK SPECIFIED ELSEWHERE

A. All Division 21 Fire Suppression sections included herein.
B. Division 02: Existing Conditions. Coordinate with Civil Engineer.
   1. Coordination of excavation of trenches and the installation of piping on site.
BASIC MATERIALS AND METHODS - FIRE PROTECTION

C. Division 07: Thermal and Moisture Protection.
   1. Sealants and caulking
   2. Firestopping

D. Division 09: Finishes:
   1. Division 21 installers shall perform all painting, except where specifically stated otherwise in Division 09.

E. Division 26: Electrical is related to work of:
   1. Fire protection alarms and relays
   2. Detectors and monitoring
   3. Life safety provisions

1.7 CODES AND STANDARDS

A. The Contractor is cautioned that code requirements not explicitly detailed in these specifications or drawings, but which may be reasonably inferred or implied from the nature of the project, must be provided as part of the contract.

B. Perform all tests required by governing authorities and required under all Division 21 Sections. Provide written reports on all tests.

C. Electrical devices and wiring shall conform to the latest standards of NEC; all devices shall be UL listed and labeled.

D. All excavation work must comply with all provisions of state laws including notification to all owners of underground utilities at least 48 business day hours, but not more than 10 business days, before commencing an excavation.

E. Provide in accordance with rules and regulations of the following:
   1. Building Codes enforced by the Authority Having Jurisdiction in Oregon:
      b. 2010 Oregon Mechanical Specialty Code (OMSC) based on 2009 International Mechanical Code (IMC) and International Fuel Gas Code (IFGC) with State Amendments
      c. 2011 Oregon Plumbing Code (OPC) based on 2009 Uniform Plumbing Code (UPC) with State Amendments
      d. Oregon Fire Code (Based on the International Fire Code)
      e. National Electric Code (NEC) with State Amendments
   2. Local, city, county and state codes and ordinances
   3. Local Bureau of Buildings
   4. Local Health Department
   5. Local and State Fire Prevention Districts
   6. State Administrative Codes

F. Provide in accordance with appropriate referenced standards of the following:
   1. NFPA - National Fire Protection Association
   2. CSA - Canadian Standards Association
   3. ANSI - American National Standards Institute
   4. ASME - American Society of Mechanical Engineers
   5. ASTM - American Society for Testing Materials
   6. AWS - American Welding Society
   7. AWWA - American Water Works Association
   8. FM - Factory Mutual
   9. MSS - Manufacturer's Standardization Society
   10. NEMA - National Electrical Manufacturer's Association
BASIC MATERIALS AND METHODS - FIRE PROTECTION

11. UL - Underwriter's Laboratories
12. ADA - Americans with Disabilities Act
13. ETL - Electrical Testing Laboratories
14. IAPMO - International Association of Plumbing and Mechanical Officials

1.8 QUALITY ASSURANCE

A. Manufacturer's Nameplates: Nameplates on manufactured items shall be aluminum or Type 304 stainless steel sheet, not less than 20 USG (0.0375"), riveted or bolted to the manufactured item, with nameplate data engraved or punched to form a non-erasable record of equipment data.

B. Current Models. All work shall be as follows:
   1. Manufactured items furnished shall be the current, cataloged product of the manufacturer.
   2. Replacement parts shall be readily available and stocked in the USA.

C. Experience: Unless more stringent requirements are specified in other sections of Division 21, manufactured items shall have been installed and used, without modification, renovation or repair, on other projects for not less than one year prior to the date of bidding for this project.

1.9 GENERAL REQUIREMENTS

A. Examine all existing conditions at building site.
B. Review contract documents and technical specifications for extent of new work to be provided.
C. Provide and pay for all permits, licenses, fees and inspections.
D. Install equipment and materials to provide required access for servicing and maintenance. Coordinate the final location of concealed equipment and devices requiring access with final location of required access panels and doors. Allow ample space for removal of all parts that require replacement or servicing. This work shall include furnishing and installing all access doors required for mechanical access.
E. Coordinate equipment and materials installation with other building components.
F. Verify all dimensions by field measurements.
G. Arrange for chases, slots, and openings in other building components to allow for installations.
H. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
I. Sequence, coordinate, and integrate installations of materials and equipment for efficient flow of the work. Give particular attention to equipment requiring positioning prior to closing-in the building.
J. Coordinate the cutting and patching of building components to accommodate the installation of equipment and materials. Contractor to provide for all cutting and patching required for installation of his work unless otherwise noted.
K. Install fire protection services and overhead equipment to provide the maximum headroom possible.
L. Install equipment to facilitate maintenance and repair or replacement of equipment components. Connect equipment for ease of disconnecting, without interference with other installations.
M. Coordinate the installation of materials and equipment above ceilings with ductwork, piping, conduits, suspension system, light fixtures, cable trays, and other installations.
N. Coordinate connection of systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
BASIC MATERIALS AND METHODS - FIRE PROTECTION

O. Coordinate with Owner in advance to schedule shutdown of existing systems to make new connections. Provide valves in new piping to allow existing system to be put back in service with minimum down time.

P. All materials (such as insulation, ductwork, piping, wiring, controls, etc.) located within air plenum spaces, air shafts, and occupied spaces shall have a flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E84 (NFPA 255) Method. In addition, the products, when tested, shall not drip flame particles, and flame shall not be progressive. Provide Underwriters Laboratories, Inc., label or listing, or satisfactory certified test report from an approved testing laboratory to prove the fire hazard ratings for materials proposed for use do not exceed those specified.

Q. Coordinate installation of floor drains and floor sinks with work of other trades, such that finished floor slopes to drains and floor sinks are flush with surrounding floor.

R. Products made of or containing lead, asbestos, mercury or other known toxic or hazardous materials are not acceptable for installation under this Division. Any such products installed as part of the work of the Division shall be removed and replaced and all costs for removal and replacement shall be borne solely by the installing Contractor.

1.10 MINOR DEVIATIONS

A. The Contractor shall review the structural and architectural conditions and drawings affecting his work. It is the specific intention of this section that the contractor's scope of work shall include
   1. Proper code complying support systems for all equipment whether or not scheduled or detailed on drawings or in these specifications
   2. Minor deviations from the mechanical plans required by architectural and structural coordination.

B. The Contractor shall study the operational requirements of each system, and shall arrange his work accordingly, and shall furnish such fittings, offsets, supports, accessories, as are required for the proper and efficient installation of all systems from the physical space available for use by this section. This requirement extends to the Contractor's coordination of this section's work with the "Electrical Work." Should conflicts occur due to lack of coordination, the time delay, cost of rectification, demolition, labor and materials, shall be borne by the Contractor and shall not be at a cost to the Owner.

C. Advise the Architect, in writing, in the event a conflict occurs in the location or connection of equipment. Bear all costs for relocation of equipment, resulting from failure to properly coordinate the installation or failure to advise the Architect of conflict.

1.11 PRODUCT SUBSTITUTIONS

A. The Contractor shall certify the following items are correct when using substituted products other than those scheduled or shown on the drawings as a basis of design:
   1. The proposed substitution does not affect dimensions shown on drawings.
   2. The Contractor shall pay for changes to building design, including engineering design, detailing, structural supports, and construction costs caused by proposed substitution.
   3. The proposed substitution has no adverse effect on other trades, construction schedule, or specified warranty requirements.
   4. Maintenance and service parts available locally are readily obtainable for the proposed substitute.

B. The Contractor further certifies function, appearance, and quality of proposed substitution are equivalent or superior to specified item.

C. The Contractor agrees that the terms and conditions for the substituted product that are found in the contract documents apply to this proposed substitution.
1.12 SHOP DRAWINGS AND EQUIPMENT SUBMITTALS
A. See Section 211000.

1.13 COORDINATION DOCUMENTS
A. See Section 211000.

1.14 START-UP SERVICE AND BUILDING COMMISSIONING
A. Prior to start-up, be assured that systems are ready, including checking the following: Proper equipment rotation, proper wiring, auxiliary connections, lubrication, venting, controls, and installed and properly set relief and safety valves.
B. Provide services of factory-trained technicians for start-up of pumps and other major pieces of equipment. Certify in writing compliance with this Paragraph, stating names of personnel involved and the date work was performed.
C. Refer to other Division 21 Sections for additional requirements.

1.15 INSTRUCTION, MAINTENANCE, AND O&M MANUALS
A. O&M Manuals: Upon completion of the work, the Contractor shall submit to the Architect complete set of operating instructions, maintenance instructions, part lists, and all other bulletins and brochures pertinent to the operation and maintenance for equipment furnished and installed as specified in this section, bound in a durable binder. Refer to Division 01.
B. The Contractor shall be responsible for proper instruction of Owner's personnel for operation and maintenance of equipment, and apparatus installed as specified in Division 21 to be no less than 2 hours for each piece of equipment.

1.16 DELIVERY, STORAGE AND HANDLING
A. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage, and handling.
B. Store equipment and materials in an environmentally controlled area at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage. Piping shall be stored in bundles covered with Visqueen. Piping showing signs of rust shall be removed from site and replaced.
C. Coordinate deliveries of materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.

1.17 POSTED OPERATING INSTRUCTIONS
A. Furnish approved operating instructions for systems and equipment indicated in the technical sections for use by operation personnel. The operating instructions shall include wiring diagrams, control diagrams, and control sequence for each principal system and equipment. Print or engrave operating instructions and frame under glass or in approved laminated plastic. Post instructions where directed. Attach or post operating instructions adjacent to each principal system and equipment including start-up, operating, shutdown, safety precautions and procedure in the event of equipment failure. Provide weather-resistant materials or weatherproof enclosures for operating instructions exposed to the weather. Operating instructions shall not fade when exposed to sunlight and shall be secured to prevent easy removal.
1.18 SAFETY AND INDEMNITY

A. The Contractor shall be solely and completely responsible for conditions of the job site including safety of all persons and property during performance of the work. This requirement will apply continuously and not be limited to normal hours of work.

B. No act, service, Drawing, review, or Construction Review by the Owner, Architect, the Engineers or their consultants, is intended to include the review of the adequacy of the Contractor’s safety measures, in, on, or near the construction site.

C. The Contractor performing work under this Division of the Specifications shall hold harmless, indemnify and defend the Owner, the Architect, the Engineers and their consultants, and each of their officers, employees and agents from any and all liability claim, losses or damage arising, or alleged to arise from bodily injury, sickness, or death of a person or persons, and for all damages arising out of injury to or destruction of property arising directly or indirectly out of, or in connection with, the performance of the work under the Division of the Specifications, and from the Contractor’s negligence in the performance of the work described in the Construction Contract Documents; but not including the sole negligence of the Owner, the Architect, the Engineers, and their consultants or their officers, employees and agents.

1.19 CLEANING AND CLOSING

A. All work shall be inspected, tested, and approved before being concealed or placed in operation.

B. Upon completion of the work, all equipment installed as specified in this section, and all areas where work was performed, shall be cleaned to provide operating conditions satisfactory to the Architect.

1.20 WARRANTIES

A. All equipment shall be provided with a minimum one-year warranty to include parts and labor. Refer to individual Equipment Specifications for extended or longer-term warranty requirements.

B. Provide complete warranty information for each item, to include product or equipment, date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, telephone numbers and procedures for filing a claim and obtaining warranty services.

C. Service during warranty period: Contractor shall provide maintenance as specified elsewhere during the 12-month warranty period.

1.21 GUARANTEE

A. The Contractor shall guarantee and service all workmanship and materials to be as represented by him and shall repair or replace, at no additional cost to the Owner, any part thereof which may become defective within the period of one (1) year after the Date of Final Acceptance, ordinary wear and tear excepted.

B. Contractor shall be responsible for and pay for any damages caused by or resulting from defects in Contractors work.

PART 2 - PRODUCTS

2.1 GENERAL

A. Furnish and install all new material, equipment, and apparatus hereinafter specified unless specifically noted otherwise. All material, equipment, and apparatus shall be identified by the manufacturer’s name, nameplate, and pertinent data.

B. All materials, equipment, and apparatus are mentioned as standards unless noted otherwise. The words “or approved equal” shall be considered to be subsequent to all manufacturers’ names used herein, unless specifically noted that substitutes are not allowed.
2.2 SUPPORTS AND ANCHORS

A. General: Comply with applicable codes pertaining to product materials and installation of supports and anchors, including, but not limited to, the following:
1. UL and FM Compliance: Provide products, which are UL listed and FM approved.
2. ASCE 7-05: “American Society of Civil Engineers.”
3. 2006 International Building Code (IBC)
4. MSS Standard Compliance: Manufacturer’s Standardization Society (MSS).
6. NFPA: Pamphlet number 13 and 14 for fire protection systems.
7. Provide copper plated or plastic coated supports and attachment for copper piping systems. Field applied coatings or tape is unacceptable.

B. Horizontal Piping Hangers and Supports: Except as otherwise indicated, provide factory-fabricated hangers and supports of one of the following MSS types listed.
1. Adjustable Steel Clevis Hangers: MSS Type 1.
2. Adjustable Steel Swivel Band Hangers: MSS Type 10.
4. Pipe Slides and Slide Plates: MSS Type 35, including one of the following plate types:
   a. Plate: Unguided type.
   b. Plate: Guided type.
   c. Plate: Hold-down clamp type.
5. Pipe Saddle Supports: MSS Type 36, including steel pipe base support and cast iron floor flange.
6. Pipe Saddle Supports with U-Bolt: MSS Type 37, including steel pipe base support and cast iron floor flange.
7. Adjustable Pipe Saddle Supports: MSS Type 38, including steel pipe base support and cast iron floor flange.
8. Single Pipe Roller with Malleable Sockets: MSS Type 41.
9. Adjustable Roller Hangers: MSS Type 43.
10. Pipe Roll Stands: MSS Type 44.
11. Pipe Guides: Provide factory-fabricated guides of cast semi-steel or heavy fabricated steel, consisting of a bolted two-section outer cylinder and base with a two-section guiding spider bolted tight to pipe. Size guide and spiders to clear pipe and insulation (if any), and cylinder. Provide guides of length recommended by manufacturer to allow indicated travel.

C. Horizontal Cushioned Pipe Clamp: Where pipe hangers are called out to absorb vibration or shock install a piping clamp with thermoplastic elastomer insert. Cush-A-Clamp or equal.

D. Vertical Piping Clamps: Provide factory-fabricated two-bolt vertical piping riser clamps, MSS Type 8.

E. Hanger-Rod Attachments: Except as otherwise indicated, provide factory-fabricated hanger-rod attachments of one of the following MSS types listed.
1. Steel Turnbuckles: MSS Type 13.
2. Steel Clevises: MSS Type 14.
3. Swivel Turnbuckles: MSS Type 15.
5. Steel Weldless Eye Nuts: MSS Type 17.
F. Building Attachments: Except as otherwise indicated, provide factory-fabricated building attachments of one of the following types listed.

1. Concrete Inserts: MSS Type 18 or Blue Banger Hanger by Simpson
2. Steel Brackets: One of the following for indicated loading:
   b. Medium Duty: MSS Type 32.
   c. Heavy Duty: MSS Type 33.
3. Horizontal Travelers: MSS Type 58.
4. Internally Threaded Expansion Shell Anchors: By Simpson or approved equal.
5. Concrete Screw Anchors: Titen HD by Simpson or approved equal.

G. Saddles and Shields (for heat traced pipe): Except as otherwise indicated, provide saddles or shields under piping hangers and supports, factory-fabricated, for all insulated piping. Size saddles and shields for exact fit to mate with pipe insulation.

1. Pipe Covering Protection Saddles: MSS Type 39; fill interior voids with segments of insulation matching adjoining insulation.
2. Insulation Protection Shields: MSS Type 40, 18” minimum, or of the length recommended by manufacturer to prevent crushing of insulation. High-density insulation insert lengths shall match or exceed shield length.
3. Thermal Hanger Shields: Constructed of 360° insert of waterproofed calcium silicate (60 psi flexural strength minimum) encased in 360° sheet metal shield. Provide assembly of same thickness as adjoining insulation. Shield length shall match or exceed length of calcium silicate insert.
4. Thermal Hanger Couplings: Constructed of high strength plastic coupling to retain tubing and join insulation at clevis hangers and strut-mounted clamps. Klo-Shure Insulation Coupling or equal.

H. Miscellaneous Materials:

1. Metal Framing: Provide products complying with NEMA STD ML1.
2. Steel Plates, Shapes, and Bars: Provide products complying with ASTM A36.
3. Cement Grout: Portland Cement (ASTM C150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C404, Size No. 2). Mix at a ratio of 1.0 part cement to 3.0 parts sand by volume, with minimum amount of water required for placement and hydration.
4. Heavy-Duty Steel Trapezes: Fabricate from steel shapes selected for loads required. Weld steel in accordance with AWS standards.
5. Pipe Brackets: “HoldRite” copper plated brackets. Insulate brackets attached to metal studs with felt.

2.3 ACCESS PANELS AND ACCESS DOORS

A. Provide all access doors and panels to serve equipment under this work, including those which must be installed, in finished architectural surfaces. Frame of 16-gauge steel, door of 20 gauge steel. 1” flange width, continuous piano hinge, key operated, prime coated. Refer to Architectural Specifications for the required product Specification for each surface. Contractor is to submit schedule of access panels for approval. Exact size, number and location of access panels is not shown on Plans. Access doors shall be of a size to permit removal of equipment for servicing. Access door shall have same rating as the wall or ceiling in which it is mounted. Provide access panel for each concealed valve. Use no panel smaller than 12” x 12” for simple manual access, or smaller than 24” x 24” where personnel must pass through. Provide cylinder lock for access door serving mixing or critical valves in public areas.
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B. Included under this work is the responsibility for verifying the exact location and type of each access panel or door required to serve equipment under this work and in the proper sequence to keep in tune with construction and with prior approval of the Architect. Access doors in fire rated partitions and ceilings shall carry all label ratings as required to maintain the rating of the rated assembly.

C. Acceptable Manufacturers: Milcor, Karp, Nystrom, or Elmdor/Stoneman.

D. Submit markup of architectural plans showing size and location of access panels required for equipment access for approval by Architect.

2.4 IDENTIFICATION MARKERS

A. Mechanical Identification Materials: Provide products of categories and types required for each application as referenced in other Division 21 Sections. Where more than single type is specified for application, selection is installer's option, but provide single selection for each product category. Stencils are not acceptable.

B. Plastic Pipe Markers:
   2. Pressure Sensitive Type: Provide pre-printed, permanent adhesive, color coded, pressure sensitive vinyl pipe markers, complying with ANSI A13.1. Secure both ends of markers with color coded adhesive vinyl tape.
   3. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastic.

C. Underground-Type Plastic Line Markers: Provide 6” wide x 4 mils thick multi-ply tape, consisting of solid metallic foil core between 2 layers of plastic tape. Markers to be permanent, bright colored, continuous printed, intended for direct burial service.

D. Valve Tags:
   1. Plastic Laminate Valve Tags: Provide 3/32” thick engraved plastic laminate valve tags, with piping system abbreviations in 1/4” high letters and sequenced valve number 1/2” high, and with 5/32” hole for fasteners.
   2. Valve Tag Fasteners: Provide solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.
   3. Access Panel Markers: Provide 1/16” thick engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve. Include 1/8” center hole to allow attachment.
   4. Non-potable Water Tags: 1/16” thick, engraved, plastic tags as indicated on Drawings.

E. Plastic Equipment Signs:
   1. Provide 4-1/2” x 6” plastic laminate sign, ANSI A.13 color coded with engraved white core lettering.
   2. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.
   3. Nomenclature: Include the following, matching terminology on schedules as closely as possible:
      a. Name and plan number
      b. Equipment service
      c. Design capacity
      d. Other design parameters, such as pressure drop, entering and leaving conditions, rpm, etc.

F. Acceptable Manufacturers: Craftmark, Seton, Brady, Marking Services, Inc., or Brimar.

NOTICE OF ALTERNATE BILLING CYCLE: The Contract will allow the Owner to require the submission of billings or estimates in billing cycles other than 30-day cycles. Billing or statements shall be submitted monthly ending on the last day of the month.

NOTICE OF EXTENDED PAYMENT PROVISION: The Contract will allow the Owner to make payment within 30 days after the date a billing or estimate is received.
BASIC MATERIALS AND METHODS - FIRE PROTECTION

2.5 ELECTRICAL

A. General:
   1. All electrical material, equipment, and apparatus specified herein shall conform to the requirements of Division 26.

B. Quality Assurance:
   1. Electrical components and materials shall be UL or ETL listed/labeled as suitable for location and use - no exceptions.

C. Low Voltage Control Wiring:
   1. General: 14 gauge, Type THHN, color coded, installed in conduit.
   2. Manufacturer: General Cable Corp., Alcan Cable, American Insulated Wire Corp., Senator Wire and Cable Co., or Southwire Co.

PART 3 - EXECUTION

3.1 GENERAL

A. Workmanship shall be performed by licensed journeymen or master fitter and shall result in an installation consistent with the best practices of trades.

B. Install work uniform, level and plumb, in relationship to lines of building. Do not install any diagonal, or otherwise irregular work unless so indicated on Drawings or approved by Architect.

3.2 MANUFACTURER'S DIRECTIONS

A. Follow manufacturers' directions and recommendations in all cases where the manufacturers of articles used on this Contract furnish directions covering points not shown on the Drawings or covered in these Specifications.

3.3 INSTALLATION

A. Coordinate the work between the various Fire Protection Sections and with the work specified under other Divisions. If any cooperative work must be altered due to lack of proper supervision or failure to make proper and timely provisions, the alternations shall be made to the satisfaction of the Engineer and at the Contractor’s cost. Coordinate wall and ceiling work with the General Contractor, and his subcontractors in locating ceiling air outlets, wall registers, etc.

B. Inspect all material, equipment, and apparatus upon delivery and do not install any damaged or defected materials.

3.4 SUPPORTS AND HANGERS

A. Installation of Building Attachments: Install building attachments at required locations within concrete or on structural steel for proper piping support. Install additional building attachments where support is required for additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed. Fasten insert securely to forms. Where concrete with compressive strength less than 2,500 psi is indicated, install reinforcing bars through opening at top of inserts.

B. Proceed with installation of hangers, supports, and anchors only after required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including, but not limited to, proper placement of inserts, anchors, and other building structural attachments.
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C. Install hangers, supports, clamps, and attachments to support piping properly from building structure. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze-type hangers where possible. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping.

D. Install hangers within 12 inches of every change in piping direction, end of pipe run or concentrated load, and within 36 inches of every major piece of equipment. Hangers shall be installed on both sides of flexible connections. Where flexible connection connects directly to a piece of equipment only one hanger is required.

E. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.

F. Support sprinkler piping and gas independently of other piping.

G. Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper plated, or by other recognized industry methods.

H. Hanger Spacing in accordance with following minimum schedules (other spacings and rod sizes may be used in accordance with the NFPA):
   1. Steel Pipe (Water Filled):
      
      | Pipe Size       | Max. Hanger Spacing | Rod Size |
      |-----------------|---------------------|----------|
      | 1/2" to 1 1/4"  | 5 feet              | 3/8"     |
      | 1 1/2" to 2"    | 7 feet              | 3/8"     |
      | 2 1/2" to 3"    | 10 feet             | 1/2"     |
      | 4" and larger   | 12 feet             | 5/8"     |

I. Provisions for Movement:
   1. Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
   2. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connecting equipment.
   3. Insulated Piping: Comply with the following installation requirements:
      a. Clamps: Attach clamps, including spacers, (if any), to piping with clamps projecting through insulation.
      b. Shields: Where low compressive strength insulation or vapor barriers are indicated on cold or chilled water piping, install shields or inserts.
      c. Saddles: Where insulation without vapor barrier is indicated install protection saddles.

J. Installation of Anchors:
   1. Install anchors at proper locations to prevent excessive stresses and to prevent transfer of loading and stresses to connected equipment.
   2. Fabricate and install anchor by welding steel shapes, plates and bars to piping and to structure.
   3. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions, to limit movement of piping and forces to maximums recommended by manufacturer for each unit.
   4. Anchor Spacings: Where not otherwise indicated, install anchors at ends of principal pipe runs, at intermediate points in pipe runs between expansion loops and bends.
BASIC MATERIALS AND METHODS - FIRE PROTECTION

K. Equipment Supports:
1. Provide all concrete bases, unless otherwise furnished as work of Division 03. Furnish to Division 03 Contractor scaled layouts of all required bases, with dimensions of bases, and location to column centerlines. Furnish templates, anchor bolts, and accessories necessary for base construction.
2. Provide structural steel stands to support equipment not floor mounted or hung from structure. Construct of structural steel members or steel pipe and fittings. Provide factory-fabricated tank saddles for tanks.

L. Adjusting:
1. Hanger Adjustment: Adjust hangers so as to distribute loads equally on attachments.
2. Support Adjustment: Provide grout under supports so as to bring piping and equipment to proper level and elevations.
3. Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer’s touch-up paint.

3.5 RAILS, PIPE PORTALS

A. Install per manufacturer’s instructions.
B. Coordinate with other trades they are installed when roofing is being installed.

3.6 ELECTRICAL REQUIREMENTS

A. Fire Protection Contractor shall coordinate with Division 26 work to provide complete systems as required to operate all devices installed under this Division of work.

B. Installation of Electrical Connections: Furnish, install, and wire (except as may be otherwise indicated) all fire protection motors and controls in accordance with the following schedule and in accordance with equipment manufacturer’s written instructions and with recognized industry practices, and complying with applicable requirements of UL, NEC, and NECA’s “Standard of Installation” to ensure that products fulfill requirements.

C. Division 21 has responsibilities for electrically powered or controlled fire protection equipment which is specified in Division 21 Specifications or scheduled on Division 15 Drawings. The specific division of responsibilities between Division 21 and 26 for furnishing or wiring this equipment is as follows:
1. Division 21 Responsibilities:
   a. DISCONNECTS: Provide the disconnects which are part of factory wired Division 21 equipment. Factory wiring to include wiring between motor and disconnect or combination starter/disconnect.
   b. CONTROLS: Division 21 Contractor is responsible for the following equipment in its entirety. This equipment includes but is not limited to the following:
      1) Control relays necessary for controlling Division 21 equipment.
      2) Low or non-load voltage control components
      3) Non-life safety related valve actuators
      4) Solenoid valves, EP and PE switches
   c. FIRE AND LIFE SAFETY EQUIPMENT:
      1) Fire Sprinkler System: Division 21 is responsible for providing necessary controls including flow switches and alarm bells.
      2) Specialized fire suppression systems: Division 21 is responsible for providing necessary system controls and any required control interface wiring to these controls. Division 26 is responsible for bringing power to point of connection with the system.
D. Division 26 has responsibilities for electrically powered or controlled mechanical equipment which is specified in Division 21 Specifications or scheduled on Division 21 Drawings. The specific division of responsibilities between Division 21 and 26 for furnishing or wiring this equipment is as follows:

1. Division 26 Electrical Responsibilities:
   a. DISCONNECTS: Provide all disconnects necessary for Division 21 mechanical equipment which are not provided as part of factory wired Division 21 equipment. Provide power wiring to all disconnects. In addition provide power wiring between motor and disconnect when the disconnect is not factory installed. See also Variable Frequency Drive above for special wiring requirements.
   b. CONTROLS: Division 26 Contractor is responsible for providing power to control panels and control circuit outlets.
   c. FIRE AND LIFE SAFETY EQUIPMENT:
      1) Fire Sprinkler System: Division 26 is responsible for providing power wiring to fire protection controls including flow switches and alarm bells.
      2) Specialized fire suppression systems: Division 26 is responsible for providing power wiring to suppression system and its controls.

2. Coordinate with other work, including wires/cables, raceway and equipment installation, as necessary to properly interface installation of electrical connections for equipment with other work.

3. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer’s written instructions and wiring diagrams. Mate and match conductors of electrical connections for proper interface between electrical power supplies and installed equipment.

4. Maintain existing electrical service and feeders to occupied areas and operational facilities, unless otherwise indicated, or when authorized otherwise in writing by Owner, or Architect/Engineer. Provide temporary service during interruptions to existing facilities. When necessary, schedule momentary outages for replacing existing wiring systems with new wiring systems. When that “cutting-over” has been successfully accomplished, remove, relocate, or abandon existing wiring as indicated.

5. Cover splices with electrical insulating material equivalent to, or of greater insulation resistivity rating, than electrical insulation rating of those conductors being spliced.

6. Prepare cables and wires, by cutting and stripping covering armor, jacket, and insulation properly to ensure uniform and neat appearance where cables and wires are terminated. Exercise care to avoid cutting through tapes which will remain on conductors. Also avoid “ringing” copper conductors while skinning wire.

3.7 IDENTIFICATION MARKERS

A. General: Where identification is to be applied to surfaces which require insulation, painting, or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

B. Piping System Identification:
   1. Install pipe markers on each system indicated to receive identification, and include arrows to show normal direction of flow.
   2. Locate pipe markers as follows:
      a. Near each valve and control device
      b. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern
      c. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures
      d. At access doors, manholes, and similar access points which permit view of concealed piping
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e. Near major equipment items and other points of origination and termination
f. Spaced horizontally at maximum spacing of 20' along each piping run, with minimum of one in each room. Vertically spaced at each story transverse.

C. Underground Piping Identification: During backfilling/topsoiling of each exterior underground piping system, install continuous underground-type plastic line marker, located directly over buried line at 6” to 8” below finished grade. Where multiple small lines are buried in common trench and do not exceed overall width of 16”, install single line marker.

D. Equipment Identification: Locate engraved plastic laminate signs on or near each major item of mechanical equipment and each operational device. Provide signs for the following:

1. Main control and operating valves, including safety devices
2. Meters, gauges and similar units
3. Compressors, chillers, and similar motor-driven units
4. Tanks and pressure vessels
5. Sprinkler and standpipe equipment

E. Text of Signs: In addition to name of identified unit, provide lettering to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations. Equipment signs shall include an identification of the area or other equipment served by the equipment being labeled.

3.8 TESTING

A. Provide all tests specified hereinafter and as otherwise required. Provide all test equipment, including gauges, instruments, sprinkler Heads and other equipment required. Test all rotational equipment for proper direction of rotation. Upon completion of testing, certify to the Architect, in writing, that the specified tests have been performed and that the installation complies with the specified requirements and provide a report of the test observations signed by qualified inspector.

END OF SECTION
PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS
A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 210500 - Basic Materials and Methods, and other Sections in Division 21 specified herein.

1.2 DEFINITIONS
A. Pipe sizes used in this Section are nominal pipe size (NPS) specified in inches.
B. Working plans as used in this Section refer to documents (including drawings and calculations) prepared pursuant to requirements in NFPA 13 for obtaining approval of authority having jurisdiction.
C. NICET - National Institute for Certification In Engineering Technologies
D. Other definitions for fire protection systems are included in referenced NFPA standards.

1.3 DESCRIPTION OF WORK
A. The work includes designing new, providing and installing a complete and fully operable automatic sprinkler system as described in this Section of the Specification and as shown on the contract construction drawings and shall be in accordance with rules, regulations and standards as required by the following authorities having jurisdiction.
   1. State of Oregon
   2. City of Eugene
   3. Building Department
   4. Fire Prevention Division, Fire Marshal's Office
   5. University of Oregon
B. Work to be in accordance with criteria of the following design and installation standards:
   2. National Fire Protection Association
      a. No. 13 - Sprinkler Systems
      b. No. 14 - Standpipes & Hose Systems
      c. No. 24 - Private Fire Service Mains
      d. No. 70 - National Electrical Code
      e. No. 101-Life Safety Code
   6. Underwriters Laboratories, Inc.
   7. Industrial Risk Insurance Underwriters
   8. Owner’s insurance agency
C. Work includes but is not limited to the following:
   1. Automatic Wet Type Sprinkler System
   2. Standpipes: Wet type
   3. All cutting and patching.
   4. Provide all pipe, fittings, sprinklers, valves, signs, flow switches, tamper switches, protective painting, test connections, drains and tests necessary to make the entire system complete and operative.
   5. Coordinate with plumbing contractor for capacity of all sprinkler main, test, and auxiliary drain connections.
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6. Valve tags and instruction plates shall be mounted and/or hung per local fire department requirements.
7. All sleeves and inserts.

1.4 SUBMITTALS

A. Product Data: Submit six copies of manufacturer’s technical data and installation instructions for fire protection materials and products.
1. Thirty days after the awarding of contract, contractor shall submit list of manufacturer’s names and model numbers for approval to architect. This list shall identify any prior approved substituted items contractor wishes to use. Do not submit technical data until list has been approved. This is mandatory.
2. Prior to construction submit for approval items including but not be limited to the following:
   a. Coordinated layout drawings. Lettering shall be minimum 1/8” high
   b. Sprinklers and escutcheons - designating area of use
   c. Valves, valve boxes, flow switches, and tamper switches
   d. Pipe, fittings, sway bracing, inserts, anchors and hangers
   e. Inspector’s test and drain station
   f. Hose valves, pressure relief valves, and pressure reducing valves

B. Working Plans: Prepare scaled working plans for fire protection pipe and fittings including, but not necessarily limited to, pipe and tube sizes, locations, and elevations and slopes of horizontal runs, wall and floor penetrations, and connections. Indicate interface between and spatial relationship to piping and adjacent equipment. Lettering shall be minimum 1/8” high. All design work shall be done under supervision of licensed engineer.
1. Spacing of fire sprinklers shall be coordinated with lights, air conditioning outlets, sound speakers, architectural reflected ceiling plan; obstruction from light fixtures and other architectural features; and sprinkler piping shall be coordinated with HVAC ductwork & piping, plumbing, electrical conduit, cable trays and structure prior to the installation.
   Drawings shall be composite type including mechanical, plumbing and lighting equipment with sprinkler and sprinkler drain piping.

C. Submittal Drawings: Submit shop drawings to Agency having jurisdiction for approval bearing engineer of record stamp. Submit six approved copies, bearing stamp and/or signature of authority having jurisdiction to the Engineer for approval.
1. Contractor shall submit sprinkler head locations to architect for approval.
2. Each calculation shall include legible schematic of system showing all hydraulic reference points.

D. Hydraulic Calculations: Prepare hydraulic calculations of fire protection systems. Submit to authority having jurisdiction for approval. Submit six approved copies, bearing stamp, and/or signature of Agency having jurisdiction to Owner’s representative for approval.
1. Contractor shall submit published piping friction loss data from manufacturer with hydraulic calculations.

E. Certificate of Installation: Submit certificate upon completion of fire protection piping work, which indicates that work has been tested in accordance with NFPA 13, and also that system is operational, complete, and has no defects.

F. Maintenance Data: Submit maintenance data and parts lists for fire protection materials and products. Include this data, product data, shop drawings, approval drawings, approval calculation, certificate of installation, and record drawings in maintenance manual; in accordance with requirements of the General Conditions and of Division 01.
FIRE PROTECTION

G. Operating and Maintenance Instructions: Provide the Owner with three sets of operating and maintenance instructions covering completely the operation and maintenance of sprinkler equipment and controls. Manual shall be assembled in a 3-ring binder and arranged in following sections:

1. Site Utilities: Drawings showing location, size, depth of all connections, valve boxes, manholes, etc., as installed.
2. Section No. 1: A chart tabulating all types of pipe fittings, valves, and piping specialties installed in each system.
3. Section No. 2: A chart tabulating all pressures, valve settings for fire department and sprinkler pressure reducing valves as required by S.F.F.D. Provide pressure reducing valve flow test documentation.
4. Section No. 3: Manufacturer's brochures of all sprinkler heads.
5. Section No. 4: Tamper switches and flow switches.
6. Section No. 5: Fire Department connections.
7. Section No. 6: Reproducible copies of approved working drawings prepared to facilitate the actual installation of ductwork and piping. Drawings shall indicate location of all concealed valves, and other apparatus.
9. Section No. 8: Approval Calculations.
10. Section No. 9: Certificate of Installation.
11. Section No. 10: Guarantees.
12. The Contractor is responsible for proper instruction of Owner’s personnel for operation and maintenance of all material, equipment and apparatus provided.

1.5 DESIGN DESCRIPTION

A. This section of the specification combined with any of the contract drawings are intended as a guide to establish a basis of design for the systems required.

B. Contractor shall examine the existing building, the Architectural, Plumbing, Interior Design, Structural, Mechanical and Electrical drawings, layout and install a completely hydraulically sized sprinkler system for all existing and new areas. Space shall be provided for any valving and equipment to be used.
1. System shall start at five feet from the building exterior and extend throughout the new and existing portions of the building.
2. Contractor shall contact Owner’s insurance agency to incorporate insurer’s design requirements in this layout document. Factory Mutual shall review layout drawings and calculations. Incorporate all of their design criteria into documents.

C. The building shall be served with a wet type sprinkler system.

D. All areas shall be sprinklered as the construction progresses, including accessible pipe chases, elevator pits, etc.

E. Pressure restricting devices shall be installed on any branch outlet exceeding 100 PSI.

F. All electrical devices used for this system shall be compatible with the fire alarm system, refer to Division 26.

G. Seismic Requirement: All automatic sprinkler and standpipe system to be seismically braced and anchored for IBC Seismic Zone D, FM and NFPA 13. Submit shop drawings on methods and materials.
1. Do not use NFPA Earthquake Zone Chart.
FIRE PROTECTION

1.6 HYDRAULIC DESIGN

A. System shall be a straight line or gridded system per NFPA No. 13 with the following exceptions:
   1. For all systems the design area shall be the hydraulically most demanding rectangular area.
   2. Minimum pressure for any sprinkler head shall not be less than 7 psi.

B. Fire Standpipes: Pipe schedule per IBC Chapter 9 or hydraulically calculated at 500 GPM for first standpipe and 250 GPM for each additional standpipe. Wet standpipes shall maintain 100 Psi at top of each riser.

C. Total Combined Inside & Outside Hose Allowances: Hydraulic calculations shall include an allowance for hose streams, added at the point of connection to the water supply.

D. Safety Factor: 10 Psi, or 10 percent of static and residual pressure, whichever is greater.

E. Light Hazard Areas: Water density of 0.10 GPM per square foot calculated for an area of 1500 square feet in the most remote location.

F. Ordinary Group I Hazard Areas: Water density of 0.15 GPM per square foot calculated for an area of 1500 square feet in the most remote locations.

G. Ordinary Group II Hazard Areas: Water density of 0.20 GPM per square foot calculated for an area of 1500 square feet in the most remote locations.

H. Head spacing shall not exceed the limits described in NFPA Pamphlet No. 13.
   1. Light Hazard: 225 sq.ft. (for smooth ceiling)
   2. Ordinary Hazard: 130 sq. ft.
   3. Extra Hazard: 100 sq. ft.

I. Maximum floor areas protected by any one sprinkler system riser:
   1. Light Hazard: 52,000 sq.ft.
   2. Ordinary Hazard: 52,000 sq.ft.

J. Flow Data: Contractor is to verify flow data (static pressure, residual pressure and GPM flowing) available at site and provide design for available pressure and flow.

1.7 RELATED WORK SPECIFIED ELSEWHERE

A. Section 210500: Basic Materials and Methods

B. Division 26: Electrical. Coordinate for electrical wiring of detectors, flow alarm switches, tamper switches, fire alarm bell connection by life safety section for remote monitoring. All electrical devices used for this system shall be compatible with the fire alarm system.

C. Division 09: Finishes.

D. Division 02: Existing Conditions. Coordinate with General Contractor for excavation for the underground water supply system.

E. Coordination with Plumbing for drain

1.8 QUALITY ASSURANCE

A. The Contractor for the fire protection installation shall be duly qualified Fire Protection Contractor, experienced and regularly engaged in the installation of fire protection systems with a license classification of C-16. Where local authorities require additional licensing of the Fire Protection Contractor, and/or workmen, such a license shall be mandatory for a prospective Contractor.
   1. Contractor is to verify flow data (static pressure, residual pressure and GPM flowing) available at site and provide design for available pressure and flow.
   2. The Fire Protection contractor shall be the Engineer of Record for the automatic sprinkler and standpipe system.

SERA Architects, Inc.

NOTICE OF ALTERNATE BILLING CYCLE: The Contract will allow the Owner to require the submission of billings or estimates in billing cycles other than 30-day cycles. Billing or statements shall be submitted monthly ending on the last day of the month.

NOTICE OF EXTENDED CERTIFICATION PROVISION: The Contract will allow the Owner to certify billings and estimate within 20 days after the billings and estimates are received from the original contractor.

NOTICE OF EXTENDED PAYMENT PROVISION: The Contract will allow the Owner to make payment within 30 days after the date a billing or estimate is received.
FIRE PROTECTION

3. Permits - The Fire Protection Contractor shall obtain permits for the installation or construction as required for approval and installation of the fire protection system. The Fire Protection Contractor shall submit working plans to the authorities having jurisdiction to obtain approval.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Division 01. Handle components carefully to prevent damage, denting, and scoring. Do not install damaged components. Damaged components shall be replaced with new components.

B. Store/protect products under provisions of Division 01. Store components in clean, dry place. Protect from weather, dirt, water, construction debris, and physical damage.

1.10 GUARANTEE

A. Provide a one-year (12 months) guarantee under provisions of Division 01. The guarantee shall include parts, shipping, labor, travel costs, living expenses, required fees, and any other associated cost or expense to repair or replace products or systems. The guarantee period is to begin on the date of acceptance of the fire protection installation by the Owner.

PART 2 - PRODUCTS

2.1 GENERAL

A. All products to be commercial grade, new and of the manufacturer’s latest design model. Products manufacturers outside of North America will not be accepted without written approval from engineer prior to submission of bid.

B. All products to be UL listed and/or FM approved, except for items, which are not required to be listed by code.

C. All products shall be delivered and stored in original containers. Containers shall be clearly marked or stamped with manufacturer’s name and rating.

D. The following items to be included but specified under Section 210500: Basic Materials and Methods.
   1. Hangers and supports
   2. Escutcheons plates, flashings and sleeves
   3. Access panel and doors
   4. Identification markers and signs
   5. Expansion compensators and flexible connectors
   6. Anchors and seismic restraints
   7. Excavation and backfill

E. Coordination: All piping and pre-action system in basement data center area will be required to be fully coordinated with data center design team prior to installation.

2.2 UNDERGROUND PIPE COATING:

A. All underground ferrous piping shall be covered with:
   1. Either two coats of 10 Mill Scotch Wrap No. 51, or with;
   2. “XTRU-COAT” prefabricated extruded cover with joints sealed with two coats of 10 Mill Scotch Wrap #51.
   3. Or approved equal

2.3 THRUST BLOCKS

A. Provide thrust blocks at changes in pipe direction, changes in pipe sizes, dead-end stops and at valves.
FIRE PROTECTION

B. Calculate area of undisturbed earth of thrust block based on actual soil conditions and water test pressure of 200 Psi.

C. Concrete and reinforcing steel shall be as specified in Division 03 and 05. All concrete shall be Class A, unless specified otherwise.

D. Miscellaneous nuts and bolts shall be stainless steel.

2.4 RODS AND CLAMPS

A. Socket clamps shall be stainless steel; four bolt type, equipped with stainless steel socket clamp washers and nuts Grinnell Fig. 595 and 594, Elcen Fig. 37 and 37X, or equal.

B. Rods shall be stainless steel, 3/4” diameter.

2.5 PIPE AND FITTINGS - ABOVE GROUND

A. General: The piping products listed below by manufacturer's name and model numbers are the only acceptable materials listed for this project. Substitutions of pipe must be submitted and approved in writing by the architect prior to bid. No copper pipe shall be allowed in the wet fire sprinkler system.

B. Piping or fittings that show substantial rust or breaks in coating will be removed and replaced.

C. Allied Tube & Conduit: Schedule 40 black steel, ASTM A-135 stamped on pipe, UV cured acrylic finish; Stockham, Grinnell or Warwick Class 150 threaded malleable, ASTM A197, ASTM A126, or Victaulic roll-grooved fittings and couplings, only.

D. Allied Tube: Scheduled 10 black steel pipe, ASTM A-135 stamped on pipe, UV cured acrylic finish; Victaulic roll-grooved fittings and couplings.

E. Shop-weld thread-o-lets may be used in lieu of tee fittings, but field (site) welding will not be permitted.

F. Mechanical Couplings: Victaulic grooved couplings style 07, 75 or 77, or equal by Gruvlok.

G. Mechanical Tees: Victaulic style 920, Gruvlok. U-bolt mechanical tees are not acceptable.

H. Flexible sprinkler connector for suspended ceiling sprinkler application: Flexhead or equal Factory Mutual approved system.

I. Use rigid couplings where flexibility is not required or provide necessary sway bracing.

J. Prohibited Piping and Fittings: Copper pipe, CPVC pipe, pipe less than schedule 40 for threaded or less than schedule 10 for roll grooving; Super 40 "Dyna-Flow", "Dyna-Thread", "Fireflow", XL Thinnaw, "Eddyite" by Bullmoose and Threadable Lightwall pipe are not allowed. POZ-LOK, U-bolt Victaulic style 921 mechanical tees, Victaulic style 99 Roust-A-Bout, Victaulic style 90 Plainlock, Hooker style fitting, quick disconnect, boltless, snap-joint, field drilling or welding of any main or branch lines, and any device specifically prohibited by the local authority having jurisdiction is not allowed. No unions shall be permitted for any size pipe. Plain end fittings are not allowed.

2.6 SPRINKLER HEADS - GENERAL

A. Sprinkler heads shall be regular automatic closed-type heads of ordinary degree temperature rating except that sprinkler heads installed in the vicinity of heating equipment or in special occupancy areas shall be of the temperature rating as described in NFPA No. 13.

B. Provide quick response heads in all new light hazard occupancies.

C. Provide corrosion-resistant sprinkler heads where they are exposed to weather, moisture or corrosive vapors.
NOTICE OF ALTERNATE BILLING CYCLE: The Contract will allow the Owner to require the submission of billings or estimates in billing cycles other than 30-day cycles. Billing or statements shall be submitted monthly ending on the last day of the month.

NOTICE OF EXTENDED CERTIFICATION PROVISION: The Contract will allow the Owner to certify billings and estimates within 20 days after the billings and estimates are received from the original contractor.

NOTICE OF EXTENDED PAYMENT PROVISION: The Contract will allow the Owner to make payment within 30 days after the date a billing or estimate is received.

FIRE PROTECTION

D. The Contractor shall furnish spare heads. The heads shall be packed in a suitable container and shall be representative of, and in proportion to, the number of each type and temperature rating head installed. In addition to the spare heads, the contractor shall furnish not less than two special sprinkler head wrenches. Refer to NFPA 13 section; "Stock of Spare Heads".

2.7 SPRINKLER HEADS AND ESCUTCHEONS

A. Sprinkler heads installed shall be upright or pendant, as conditions require, and shall be of the following type and finish for the areas designated. Unless otherwise specified, sprinklers shall be small frame type, center bulb capsule for finished areas, fusible link for unfinished areas, and ½” orifice. Extended coverage sprinkler heads are not allowed.

<table>
<thead>
<tr>
<th>Building Area</th>
<th>Sprinkler Head</th>
<th>Sprinkler Finish</th>
<th>Escutcheon Finish</th>
<th>Temp. Deg.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unfinished Retail, Office, Garage &amp; Mechanical Rooms</td>
<td>Upright/Pendant</td>
<td>Brass</td>
<td>None</td>
<td>165°F</td>
</tr>
<tr>
<td>Electrical, Telephone &amp; Switchgear Rooms</td>
<td>Upright</td>
<td>Brass</td>
<td>None</td>
<td>286°F</td>
</tr>
<tr>
<td>Finished Ceilings</td>
<td>Semi-recessed Pendant</td>
<td>White</td>
<td>White</td>
<td>165°F</td>
</tr>
<tr>
<td></td>
<td>Concealed Pendant</td>
<td>Brass</td>
<td>White Coverplate</td>
<td>165°F</td>
</tr>
<tr>
<td>Soffit</td>
<td>Flush Sidewall</td>
<td>White</td>
<td>White</td>
<td>165°F</td>
</tr>
<tr>
<td>Sidewall</td>
<td>Horizontal Sidewall</td>
<td>Brass</td>
<td>None</td>
<td>165°F</td>
</tr>
</tbody>
</table>

B. Manufacturer: TYCO only.

2.8 VALVING

A. 2” or Smaller:
   1. Control Valve: OS&Y rising stem type gate valve bronze body, bonnet and disc, copper alloy stem, threaded ends, 175 PSI WOG min. Provide with tamper switch.
   2. Check Valve: Swing check type with bronze body, cap and disc, threaded ends, 175 PSI WOG min.
   3. Drip Valve: 3/4", cast brass automatic ball drip type, threaded ends, 175 PSI WOG min.
   4. Testing Valve: 1-1/4", test and drain, sight glass, ½” test orifice, lever operated, 300 psi WOG. Drain to mop sink or drain riser.
   5. Main Drain Valve: 2", angle gate valve, bronze body, copper alloy stem, threaded ends, 175 psi WOG. Drain to mop sink or drain riser.

B. 2-1/2” or Larger:
   1. Control Valve: Lug type wafer valve with tamper switch, ductile iron body, nickel plated ductile iron disc, stainless steel stem and Buna-N seat, 175 PSI WOG min.
   2. Control Valve: OS&Y rising stem type gate valve, cast iron body and bonnet, bronze stem, seat and disc, flanged ends, 175 PSI WOG min. Provide with tamper switch.
   3. Check Valve: Swing check type with cast iron body, bolted cap and disc, flanged ends, 175 PSI WOG min.
   4. Manufacturer: Grinnell, Stockham, Milwaukee, Mueller, Kennedy, Elkart or AGF.
2.9 BACKFLOW PREVENTER
   A. Provide listed backflow prevention device as required by local codes and ordinances. Backflow prevention devices installed in the vertical position shall be approved for that orientation.
   B. Double check detector check valve assembly: Epoxy coated, ductile iron construction, 175 Psig working pressure, complete with two spring loaded "Y" type check valves, "Y" strainer with hose bibb on suction side of assembly, two OS&Y gate valves, test cocks, bypass water meter and bypass double-check. Febco #856-DCDA, Conbraco or approved equal.

2.10 WET and dry SPRINKLER ALARM CHECK VALVEs
   A. Contractor shall provide completely engineered wet alarm check valve, retarding chamber, and trim assembly for each floor. Viking #H-2, Tyco or Reliable.
   B. Contractor shall provide completely engineered dry alarm check valve, air supply, and trim assembly for each stair standpipe. Tyco DPV-1, Viking, or Reliable.

2.11 VALVE BOXES
   A. Cast iron valve boxes for shutoff valves buried in ground shall be complete with bellbottoms, extension piece, top and cover. Boxes shall be suitable for the types of valves with which they are used. All valve boxes shall have a concrete collar flush with grade.
   B. Lids shall have the applicable letters embossed upon the top surface. Tagging shall match existing lids.
   C. Manufacturer: Tyler, ITT Grinnell, or equal.

2.12 INTEGRAL INSPECTORS ALARM TEST AND SYSTEM DRAIN
   A. Combination system drain and visible orifice insert/sight glass for testing system alarm; with screwed or grooved inlet and outlet connections, Malleable iron hand wheel, EPDM valve seats, maximum working pressure 300 Psi, 1/2" orifice insert, Bronze housing, UL listed and FM Approved. Victaulic TestMaster II style 720, or approved equal.
   B. Water pressure gauge, range 0-300 Psi, in 5 Psi increments, brass case - 3-1/2" diameter, 1/4" NPT male pipe connection, UL listed. Locate pressure gage on riser per code. Star Sprinkler, Ashcroft or approved equal.
   C. Pressure gauge test valve, brass 1/4" screwed ends, 300 Psi WOG. United or approved equal.
   D. All relief, main, auxiliary and equipment drains shall be routed separately to floor drain or air gap fitting (by plumbing).

2.13 TAMPER SWITCHES
   A. Switch shall be mounted so as not to interfere with normal operation of the valve and be adjusted to operate when handle of valve has traveled more than one-fifth the distance of its normal operating position. Electrical Contractor shall provide conduit from switch to fire alarm panel.
   B. Housing shall be of aluminum, acid-treated, primed and finished in baked red enamel. Removal of housing shall cause switch to operate. Inside shall be single pole, double throw micro switch with connection for electrical conduit.
   C. Install on all control valves.
   D. Manufacturer: Potter-Electric, Notifier, Ellenco, or Simplex.
2.14 EXTERIOR ALARM
A. Electric bell, 10” diameter, U.L. listed, 120 VAC, 99 dB at 10 FT; Potter model PBA12010 or equal.
B. Provide signage stating “IF RINGING CALL 911”
C. Electric Horn: Potter-Electric, Ellenco, Notifier, or Simplex weatherproof, 120 VAC.

2.15 FIRE DEPARTMENT HOSE VALVES
A. Fire Department Valves: 2-1/2” brass construction female to male angle valve with cap and chain, rough chrome finish and mounted 48” above finished floor.
B. Manufacturer: Croker, Elkhart, Powhatan Brass, Potter-Roemer or Zurn.

2.16 ROOF MANIFOLD
A. 6” x 2-1/2” x 2-1/2” straight pattern cast brass roof manifold, Croker Model No. 294 or approved equal.

2.17 2.15 PRE-ACTION SYSTEM
A. System Components
   1. Deluge Valve
   2. Deluge Valve Trim Including:
      a. Test Drain Valve
      b. Auxiliary Drain Valve
      c. Drain Cup
      d. Drip Check
      e. Alarm Test Shut Off Valve
      f. Strainer Orifice Check Valve
      g. Pressure Operated Relief Valve
      h. Priming Valve
      i. Emergency Release
      j. Priming Pressure Gauge and Valve
      k. Water Supply Pressure Gauge and Valve
   3. Water Flow Alarm Trim:
      a. Alarm Pressure Switch
   4. Riser Valves:
      a. Water Supply Control Valve
      b. Rubber Seat Check Valve
      c. System Main Drain Valve
   5. System Air Supply Trim:
      a. System Pressure Gauge and Valve
      b. Soft Seat Check Valve
      c. Air Supervisory Pressure Switch
      d. Air Supply Control Valve
      e. Dry System Air Supply
   6. Release Trim:
      a. Strainer
      b. Solenoid Valve

PART 3 - EXECUTION

3.1 GENERAL
A. This system to be installed by an experienced firm regularly engaged in the installation of automatic sprinkler system as specified by the requirements of the Specifications.
3.2 PERFORMANCE OF WORK

A. Examine areas and conditions under which materials are to be installed. Layout the system to suit the different types of construction and equipment as indicated on the drawings and in accordance with NFPA Pamphlet No. 13 and 14.

B. Work to start immediately after authorization has been given to proceed so that the overall progress of the construction is not delayed.

C. Coordinate with other trades as necessary to properly interface components of the sprinkler system.

D. Follow manufacturer's directions and recommendations in all cases.

E. The omission from the drawings or Specifications of any details of construction, installation, materials, or essential specialties shall not relieve the Contractor from furnishing the same in place for a complete system.

3.3 TEMPORARY FIRE PROTECTION

A. Provide all temporary valving, piping, Siamese connections and other components as directed by the fire agency office during all phases of construction.

3.4 INSTALLATION - GENERAL

A. Fire protection system shall be installed in accordance with the approved Drawings. The finished ceiling is not to be erected until all fire protection piping has been installed, tested, and inspected. Sprinkler heads located in the electrical equipment, elevator, or similar rooms shall be furnished with deflectors to prevent water spray on equipment.

B. The arrangement of all pipes shall conform to all architectural requirements and field conditions, shall be as straight and direct as possible, forming right angles or parallel lines with building walls and other pipes, and shall be neatly spaced. Offsets will be permitted only where required to permit the pipes to follow the walls. Standard fittings shall be used for offsets. All risers shall be erected plumb and true, shall be parallel with the walls and other pipes, and shall be neatly spaced. All work shall be coordinated with HVAC, Plumbing, Electrical and Structural work in order to avoid interference and unnecessary cutting of floors or walls.

C. All sprinkler heads to be installed in ceilings throughout the scope of work building as listed in Section 2.6. All areas without ceilings shall have rough brass upright or pendent heads as shown on drawings.

D. Sprinkler heads in all finished areas are to be installed on a true axis line in both directions, with maximum deviation from the axis line of 1 inch plus or minus and shall be plus or minus 1" within center of tile. At the completion of the installation, if any heads are found to exceed the above-mentioned tolerance, they shall be removed and reinstalled.

E. No pipes or other apparatus shall be installed so as to interfere in any way with full swing of doors.

F. The arrangement, positions, and connections of pipes, drains, valves, etc., shall be as required by NFPA Pamphlet #13 for all areas to be sprinklered. However, the right is reserved by the Architect to change the location of any item to accommodate conditions, which may arise during progress of the work, without additional compensation for such changes provided that no additional heads are required prior to the installation of the work.

G. Where required, piping shall be installed concealed in building construction, or though steel beams, to obtain adequate head room.

H. All pipe throughout the job shall be reamed smooth before being installed. Pipe shall not be split, bent, flattened, or otherwise injured either before or during installation.
NOTICE OF ALTERNATE BILLING CYCLE: The Contract will allow the Owner to require the submission of billings or estimates in billing cycles other than 30-day cycles. Billing or statements shall be submitted monthly ending on the last day of the month.

NOTICE OF EXTENDED CERTIFICATION PROVISION: The Contract will allow the Owner to certify billings and estimates within 20 days after the billings and estimates are received from the original contractor.

NOTICE OF EXTENDED PAYMENT PROVISION: The Contract will allow the Owner to make payment within 30 days after the date a billing or estimate is received.

I. Provide protective pans under pipes passing over high voltage electrical bus duct or switchgear equipment. The pan shall be constructed of 12 gauge black iron with a 6 inch lip, the corners being welded to make the pans watertight. Each pan shall be given three coats of Rust-Oleum paint and shall be supported by pipe hangers. The pan shall drain clear of the bus duct or switchgear.

J. All pipe interiors shall be thoroughly cleaned of foreign matter before installation, and shall be kept clean during installation by plugging or other approved means. Piping shall be covered with Visqueen during storage. Piping that shows signs of rusting will be removed from job site and replaced.

K. Field Connections: Any modifications to system required by field conditions, physical equipment changes or compliance with code regulations shall be made promptly without cost to Owner.

L. Interference: No piping or sprinkler devices shall interfere with the operations of any door, window or mechanical and electrical systems. No part of this system shall visibly be installed in the physical parameter of any window. Sprinkler mains and branch piping shall not interfere with existing or future ceiling, light fixtures and HVAC diffusers.

M. Threaded Pipe: Threads shall be clean cut, standard and tapered. Threads shall be made up using flaked graphite and lubricating oil, piping compound or Teflon tape applied to the male threads only.

N. Grooved Pipe: Installation shall be as prescribed in the Victaulic Piping Manual only. Holes in the piping are to be made in the fabrication shop, not at the job site. Contractor shall provide at the project site a sample of each type of coupling (threaded, standard grooved coupling and mechanical type), showing complete assembly with pipe connections.

O. Keep all pipe and other openings closed to prevent entry of foreign matter. Cover all equipment and apparatus to protect against dirt, water, chemical or mechanical damage, before and during construction period. Restore to original condition all apparatus and equipment damaged prior to final acceptance, including restoration of damaged shop coats of paint.

P. Location of sprinkler piping is critical.
   1. Where ceiling space is at a minimum under beams location of ductwork takes precedence, coordinate accordingly.
   2. Include in base bid (3) two-hour coordination meetings with Owner, Architect, and Engineer for coordination of sprinkler pipe routing.
   3. Coordinate beam and shear wall penetrations with Structural Engineer. Obtain written approval for all beam penetrations from Structural Engineer.

Q. Elevator Pits: For hydraulic elevators provide sprinkler heads in elevator pits per elevator code. Provide control valve with tamper switch to each pit area. Coordinate with Division 26 Fire Alarm System.

R. Tracer wire shall be wrapped and taped to non-metallic underground piping at maximum 20 foot intervals.

3.5 SLEEVES AND FLASHINGS

A. Wherever pipes are exposed and pass through walls, floors, partitions or ceilings, they shall be fitted with chromium plated steel escutcheons held in place with setscrews. Care shall be taken to protect the escutcheons during the course of construction.

B. Penetrations through fire rated walls and floors shall be sealed with listed mastic of similar fire rating.

3.6 HANGERS, INSERTS, SUPPORTS, AND SWAY BRACING

A. Hangers and supports shall be installed per NFPA #13 sections on Hangers and Protection of Piping Against Damage Where Subject to Earthquake. Provide restraint from movement at end sprinkler on branch line per NFPA 13.
FIRE PROTECTION

3.7 SAFETY TESTING & VERIFICATION
   A. Flush, test, and inspect sprinkler piping systems according to NFPA 13 Chapter "System Acceptance."
   B. Provide NFPA 13 Contractor's Material & Test Certificate Form 85A for above ground piping and Form 85B for underground piping.
   C. Provide manpower to test the function and performance of all Life Safety System components and devices per floor and per zone basis in accordance with the local requirements.

3.8 IDENTIFICATION
   A. In addition to the requirements of Section 210500, provide pipe markers every 20 feet, once in every room, and at each building level traversed, minimum.
   B. Provide hydraulic design data nameplates on the riser of each sprinkler system in accordance with NFPA 13
   C. Equipment such as valves, drains, etc., shall be provided with signs that identify type of equipment and service. The tag shall be securely fastened to the handle or spindle of the valve by a brass chain. Furnish four schedules of valves so tagged. There shall also be furnished four diagrammatic charts showing schematically the complete sprinkler system with major control valves and numbers thereof. One set of Schedules and charts shall be mounted in glazed frames located where directed.

3.9 AS-BUILT RECORD DRAWINGS AND CERTIFICATION
   A. As-built Record Drawings are to be kept up-to-date and the Master Copy kept at the job site. Prior to final acceptance of work being approved, these drawings are to be turned over to the Owner's Representative for approval.
   B. Written certification from the insuring agents, and authorities having jurisdiction that the tests were satisfactory.
   C. After installation is complete and tests satisfactorily approved, deliver test certificates and approval by the local Fire Authorities and the FMA to the architect. Final acceptance of sprinkler/standpipe system by Owner's Representative shall be contingent upon receipt of certificate and approval from authorities having jurisdiction and for the delivery of final As-Built Drawings.

END OF SECTION
PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS

A. All work under this Section shall comply with the requirements of General Conditions, Supplemental Conditions, Special Conditions and Division 01 - General Requirements, and shall include all Plumbing Sections specified herein.

1.2 SCOPE OF THIS SECTION

A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to, the following:
   1. Compliance with all codes and standards applicable to this jurisdiction
   2. Shop Drawings for Equipment
   3. Coordination Documents
   4. Record Drawings
   5. Start-up Service and Building Commissioning
   6. Instruction, Maintenance, and O & M Manuals
   7. Work associated with Delivery, Storage, and Handling of products
   8. Work associated with provision of Temporary Facilities
   9. Preparation of Posted Operating Instructions
   10. Meeting Project Safety and Indemnity requirements
   11. Proper Cleaning and Closing
   12. Supplying proper Warranty information
   13. Supply specified Guarantee documentation
   14. Design and provision of Supports and Anchors
   15. Pipe Portals
   16. Equipment Rails
   17. Access Panels and Doors
   18. Identification Markers
   19. Coordination of Electrical requirements for equipment provided

1.3 DESCRIPTION OF WORK

A. The Contract Documents, including Specifications and Construction Drawings, are intended to provide all material and labor to install complete plumbing systems for the building and shall interface with all existing building systems affected by new construction.

B. The Contractor shall refer to the architectural interior details, existing installation, floor plans, elevations, and the structural and other Contract Drawings and he shall coordinate his work with that of the other trades to avoid interference. The plans are diagrammatic and show generally the locations of the fixtures, equipment, and pipeline and are not to be scaled; all dimensions and existing conditions shall be checked at the building.

C. The Contractor shall comply with the project closeout requirements as detailed in General Requirements of Division 01.

D. Project involves interface with existing building and site systems, effort has been made to note existing utilities and services. However, the Contractor should thoroughly familiarize themselves with existing conditions and be aware that in some cases information is not available as to concealed conditions, which exist in portions of the existing building affected by this work.

1.4 DESCRIPTION OF BID DOCUMENTS

A. Specifications:
   1. Specifications, in general, describe quality and character of materials and equipment.
   2. Specifications are of simplified form and include incomplete sentences.
B. Drawings:
1. Drawings in general are diagrammatic and indicate sizes, locations, connections to equipment and methods of installation.
2. Before proceeding with work check and verify all dimensions.
3. Assume all responsibility for fitting of materials and equipment to other parts of equipment and structure.
4. Make adjustments that may be necessary or requested, in order to resolve space problems, preserve headroom, and avoid architectural openings, structural members and work of other trades.
5. Where existing pipes, conduits and/or ducts prevent installation of new work as indicated, relocate, or arrange for relocation, of existing pipes, conduits and/or ducts. Verify exact location and elevation of existing piping prior to any construction.
6. If any part of Specifications or Drawings appears unclear or contradictory, apply to Architect or Engineer for his interpretation and decision as early as possible, including during bidding period.

1.5 DEFINITIONS
A. "Above Grade": Not buried in the ground and not embedded in concrete slab on ground.
B. "Actuating" or "Control" Devices: Automatic sensing and switching devices such as thermostats, pressure, float, electro-pneumatic switches and electrodes controlling operation of equipment.
C. "Below Grade": Buried in the ground or embedded in concrete slab on ground.
D. "Concealed": Embedded in masonry or other construction, installed in furred spaces, within double partitions or hung ceilings, in trenches, in crawl spaces, or in enclosures. In general, any item not visible or directly accessible.
E. "Connect": Complete hook-up of item with required service.
F. "Exposed": Not installed underground or "concealed."
G. "Furnish": To supply equipment and products as specified.
H. "Indicated," "Shown" or "Noted": As indicated, shown or noted on Drawings or Specifications.
I. "Install": To erect, mount and connect complete with related accessories.
J. "Motor Controllers": Manual or magnetic starters (with or without switches), individual push buttons or hand-off-automatic (HOA) switches controlling the operation of motors.
K. "Piping": Pipe, tube, fittings, flanges, valves, controls, strainers, hangers, supports, unions, traps, drains, insulation, and related items.
L. "Provide": To supply, install and connect as specified for a complete, safe and operationally ready system.
M. "Reviewed," "Satisfactory" or "Directed": As reviewed, satisfactory, or directed by or to Architect/Engineer/Owner.
N. "Rough-In": Provide all indicated services in the necessary arrangement suitable for making final connections to fixture or equipment.
O. "Shall": An exhortation or command to complete the specified task.
P. "Similar" or "Equal": Of base bid manufacture, equal in materials, weight, size, design, and efficiency of specified products.
Q. "Supply": To purchase, procure, acquire and deliver complete with related accessories.
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R. “Typical” or “Typ”: Exhibiting the qualities, traits, or characteristics that identify a kind, class, number, group or category. Of or relating to a representative specimen. Application shall apply to all other similarly identified on plan or detail.

S. "Will": A desire to complete the specified task. Allows some flexibility in application as opposed to "Shall."

T. "Wiring": Raceway, fittings, wire, boxes and related items.

U. "Work": Labor, materials, equipment, apparatus, controls, accessories, and other items required for proper and complete installation.

1.6 RELATED WORK SPECIFIED ELSEWHERE

A. All Division 22 Plumbing sections included herein.

B. Division 02: Existing Conditions. Coordinate with Civil Engineer.
   1. Coordination of excavation of trenches and the installation of mechanical systems and piping on site.

C. Division 03: Concrete.
   1. All concrete work for Plumbing Division shall be included in Division 22 under the appropriate Sections and shall include:
      a. Concrete curbs and housekeeping pads for the mechanical equipment.
      b. Thrust blocks, pads, and boxes for mechanical equipment.
      c. Coordination of floor drain and floor sink installations in sloped floors.

D. Division 05:

E. Division 07: Thermal and Moisture Protection.
   1. Flashing and sheet metal
   2. Sealants and caulking
   3. Firestopping

F. Division 09: Finishes:
   1. Division 22 installers shall perform all painting, except where specifically stated otherwise in Division 09.
   2. Painting of all exposed steel, piping, insulation, equipment and materials.
   3. Paint all exposed gas piping, interior and exterior to the building, yellow.

G. Division 26: Electrical is related to work of:
   1. Power connections to all plumbing equipment
   2. Life safety provisions

1.7 CODES AND STANDARDS

A. The Contractor is cautioned that code requirements not explicitly detailed in these specifications or drawings, but which may be reasonably inferred or implied from the nature of the project, must be provided as part of the contract.

B. Perform all tests required by governing authorities and required under all Division 22 Sections. Provide written reports on all tests.

C. Electrical devices and wiring shall conform to the latest standards of NEC; all devices shall be UL listed and labeled.

D. All plumbing work shall comply with the Americans with Disabilities Act (ADA).

E. All excavation work must comply with all provisions of state laws including notification to all owners of underground utilities at least 48 business day hours, but not more than 10 business days, before commencing an excavation.
F. Provide in accordance with rules and regulations of the following:
   1. Building Codes enforced by the Authority Having Jurisdiction in Oregon:
      b. 2010 Oregon Mechanical Specialty Code (OMSC) based on 2009 International Mechanical Code (IMC) and International Fuel Gas Code (IFGC) with State Amendments
      c. 2011 Oregon Plumbing Code (OPC) based on 2009 Uniform Plumbing Code (UPC) with State Amendments
      d. Oregon Fire Code (Based on the International Fire Code)
      e. National Electric Code (NEC) with State Amendments
   2. Local, city, county and state codes and ordinances
   3. Local Bureau of Buildings
   4. Local Health Department
   5. Local and State Fire Prevention Districts
   6. State Administrative Codes

G. Provide in accordance with appropriate referenced standards of the following:
   1. NFPA - National Fire Protection Association
   2. CSA - Canadian Standards Association
   3. ANSI - American National Standards Institute
   4. ASHRAE - American Society of Heating, Refrigerating & Air Conditioning Engineers
   5. ASME - American Society of Mechanical Engineers
   6. ASTM - American Society for Testing Materials
   7. AWS - American Welding Society
   8. AWWA - American Water Works Association
   9. FM - Factory Mutual
   10. MSS - Manufacturer's Standardization Society
   11. NEMA - National Electrical Manufacturer's Association
   12. SMACNA - Sheet Metal and Air Conditioning Contractors National Association
   13. UL - Underwriter's Laboratories
   14. ADA - Americans with Disabilities Act
   15. ETL - Electrical Testing Laboratories
   16. ASSE - American Society of Sanitary Engineers
   17. PDI - Plumbing and Drainage Institute
   18. IAPMO - International Association of Plumbing and MechanicalOfficials
   19. CISPI - Cast Iron Soil Pipe Institute

1.8 QUALITY ASSURANCE

A. Manufacturer's Nameplates: Nameplates on manufactured items shall be aluminum or Type 304 stainless steel sheet, not less than 20 USG (0.0375”), riveted or bolted to the manufactured item, with nameplate data engraved or punched to form a non-erasable record of equipment data.

B. Current Models. All work shall be as follows:
   1. Manufactured items furnished shall be the current, cataloged product of the manufacturer.
   2. Replacement parts shall be readily available and stocked in the USA.

C. Experience: Unless more stringent requirements are specified in other sections of Division 22, manufactured items shall have been installed and used, without modification, renovation or repair, on other projects for not less than one year prior to the date of bidding for this project.

1.9 GENERAL REQUIREMENTS

A. Examine all existing conditions at building site.

B. Review contract documents and technical specifications for extent of new work to be provided.

C. Provide and pay for all permits, licenses, fees and inspections.
D. Install equipment and materials to provide required access for servicing and maintenance. Coordinate the final location of concealed equipment and devices requiring access with final location of required access panels and doors. Allow ample space for removal of all parts that require replacement or servicing. This work shall include furnishing and installing all access doors required for mechanical access.

E. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected. Refer to Equipment Specifications in Divisions 02 through 48 for rough-in requirements.

F. Coordinate mechanical equipment and materials installation with other building components.

G. Verify all dimensions by field measurements.

H. Arrange for chases, slots, and openings in other building components to allow for plumbing installations.

I. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.

J. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing-in the building.

K. Coordinate the cutting and patching of building components to accommodate the installation of mechanical equipment and materials. Contractor to provide for all cutting and patching required for installation of his work unless otherwise noted.

L. Where mounting heights are not detailed or dimensioned, install plumbing services and overhead equipment to provide the maximum headroom possible.

M. Install plumbing equipment to facilitate maintenance and repair or replacement of equipment components. Connect equipment for ease of disconnecting, without interference with other installations.

N. Coordinate the installation of plumbing materials and equipment above ceilings with ductwork, piping, conduits, suspension system, light fixtures, cable trays, sprinkler piping and heads, and other installations.

O. Coordinate connection of plumbing systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

P. Coordinate with Owner in advance to schedule shutdown of existing systems to make new connections. Provide valves in new piping to allow existing system to be put back in service with minimum down time.

Q. All materials (such as insulation, piping, wiring, controls, etc.) located within air plenum spaces, air shafts, and occupied spaces shall have a flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E84 (NFPA 255) Method. In addition, the products, when tested, shall not drip flame particles, and flame shall not be progressive. Provide Underwriters Laboratories, Inc., label or listing, or satisfactory certified test report from an approved testing laboratory to prove the fire hazard ratings for materials proposed for use do not exceed those specified.

R. Coordinate installation of floor drains and floor sinks with work of other trades, such that finished floor slopes to drains and floor sinks are flush with surrounding floor.

S. Products made of or containing lead, asbestos, mercury or other known toxic or hazardous materials are not acceptable for installation under this Division. Any such products installed as part of the work of the Division shall be removed and replaced and all costs for removal and replacement shall be borne solely by the installing Contractor.

NOTICE OF ALTERNATE BILLING CYCLE: The Contract will allow the Owner to require the submission of billings or estimates in billing cycles other than 30-day cycles. Billings or statements shall be submitted monthly ending on the last day of the month.

NOTICE OF EXTENDED CERTIFICATION PROVISION: The Contract will allow the Owner to certify billings and estimate within 20 days after the billings and estimates are received from the original contractor.

NOTICE OF EXTENDED PAYMENT PROVISION: The Contract will allow the Owner to make payment within 30 days after the date a billing or estimate is received.
1.10 MINOR DEVIATIONS

A. The Drawings are diagrammatic and show the general arrangements of all plumbing work and requirements to be performed. It is not intended to show or indicate all offsets, fittings, and accessories which will be required as a part of the work of this Section.

B. The Contractor shall review the structural and architectural conditions affecting his work. It is the specific intention of this section that the contractor's scope of work shall include
   1. Proper code complying support systems for all equipment whether or not scheduled or detailed on drawings or in these specifications
   2. Minor deviations from the mechanical plans required by architectural and structural coordination.

C. The Contractor shall study the operational requirements of each system, and shall arrange his work accordingly, and shall furnish such fittings, offsets, supports, accessories, as are required for the proper and efficient installation of all systems from the physical space available for use by this section. This requirement extends to the Contractor's coordination of this section's work with the "Electrical Work." Should conflicts occur due to lack of coordination, the time delay, cost of rectification, demolition, labor and materials, shall be borne by the Contractor and shall not be at a cost to the Owner.

D. Minor deviations in order to avoid conflict shall be permitted where the design intent is not altered.

E. Advise the Architect, in writing, in the event a conflict occurs in the location or connection of equipment. Bear all costs for relocation of equipment, resulting from failure to properly coordinate the installation or failure to advise the Architect of conflict.

1.11 PRODUCT SUBSTITUTIONS

A. The Contractor shall certify the following items are correct when using substituted products other than those scheduled or shown on the drawings as a basis of design:
   1. The proposed substitution does not affect dimensions shown on drawings.
   2. The Contractor shall pay for changes to building design, including engineering design, detailing, structural supports, and construction costs caused by proposed substitution.
   3. The proposed substitution has no adverse effect on other trades, construction schedule, or specified warranty requirements.
   4. Maintenance and service parts available locally are readily obtainable for the proposed substitute.

B. The Contractor further certifies function, appearance, and quality of proposed substitution are equivalent or superior to specified item.

C. The Contractor agrees that the terms and conditions for the substituted product that are found in the contract documents apply to this proposed substitution.

1.12 SHOP DRAWINGS AND EQUIPMENT SUBMITTALS

A. Prior to construction submit for review all materials and equipment in accordance with Division 01 requirements.

B. After approval of preliminary list of materials, the Contractor shall submit Shop Drawings and manufacturer's Certified Drawings to the Architect for approval.

C. The Contractor shall submit approved Shop Drawings and manufacturer's equipment cuts, of all equipment requiring connection by Division 26, to the Electrical Contractor for final coordination of electrical requirements. Contractor shall bear all additional costs for failure to coordinate with Division 26.
D. Submittals and Shop Drawings shall be submitted as a complete package bound in a 3-ring binder with tabs for each specification section. The approved submittals shall be converted into Operations & Maintenance Manuals at the completion of the project. Submit six (6) typed copies of submittals. Refer to Division 01 for additional requirements.

1.13 UNIT PRICING SUBMITTALS

A. Prior to construction submit for review all materials and equipment in accordance with Division 01 requirements.

B. Preliminary List of Materials and Unit Price Items: Within thirty (30) days after awarding of the Contract, submit to architect for preliminary approval a complete list of manufacturer’s names and model numbers of proposed materials and equipment. Also include proposed list of unit price items for review.
   1. Indicate substituted items.
   2. Identify test and balancing agency.
   3. Identify independent testing laboratory for water analysis.

C. The Contractor shall submit with preliminary list of materials a unit price list for each item furnished on this project. Included with price shall be labor cost index.

D. Submittals and Shop Drawings shall be submitted as a complete package bound in a 3-ring binder with tabs for each specification section. Submit six (6) typed copies of submittals. Refer to Division 01 for additional requirements.

1.14 COORDINATION DOCUMENTS

A. The Contractors shall prepare coordinated Shop Drawings to coordinate the installation and location of all piping and all system appurtenances with other trades. The Drawings shall include all mechanical rooms and floor plans. The Drawings shall be Overlay Drawings showing each discipline on a single sheet. The Drawings shall be keyed to the structural column identification system, and shall be progressively numbered. Prior to completion of the Drawings, the Contractor shall coordinate the proposed installation with the Architect and the structural requirements, and all other trades (including HVAC, Fire Protection, Electrical, Ceiling Suspension, and Tile Systems), and provide reasonable maintenance access requirements. When conflicts are identified, modify system layout as necessary to resolve. Do not fabricate, order or install any equipment or materials until coordination documents are approved by the General Contractor, Architect, and Owner. Within thirty (30) days after award of Contract, submit proposed coordination document Shop Drawing schedule, allowing adequate time for review and approval by parties mentioned above. Drawings should be prepared and submitted for approval on a floor-by-floor basis to phase with building construction.

B. The Drawings shall be prepared as follows:
   1. The Sheet Metal (Mechanical) Contractor shall prepare Drawings to an accurate scale of 1/4" = 1'-0" or larger, on reproducible media sheets (vellum) or AutoCAD disks. Obtain reproducibles or AutoCAD files of the HVAC design from the Architect, or Engineer, at cost plus. Drawings are to be same size as Contract Drawings and shall indicate location, size and elevation above finished floor, of all HVAC equipment, ductwork, and piping.
   2. The Plumbing Contractor shall obtain reproducible plans or AutoCAD disks from the Mechanical Contractor, and indicate all plumbing lines including fittings, hangers, access panels, valves, and bottom of pipe elevations above finished floor.
   3. The Fire Protection Contractor shall obtain reproducible plans or AutoCAD disks with the detailed mechanical and plumbing work shown. The Sprinkler Contractor shall indicate location of all sprinkler heads and piping, including valves and fittings, dimensions from column lines, and bottom of pipe elevations above finished floor.
   4. Plans are to incorporate all addenda items and change orders.
   5. Distribute plans to all trades and provide additional coordination as needed.
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C. Advise the Architect in the event a conflict occurs in the location or connection of equipment. Bear all costs for relocation of equipment, resulting from failure to properly coordinate the installation or failure to advise the Architect of conflict.

D. Provide means of access to all valves, controllers, operable devices, and other apparatus that may require adjustment or servicing.

E. Verify in field exact size, location, invert, and clearances regarding all existing material, equipment and apparatus, and advise the Architect of any discrepancies between those indicated on the Drawings and those existing in the field prior to any installation related thereto.

F. Final Coordination Drawings with all appropriate information added are to be submitted as Record Drawings at completion of project.

G. Provide copy of Record Drawings to Testing and Balancing Contractor for their use when doing their work.

1.15 RECORD DRAWINGS

A. Before commencing installation, obtain an extra set of prints from Architect, marked "Record." Keep this set of Drawings at the job site at all times, and use it for no other purpose but to mark on it all the changes and revisions to the Contract Drawings resulting from coordination with other trades. At the completion of the project,
   1. Obtain a clean set of reproducibles from the Architect or Engineer, at cost plus, and transfer the revisions to these reproducibles in a neat and orderly fashion.
      OR
   2. Edit project AutoCAD files to incorporate all site markups, changes, and revisions to the Contract Drawings. Submit plots of Record Drawings and six copies CD Roms labeled with all record AutoCAD drawing files.

B. Provide copy of Record Drawings to Testing and Balancing Contractor for use when doing his work.

C. Mark Drawings to indicate revisions to piping, size, and location both exterior and interior; including locations of other control devices, valves, and similar units requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned to column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e. – valves, traps, strainers, expansion compensators, tanks, etc.); Change Orders; concealed control system devices.

D. Mark Specifications to indicate approved substitutions; Change Orders; actual equipment and materials used.

E. Refer also to Special Conditions in Division 01 for full scope of requirements.

1.16 START-UP SERVICE AND BUILDING COMMISSIONING

A. Prior to start-up, be assured that systems are ready, including checking the following: Proper equipment rotation, proper wiring, auxiliary connections, lubrication, venting, controls, and installed and properly set relief and safety valves.

B. Provide services of factory-trained technicians for start-up of temperature controls, boilers, pumps, and other major pieces of equipment. Certify in writing compliance with this Paragraph, stating names of personnel involved and the date work was performed.

C. Refer to other Division 22 Sections for additional requirements.
1.17 INSTRUCTION, MAINTENANCE, AND O&M MANUALS

A. O&M Manuals: Upon completion of the work, the Contractor shall submit to the Architect complete set of operating instructions, maintenance instructions, part lists, and all other bulletins and brochures pertinent to the operation and maintenance for equipment furnished and installed as specified in this section, bound in a durable binder. Refer to Division 01.

B. The Contractor shall be responsible for proper instruction of Owner’s personnel for operation and maintenance of equipment, and apparatus installed as specified in Division 22 to be no less than 2 hours for each piece of equipment.

1.18 DELIVERY, STORAGE AND HANDLING

A. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage, and handling.

B. Store equipment and materials in an environmentally controlled area at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage. Piping shall be stored in bundles covered with visqueen. Piping showing signs of rust shall be removed from site and replaced.

C. Coordinate deliveries of mechanical materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.

1.19 TEMPORARY FACILITIES

A. Refer to Division 01 for the requirements of temporary water and sewer for construction and safety. Provide temporary water, and sewer, etc. services as necessary during the construction period and as required to maintain operation of existing systems.

1.20 POSTED OPERATING INSTRUCTIONS

A. Furnish approved operating instructions for systems and equipment indicated in the technical sections for use by operation personnel. The operating instructions shall include wiring diagrams, control diagrams, and control sequence for each principal system and equipment. Print or engrave operating instructions and frame under glass or in approved laminated plastic. Post instructions where directed. Attach or post operating instructions adjacent to each principal system and equipment including start-up, operating, shutdown, safety precautions and procedure in the event of equipment failure. Provide weather-resistant materials or weatherproof enclosures for operating instructions exposed to the weather. Operating instructions shall not fade when exposed to sunlight and shall be secured to prevent easy removal.

1.21 SAFETY AND INDEMNITY

A. The Contractor shall be solely and completely responsible for conditions of the job site including safety of all persons and property during performance of the work. This requirement will apply continuously and not be limited to normal hours of work.

B. No act, service, Drawing, review, or Construction Review by the Owner, Architect, the Engineers or their consultants, is intended to include the review of the adequacy of the Contractor’s safety measures, in, on, or near the construction site.

C. The Contractor performing work under this Division of the Specifications shall hold harmless, indemnify and defend the Owner, the Architect, the Engineers and their consultants, and each of their officers, employees and agents from any and all liability claim, losses or damage arising, or alleged to arise from bodily injury, sickness, or death of a person or persons, and for all damages arising out of injury to or destruction of property arising directly or indirectly out of, or in connection with, the performance of the work under the Division of the Specifications, and from the Contractor’s negligence in the performance of the work described in the Construction Contract Documents; but
1.22 CLEANING AND CLOSING
A. All work shall be inspected, tested, and approved before being concealed or placed in operation.
B. Upon completion of the work, all equipment installed as specified in this section, and all areas where work was performed, shall be cleaned to provide operating conditions satisfactory to the Architect.

1.23 WARRANTIES
A. All equipment shall be provided with a minimum one-year warranty to include parts and labor. Refer to individual Equipment Specifications for extended or longer-term warranty requirements.
B. Provide complete warranty information for each item, to include product or equipment, date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, telephone numbers and procedures for filing a claim and obtaining warranty services.
C. Service during warranty period: Contractor shall provide maintenance as specified elsewhere during the 12-month warranty period.

1.24 GUARANTEE
A. The Contractor shall guarantee and service all workmanship and materials to be as represented by him and shall repair or replace, at no additional cost to the Owner, any part thereof which may become defective within the period of one (1) year after the Date of Final Acceptance, ordinary wear and tear excepted.
B. Contractor shall be responsible for and pay for any damages caused by or resulting from defects in his work.

PART 2 - PRODUCTS
2.1 GENERAL
A. Furnish and install all new material, equipment, and apparatus hereinafter specified unless specifically noted otherwise. All material, equipment, and apparatus shall be identified by the manufacturer's name, nameplate, and pertinent data.
B. All materials, equipment, and apparatus are mentioned as standards unless noted otherwise. The words "or approved equal" shall be considered to be subsequent to all manufacturers' names used herein, unless specifically noted that substitutes are not allowed.

2.2 SUPPORTS AND ANCHORS
A. General: Comply with applicable codes pertaining to product materials and installation of supports and anchors, including, but not limited to, the following:
   1. UL and FM Compliance: Provide products, which are UL listed and FM approved.
   2. ASCE 7-05: "American Society of Civil Engineers."
   3. 2006 International Building Code (IBC)
   4. MSS Standard Compliance: Manufacturer's Standardization Society (MSS).
   6. Provide copper plated or plastic coated supports and attachment for copper piping systems. Field applied coatings or tape is unacceptable.
B. Horizontal Piping Hangers and Supports: Except as otherwise indicated, provide factory-fabricated hangers and supports of one of the following MSS types listed.
   1. Adjustable Steel Clevis Hangers: MSS Type 1.
   2. Adjustable Steel Swivel Band Hangers: MSS Type 10.
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4. Pipe Slides and Slide Plates: MSS Type 35, including one of the following plate types:
   a. Plate: Unguided type.
   b. Plate: Guided type.
   c. Plate: Hold-down clamp type.
5. Pipe Saddle Supports: MSS Type 36, including steel pipe base support and cast iron floor flange.
6. Pipe Saddle Supports with U-Bolt: MSS Type 37, including steel pipe base support and cast iron floor flange.
7. Adjustable Pipe Saddle Supports: MSS Type 38, including steel pipe base support and cast iron floor flange.
8. Single Pipe Roller with Malleable Sockets: MSS Type 41.
9. Adjustable Roller Hangers: MSS Type 43.
10. Pipe Roll Stands: MSS Type 44.
11. Pipe Guides: Provide factory-fabricated guides of cast semi-steel or heavy fabricated steel, consisting of a bolted two-section outer cylinder and base with a two-section guiding spider bolted tight to pipe. Size guide and spiders to clear pipe and insulation (if any), and cylinder. Provide guides of length recommended by manufacturer to allow indicated travel.

C. Horizontal Cushioned Pipe Clamp: Where pipe hangers are called out to absorb vibration or shock install a piping clamp with thermoplastic elastomer insert. Cush-A-Clamp or equal.

D. Vertical Piping Clamps: Provide factory-fabricated two-bolt vertical piping riser clamps, MSS Type 8.

E. Hanger-Rod Attachments: Except as otherwise indicated, provide factory-fabricated hanger-rod attachments of one of the following MSS types listed.
   1. Steel Turnbuckles: MSS Type 13.
   2. Steel Clevises: MSS Type 14.
   3. Swivel Turnbuckles: MSS Type 15.
   5. Steel Weldless Eye Nuts: MSS Type 17.

F. Building Attachments: Except as otherwise indicated, provide factory-fabricated building attachments of one of the following types listed.
   1. Concrete Inserts: MSS Type 18 or Blue Banger Hanger by Simpson
   2. Steel Brackets: One of the following for indicated loading:
      b. Medium Duty: MSS Type 32.
      c. Heavy Duty: MSS Type 33.
   3. Horizontal Travelers: MSS Type 58.
   4. Internally Threaded Expansion Shell Anchors: By Simpson or approved equal.
   5. Concrete Screw Anchors: Titen HD by Simpson or approved equal.

G. Saddles and Shields: Except as otherwise indicated, provide saddles or shields under piping hangers and supports, factory-fabricated, for all insulated piping. Size saddles and shields for exact fit to mate with pipe insulation.
   1. Pipe Covering Protection Saddles: MSS Type 39; fill interior voids with segments of insulation matching adjoining insulation.
   2. Insulation Protection Shields: MSS Type 40, 18" minimum, or of the length recommended by manufacturer to prevent crushing of insulation. High-density insulation insert lengths shall match or exceed shield length.
   3. Thermal Hanger Shields: Constructed of 360° insert of waterproofed calcium silicate (60 psi flexural strength minimum) encased in 360° sheet metal shield. Provide assembly of same thickness as adjoining insulation. Shield length shall match or exceed length of calcium silicate insert.
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4. Thermal Hanger Couplings: Constructed of high strength plastic coupling to retain tubing and join insulation at clevis hangers and strut-mounted clamps. Klo-Shure Insulation Coupling or equal.

H. Miscellaneous Materials:
1. Metal Framing: Provide products complying with NEMA STD ML1.
2. Steel Plates, Shapes, and Bars: Provide products complying with ASTM A36.
3. Cement Grout: Portland Cement (ASTM C150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C404, Size No. 2). Mix at a ratio of 1.0 part cement to 3.0 parts sand by volume, with minimum amount of water required for placement and hydration.
4. Heavy-Duty Steel Trapezes: Fabricate from steel shapes selected for loads required. Weld steel in accordance with AWS standards.
5. Pipe Brackets: "HoldRite" copper plated brackets. Insulate brackets attached to metal studs with felt.

2.3 PIPE PORTALS

A. Where pipe portals are not provided by other sections of Specification, provide prefabricated insulated pipe portals as required for piping penetrating through the roof where shown on plans. Field built pipe portals are acceptable alternatives - provide detail of construction for review.

B. Standard pipe portals, unless otherwise noted, shall be constructed as follows:
1. Curb shall be constructed of heavy gauge galvanized steel with continuous welds on shell seams.
2. Insulation to be 1-½” thick, 3 lb density rigid fiberglass.
3. Curb to have a raised 3” (minimum), 45° cant.
4. Curb to have 1-1/2” x 1-1/2” wood nailer (minimum).
5. Curb height to be 8” (minimum) above roof deck.
6. Cant shall be raised to match roof insulation thickness.
7. Cover or flashing to be constructed of galvanized steel or other suitable material to provide sturdy weather tight closure. Provide collars and rubber nipples with draw bands of sizes required by piping. Size curb, cover and nipples per manufacturer's recommendations.
8. Manufacturer: Roof Products Systems or Pate.

2.4 EQUIPMENT/PIPING RAILS

A. Where equipment/pipe rails are not provided by other sections of Specification, provide prefabricated reinforced equipment rails as required for support of equipment and piping. Field built curbs are acceptable alternatives - provide detail of construction for review.

B. Standard equipment rail, unless otherwise noted, shall be constructed as follows:
1. Construct of heavy gauge galvanized steel with continuous welds on shell seams.
2. Provide internal reinforcing supports welded as required to meet application requirements.
3. Equipment rails to have raised 3” (minimum), 45° cant.
4. Equipment rails to have 1 1/2” x 1 1/2” wood nailer (minimum) and counterflashing.
5. Equipment rail height to be 6” (minimum) above roof deck.
6. Cant shall be raised to match roof insulation thickness.
7. Equipment rails to be constructed to meet equipment size and weight requirements. Provide tapered rails to match roof pitch where required.
8. Manufacturer: Pate, Vent Products, Thy Curb or Roof Products Systems.
2.5 ACCESS PANELS AND ACCESS DOORS

A. Provide all access doors and panels to serve equipment under this work, including those which must be installed, in finished architectural surfaces. Frame of 16-gauge steel, door of 20 gauge steel. 1" flange width, continuous piano hinge, key operated, prime coated. Refer to Architectural Specifications for the required product Specification for each surface. Contractor is to submit schedule of access panels for approval. Exact size, number and location of access panels is not shown on Plans. Access doors shall be of a size to permit removal of equipment for servicing. Access door shall have same rating as the wall or ceiling in which it is mounted. Provide access panel for each trap primer or concealed valve. Use no panel smaller than 12" x 12" for simple manual access, or smaller than 24" x 24" where personnel must pass through. Provide cylinder lock for access door serving mixing or critical valves in public areas.

B. Included under this work is the responsibility for verifying the exact location and type of each access panel or door required to serve equipment under this work and in the proper sequence to keep in tune with construction and with prior approval of the Architect. Access doors in fire rated partitions and ceilings shall carry all label ratings as required to maintain the rating of the rated assembly.

C. Acceptable Manufacturers: Milcor, Karp, Nystrom, or Elmdor/Stoneman.

D. Submit markup of architectural plans showing size and location of access panels required for equipment access for approval by Architect.

2.6 IDENTIFICATION MARKERS

A. Mechanical Identification Materials: Provide products of categories and types required for each application as referenced in other Division 22 Sections. Where more than single type is specified for application, selection is installer's option, but provide single selection for each product category. Stencils are not acceptable.

B. Plastic Pipe Markers:
2. Pressure Sensitive Type: Provide pre-printed, permanent adhesive, color coded, pressure sensitive vinyl pipe markers, complying with ANSI A13.1. Secure both ends of markers with color coded adhesive vinyl tape.
3. Insulation: Furnish 1" thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125°F (52°C) or greater. Cut length to extend 2" beyond each end of plastic pipe marker.
4. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastic.

C. Underground-Type Plastic Line Markers: Provide 6" wide x 4 mils thick multi-ply tape, consisting of solid metallic foil core between 2 layers of plastic tape. Markers to be permanent, bright colored, continuous printed, intended for direct burial service.

D. Valve Tags:
1. Brass Valve Tags: Provide 1 1/2" diameter 19-gauge polished brass valve tags with stamp-engraved piping system abbreviation in 1/4" high letters and sequenced valve numbers 1/2" high, and with 5/32" hole for fastener. Fill tag engraving with black enamel.
2. Plastic Laminate Valve Tags: Provide 3/32" thick engraved plastic laminate valve tags, with piping system abbreviations in 1/4" high letters and sequenced valve number 1/2" high, and with 5/32" hole for fasteners.
3. Valve Tag Fasteners: Provide solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.
4. Access Panel Markers: Provide 1/16” thick engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve. Include 1/8” center hole to allow attachment.
5. Non-potable Water Tags: 1/16” thick, engraved, plastic tags as indicated on Drawings.

E. Plastic Equipment Signs:
1. Provide 4-1/2” x 6” plastic laminate sign, ANSI A.13 color coded with engraved white core lettering.
2. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.
3. Nomenclature: Include the following, matching terminology on schedules as closely as possible:
   a. Name and plan number
   b. Equipment service
   c. Design capacity
   d. Other design parameters, such as pressure drop, entering and leaving conditions, rpm, etc.

F. Acceptable Manufacturers: Craftmark, Seton, Brady, Marking Services, Inc., or Brimar.

2.7 ELECTRICAL

A. General:
1. All electrical material, equipment, and apparatus specified herein shall conform to the requirements of Division 26.
2. Provide all motors for equipment specified herein. Provide motor starters, controllers, and other electrical apparatus and wiring which are required for the operation of the equipment specified herein. VFD by Electrical if required.
3. Set and align all motors and drives in equipment specified herein.
4. Provide expanded metal or solid sheet metal guards on all V-belt drives to totally enclose the drive on all sides. Provide holes for tachometer readings. Support guards separately from rotating equipment.
5. Provide for all rotating shafts, couplings, etc., a solid sheet metal, inverted "U" cover over the entire length of the exposed shaft and support separately from rotating equipment. Cover shall extend to below the bottom of the shaft and coupling, and shall meet the requirements of the State Industrial Safety Regulations.
6. Specific electrical requirements (i.e., horsepower and electrical characteristics) for plumbing equipment are scheduled on the Drawings.

B. Quality Assurance:
1. Electrical components and materials shall be UL or ETL listed/labeled as suitable for location and use - no exceptions.

C. Motors:
1. The following are basic requirements for simple or common motors. For special motors, more detailed and specific requirements are specified in the individual equipment Specifications.
2. Torque characteristics shall be sufficient to satisfactorily accelerate the driven loads.
3. Motor sizes shall be large enough so that the driven load will not require the motor to operate in the service factor range. Unless otherwise noted on plans, all motors ½ HP or larger shall be rated for 208 or 460 volt, 3-phase, operation. Unless otherwise noted on plans, all motors less than 1/2 HP shall be rated for 120 volt, single phase operation.
4. Temperature Rating: Motor meets class B rise with class F insulation.
5. Service Factor: 1.15 for poly-phase motors and 1.35 for single phase motors.
BASIC MATERIALS AND METHODS - PLUMBING

   a. Frames: NEMA Standard No. 48 or 56; use driven equipment manufacturer's standards to suit specific application.
   b. VFD driven motors. To be provided rated for inverter duty (NEMA Standard MG-1, Part 31) and equipped with a shaft grounding device or as an insulated bearing motor.
   c. Bearings:
      1) Ball or roller bearings with inner and outer shaft seals.
      2) Re-greasable, except permanently sealed where motor is normally inaccessible for regular maintenance.
      3) Designed to resist thrust loading where belt drives or other drives product lateral or axial thrust in motor.
      4) For fractional horsepower, light duty motors, sleeve type bearings are permitted.
   d. Overload Protection: Built-in thermal overload protection where external overload protection is not provided and, where indicated, internal sensing device suitable for signaling and stopping motor at starter.
   e. Noise Rating: "Quiet."
   f. Efficiency:
      1) Motors shall have a minimum efficiency per governing State or Federal codes, whichever is higher.
      2) Motors shall meet the NEMA premium efficiency standard
   g. Nameplate: Indicate the full identification of manufacturer, ratings, characteristics, construction, special features and similar information.

D. Starters and Electrical Devices:
1. Motor Starter Characteristics:
   a. Enclosures: NEMA 1, general purpose enclosures with padlock ears, except in wet locations shall be NEMA 3R with conduit hubs.
   b. Type and size of starter shall be as recommended by motor manufacturer and the driven equipment manufacturer for applicable protection and start-up condition.
2. Manual switches shall have pilot lights and all required switch positions for multi-speed motors. Overload Protection: Melting alloy or bi-metallic type thermal overload relays, sized according to actual operating current (field measured).
3. Magnetic Starters:
   a. Heavy duty, oil resistant, hand-off-auto (HOA), or as indicated, and pilot lights, properly arranged for single speed or multi-speed operation as indicated.
   b. Trip-free thermal overload relays, each phase, sized according to actual operating current (field measured).
   c. Interlocks, pneumatic switches and similar devices as required for coordination with control requirements of Division 23 Controls sections.
   d. Built-in primary and secondary fused control circuit transformer, supplied from load side of equipment disconnect.
   e. Externally operated manual reset.
   f. Under-voltage release or protection for all motors over 20 hp.
4. Motor Connections: Liquid tight, flexible conduit, except where plug-in electrical cords are specifically indicated.
E. Low Voltage Control Wiring:
   1. General: 14 gauge, Type THHN, color coded, installed in conduit.
   2. Manufacturer: General Cable Corp., Alcan Cable, American Insulated Wire Corp., Senator Wire and Cable Co., or Southwire Co.

F. Disconnect Switches:
   1. Fusible Switches: For equipment 1/2 HP or larger, provide fused, each phase; heavy duty; horsepower rated; spring loaded quick-make, quick-break mechanism; dead front line side shield; solderless lugs suitable for copper or aluminum conductors; spring reinforced fuse clips; electro silver plated current carrying parts; hinged doors; operating lever arranged for locking in the "OPEN" position; arc quenchers; capacity and characteristics as indicated.
   2. Non-Fusible Switches: For equipment less than 1/2 horsepower, switch shall be horsepower rated; toggle switch type with thermal overload quantity of poles and voltage rating as required.

PART 3 - EXECUTION

3.1 GENERAL
   A. Workmanship shall be performed by licensed journeymen or master mechanics and shall result in an installation consistent with the best practices of trades.
   B. Install work uniform, level and plumb, in relationship to lines of building. Do not install any diagonal, or otherwise irregular work unless so indicated on Drawings or approved by Architect.

3.2 MANUFACTURER'S DIRECTIONS
   A. Follow manufacturers' directions and recommendations in all cases where the manufacturers of articles used on this Contract furnish directions covering points not shown on the Drawings or covered in these Specifications.

3.3 INSTALLATION
   A. Coordinate the work between the various Plumbing Sections and with the work specified under other Divisions. If any cooperative work must be altered due to lack of proper supervision or failure to make proper and timely provisions, the alternations shall be made to the satisfaction of the Engineer and at the Contractor's cost.
   B. Inspect all material, equipment, and apparatus upon delivery and do not install any damaged or defected materials.

3.4 SUPPORTS AND HANGERS
   A. Prior to installation of hangers, supports, anchors, and associated work, installer shall meet at project site with Contractor, installer of each component of associated work, inspection and testing agency representatives, (if any), installers of other work with requirements specified.
   B. Installation of Building Attachments: Install building attachments at required locations within concrete or on structural steel for proper piping support. Install additional building attachments where support is required for additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed. Fasten insert securely to forms. Where concrete with compressive strength less than 2,500 psi is indicated, install reinforcing bars through opening at top of inserts.
   C. Proceed with installation of hangers, supports, and anchors only after required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including, but not limited to, proper placement of inserts, anchors, and other building structural attachments.
NOTICE OF ALTERNATE BILLING CYCLE: The Contract will allow the Owner to require the submission of billings or estimates in billing cycles other than 30-day cycles. Billing or statements shall be submitted monthly ending on the last day of the month.

NOTICE OF EXTENDED CERTIFICATION PROVISION: The Contract will allow the Owner to certify billings and estimates within 20 days after the billings and estimates are received from the original contractor.

NOTICE OF EXTENDED PAYMENT PROVISION: The Contract will allow the Owner to make payment within 30 days after the date a billing or estimate is received.
c. Saddles: Where insulation without vapor barrier is indicated install protection saddles.

L. Installation of Anchors:
1. Install anchors at proper locations to prevent excessive stresses and to prevent transfer of loading and stresses to connected equipment.
2. Fabricate and install anchor by welding steel shapes, plates and bars to piping and to structure.
3. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions, to limit movement of piping and forces to maximums recommended by manufacturer for each unit.
4. Anchor Spacings: Where not otherwise indicated, install anchors at ends of principal pipe runs, at intermediate points in pipe runs between expansion loops and bends.

M. Adjusting:
1. Hanger Adjustment: Adjust hangers so as to distribute loads equally on attachments.
2. Support Adjustment: Provide grout under supports so as to bring piping and equipment to proper level and elevations.
3. Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

3.5 ELECTRICAL REQUIREMENTS

A. Plumbing Contractor shall coordinate with Division 26 work to provide complete systems as required to operate all mechanical devices installed under this Division of work.

B. Installation of Electrical Connections: Furnish, install, and wire (except as may be otherwise indicated) all plumbing, motors and controls in accordance with the following schedule and in accordance with equipment manufacturer's written instructions and with recognized industry practices, and complying with applicable requirements of UL, NEC, and NECA's "Standard of Installation" to ensure that products fulfill requirements. Carefully coordinate with work performed under the Mechanical Division of these Specifications.

C. Division 22 has responsibilities for electrically powered or controlled plumbing equipment, which is specified in Division 22 Specifications or scheduled on Division 22 Drawings. The specific division of responsibilities between Division 22 and 26 for furnishing or wiring this equipment is as follows:
1. Division 22 Mechanical Responsibilities:
   a. MOTORS: Furnish and install all motors necessary for plumbing equipment.
   b. MAGNETIC STARTERS: Furnish all magnetic starters whether manually or automatically controlled which are necessary for mechanical equipment. Furnish these starters with all control relays or transformers necessary to interface with plumbing controls. If the starter is factory installed on a piece of Division 22 equipment, also furnish and install the power wiring between starter and motor.
   c. DISCONNECTS: Provide the disconnects which are part of factory wired Division 22 plumbing equipment. Factory wiring to include wiring between motor and disconnect or combination starter/disconnect.
   d. CONTROLS: Division 22 Contractor is responsible for the following equipment in its entirety. This equipment includes but is not limited to the following:
      1) Control relays necessary for controlling Division 22 equipment.
      2) Control transformers necessary for providing power to controls for Division 22 equipment.
      3) Low or non-load voltage control components
      4) Non-life safety related valve
      5) Solenoid valves, EP and PE switches
BASIC MATERIALS AND METHODS - PLUMBING

D. Division 26 has responsibilities for electrically powered or controlled equipment which is specified in Division 22 Specifications or scheduled on Division 22 Drawings. The specific division of responsibilities between Division 22 and 26 for furnishing or wiring this equipment is as follows:

1. Division 26 Electrical Responsibilities:
   a. MOTORS: Provide the power wiring for the motors.
   b. MAGNETIC STARTERS: Except where magnetic starters are factory installed on Division 22 factory assembled equipment, Division 26 is to install magnetic starters furnished by Division 22 and install the necessary power wiring to the starter and from the starter to the motor. In the case of factory installed starters, Division 26 is to install the necessary power wiring to the starter.
   c. DISCONNECTS: Provide all disconnects necessary for Division 22 mechanical equipment which are not provided as part of factory wired Division 22 equipment. Provide power wiring to all disconnects. In addition provide power wiring between motor and disconnect when the disconnect is not factory installed. See also Variable Frequency Drive above for special wiring requirements.
   d. CONTROLS: Division 26 Contractor is responsible for providing power to control panels and control circuit outlets.

2. Coordinate with other work, including wires/cables, raceway and equipment installation, as necessary to properly interface installation of electrical connections for equipment with other work.

3. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer’s written instructions and wiring diagrams. Mate and match conductors of electrical connections for proper interface between electrical power supplies and installed equipment.

4. Maintain existing electrical service and feeders to occupied areas and operational facilities, unless otherwise indicated, or when authorized otherwise in writing by Owner, or Architect/Engineer. Provide temporary service during interruptions to existing facilities. When necessary, schedule momentary outages for replacing existing wiring systems with new wiring systems. When that “cutting-over” has been successfully accomplished, remove, relocate, or abandon existing wiring as indicated.

5. Cover splices with electrical insulating material equivalent to, or of greater insulation resistivity rating, than electrical insulation rating of those conductors being spliced.

6. Prepare cables and wires, by cutting and stripping covering armor, jacket, and insulation properly to ensure uniform and neat appearance where cables and wires are terminated. Exercise care to avoid cutting through tapes which will remain on conductors. Also avoid “ringing” copper conductors while skinning wire.

E. Motors and Motor Control Equipment: Conform to the standards of the NEMA. Equip motors with magnetic or manual line starters with overload protection. Motor starters and line voltage controls shall be installed under Electrical Section but located and coordinated as required under this Section of the work. Starters shall be combination type with non-fusible disconnect switches. All single phase fractional horsepower motors shall have built-in overload protection.

3.6 PAINTING

A. All painting shall be provided under this Division work, unless otherwise specified under Section 099100: Painting. Painting schemes shall comply with ANSI A13.1. Paint all exposed materials such as piping, equipment, insulation, steel, etc. Exposed gas piping inside and outside the building shall be painted with two coats of "Rust-O-Leum" Yellow. Exposed copper indirect waste piping serving food service equipment shall be painted metallic chrome.

B. All exposed work under Division 22 shall receive either a factory finish or a field prime coat finish, except:
   1. Exposed copper piping
   2. Aluminum jacketed outdoor insulated piping
3.7 IDENTIFICATION MARKERS

A. General: Where identification is to be applied to surfaces which require insulation, painting, or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

B. Piping System Identification:
   1. Install pipe markers on each system indicated to receive identification, and include arrows to show normal direction of flow.
   2. Locate pipe markers as follows:
      a. Near each valve and control device
      b. Near each branch, excluding short take-offs for fixtures mark each pipe at branch, where there could be question of flow pattern.
      c. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures
      d. At access doors, manholes, and similar access points which permit view of concealed piping.
      e. Near major equipment items and other points of origination and termination
      f. Spaced horizontally at maximum spacing of 20’ along each piping run, with minimum of one in each room. Vertically spaced at each story transversed.

C. Plumbing Equipment Identification: Locate engraved plastic laminate signs on or near each major item of plumbing equipment and each operational device. Provide signs for the following:
   1. Main control and operating valves, including safety devices
   2. Meters, gauges, thermometers, and similar units
   3. Pumps and similar motor-driven units
   4. Hot water system mixing valves and similar equipment
   5. Strainers, filters, treatment systems and similar equipment

D. Text of Signs: In addition to name of identified unit, provide lettering to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations. Equipment signs shall include an identification of the area or other equipment served by the equipment being labeled.

3.8 VIBRATION AND DYNAMIC BALANCING

A. Vibration tolerances shall be as specified by the "International Research and Development Corporation", Worthington, Ohio, measured by the displacement, peak to peak, as follows:
   1. Pump and Electric Motors: Below severity chart labeled "SLIGHTLY ROUGH", maximum vibration velocity of 0.157 in/sec, peak.
   2. Compressors: Same as pumps.

B. Correction shall be made to all equipment which exceeds vibration tolerances specified above. Final vibration levels shall be reported as described above.

3.9 TESTING

A. Provide all tests specified hereinafter and as otherwise required. Provide all test equipment, including test pumps, gauges, instruments, and other equipment required. Test all rotational equipment for proper direction of rotation. Upon completion of testing, certify to the Architect, in writing, that the specified tests have been performed and that the installation complies with the specified requirements and provide a report of the test observations signed by qualified inspector.

END OF SECTION
PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS
A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, and Section 220500 - Basic Materials and Methods, and other Sections in Division 22 specified herein.

1.2 RELATED WORK SPECIFIED ELSEWHERE
A. Section 220500: Basic Materials and Methods
B. Section 230700: Mechanical Insulation
C. Section 222113: Plumbing Piping, Valves and Specialties
D. Section 224000: Plumbing Fixtures
E. Section 221123: Plumbing Equipment
F. Section 222123: Pumps and specialties

1.3 SCOPE
A. All work includes removing and modifying existing and providing new plumbing. Systems as specified under this section shall include but not necessarily be limited to the following:
   1. Connection to existing building services and civil work.
   2. Removal of fixtures and piping as indicated on drawings. No pipe to be abandoned in place except piping below grade.
   3. Connection of all waste, vent, and water piping to all plumbing fixtures, drinking fountains, sinks, drains and mechanical equipment.
   4. Provide for future expansion as indicated.
   5. Connect to new mechanical equipment including chiller, cooling tower expansion tanks, domestic hot water heaters, and boilers, etc.
   6. Connect hot and/or cold water to hose bibbs and wall hydrants. Provide individual shut-off valves at each location.
   7. Provide traps on all floor drains with trap primer where specified. Pipe to trap shall be ½” minimum.
   8. Provide domestic hot water recirculation system. Each branch line to be set at one (1) gpm. Provide individual shut-off valve, check valve and ball valve with memory stop at each location.
   9. Provide floor drainage in core toilets, mechanical rooms and equipment rooms.
  10. Provide connections for all area drains, catch basins, downspouts, roof drains to storm sewer system.
  11. Gas service and meter assembly for Craft Center equipment shall be by local gas purveyor.
  12. Temporary Water Service: As directed by the General Contractor, the plumber shall provide a temporary metered water service and temporary water risers with four (2) hose bibbs installed at each level as the building proceeds upwards to the roof.

1.4 SUBMITTALS
A. Prior to construction submit for approval all materials and equipment in accordance with Division 01. Submit manufacturer's data, installation instructions, and maintenance and operating instructions for all components of this section including, but not limited to, the following:
   1. Plumbing specialties
   2. Trap primers
   3. Cleanouts
   4. Drains
5. Roof flashing  
6. Wall hydrants and hose bibbs  
7. Mixing valves  

B. Contractor shall submit a letter that all products used in the plumbing installed are certified for use in the State of Oregon.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the site in containers with manufacturer's stamp or label affixed.  
B. Store and protect products against dirt, water, chemical, and mechanical damage. Do not install damaged products - remove from project site.  

1.6 WARRANTY

A. Provide one-year (12 months) warranty. The warranty shall include parts, labor, travel costs, and living expenses incurred by the manufacturer to provide factory authorized service.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials and equipment under this Division of the Specifications shall be new, of best grade and as listed in printed catalogs of the manufacturer.  
B. All manufactured materials shall be delivered and stored in their original containers. Equipment shall be clearly marked or stamped with the manufacturer's name and rating.  
C. All items shall be furnished Vandal Proofed. One type of vandal proof screw is to be used throughout this facility. Coordinate with general contractor for type.  
D. The following products to be included as part of this work but specified under Section 220500 Basic Materials and Methods and Section 222113 Plumbing Piping, Valves and Specialties:  
   1. Piping  
   2. Valves  
   3. Hangers and supports  
   4. Escutcheon plates, flashings, and sleeves  
   5. Identification markers and signs  
   6. Anchors, alignment guides and Seismic Zone 3 requirements  
   7. Excavation and backfill  
   8. Pressure and temperature gauges  
   9. Access Panels  
E. Plumbing Fixtures: Refer to Section 224000.

2.2 VALVES: DOMESTIC WATER AND NATURAL GAS (See Section 222113)

2.3 CLEANOUTS

A. Cleanout Plugs: Bronze, taper thread countersunk head.  
B. Floor Cleanouts: Service weight cast-iron body and frame, flange with flashing clamp, adjustable cast-iron collar, caulk inside, Ty-seal or No-hub joints, neoprene plug gasket seal.  
   1. Carpeted Areas: Zurn ZN-1400-KC-VP-BP-CM or J. R. Smith 4028 C - F - C - Y - U  
   2. Tiled Areas: Zurn ZN-1400-X-KC-VP-BP or J.R. Smith 4148 - F - C - U  
   3. Unfinished Areas: Zurn ZN-1400-HD-KC-VP-BP or J.R. Smith 4108 C - F - C - U  
   4. Yard Areas: Zurn Z 1474-IN-VP or J.R. Smith 4258 - C - U  
C. Cleanout Tee: Cast iron cleanout tee with countersunk brass plug, neoprene plug gasket seal and smooth stainless steel cover.  
   1. Manufacturer: Zurn Z-1446-BP or J. R. Smith 4532 S (Y)
2.4 **ROOF FLASHING**

A. Flashing: Unless indicated otherwise on the drawings flashings for pipes through the roof shall be galvanized sheet metal, 24 gauge minimum with seams and joints lapped and soldered watertight. Coordinate with Architectural Sections for flashings and roofing.

B. Vent Pipes: Provide caulk type, vandalproof hood with Allen head vandal proof screws for all vent pipes through roof or preformed vinyl/galvanized steel assembly.

2.5 **ANTI-CONTAMINATION WALL HYDRANTS AND HOSE BIBBS**

A. Anti-Contamination Wall Hydrant, WH-1: Exterior, box-type, freeze-proof, cast-bronze construction, chrome plated finish, loose key, bronze casing, length to suit wall thickness, vacuum breaker/backflow preventor, 3/4” inlet, 3/4” threaded hose end, solder joint.
   1. Manufacturer: Smith 5509QT, Zurn or Watts

B. Anti-contamination Hose Bibbs, HB-1: Bronze body construction, polished chrome plated finish, renewable composition disc, wheel handle, ½” NPT inlet, 3/4” threaded hose end, vacuum breaker/backflow preventer, solder joint, ANSI 1011.
   1. Manufacturer: Woodford series 24P or Zurn Z1341.

2.6 **DRAINS**

A. General: Provide drains of type and size as indicated on drawings, including features, as specified herein.

B. Floor Drain, FD-1 - Finished Areas: Enamel coated cast iron body with flange, integral reversible clamping collar, seepage openings, adjustable round satin nickel bronze strainer, sediment bucket, bottom outlet, caulk inside or Ty-Seal or no-hub joint. Provide trap primer.

C. Floor Drain, FD-2 - Mechanical Rooms: Enamel coated cast iron body with flange, clamping collar, seepage openings, 8-1/2” diameter adjustable cast iron bar strainer, sediment bucket, bottom outlet, caulk inside or Ty-Seal or no-hub joint. Provide trap primer.
   1. Manufacturer: Zurn Z-520-Y-P or J.R. Smith 2350 C(Y).

D. Floor Sink, FS-1: Enamel coated cast iron body with seepage flange, acid resistant interior surfaces, aluminum dome strainer, 12” x 12” x 6”, half grate, bottom outlet, caulk inside, Ty-Seal or no-hub joint. Provide trap primer.
   1. Manufacturer: Commercial Enameling series 906-1 or Zurn-ZFD-2375-K-H-Y.

E. Downspout Fitting, DSN-1: Fabricated stainless steel downspout cover with hinged perforated cover.
   1. Manufacturer: J.R. Smith 1775.

F. Downspout connector, DSC-1: Cast iron construction, plain end outlet.
   1. Manufacturer: Neenah Series, R4927 or Zurn Z-192.

2.7 **TRAP PRIMER**

A. Cast bronze construction, vacuum breaker, ½” sweat solder connection. Install in accessible location or provide access panel.
   1. Manufacturer: PPP Oregon #1 or E&S, for use for up to 8 drains using PPP trap primer distribution units.
   2. Option: Sloan F-72-A1 used in conjunction with water closet flush valve.

B. For Multiple Units or Kitchen Areas: PPP Prime Time electronic trap primer Series PT. Coordinate 120 V, electrical service with Division 26.
2.8 MIXING VALVES ASSEMBLY
   A. Mixing Valve: 300 psi, Brass construction, thermostatic controller with check stops. Refer to drawings for schedule of each valve. Use high/low type for uses over 20 gpm.
   B. Manufacturer: Holby, Lawler, Symmons or Leonard.

2.9 EMERGENCY SHOWERS AND EYEWASHES:
   A. Emergency Eye Wash, EW-1:
      1. Wall mounted with stainless steel bowl, complete with trap, mounting bracket and dust covers.
      2. Manufacturer: Haws 7360 BT.
      3. Mixing valve: Lawler 911 EF or Guardian.

2.10 Building Domestic water metering, cold; Required:
   A. All measurements are to be remote monitored via the DDC system.
   B. Usage/flow is to be measured in K-gallons, calculated at the remote readout, and then pulsed to the DDC system.
   C. Flow meters:
      1. Pulse output ONLY via the DDC system.
      2. Approved manufacturers: Foxboro; Bailey; Cadillac.

PART 3 - EXECUTION

3.1 GENERAL
   A. This system to be installed by an experienced firm regularly engaged in the installation of plumbing systems as specified by the requirements of the Specifications.
   B. Install all items specified in this section of the Specification under the full purview of local and state governing agencies.
   C. Refer to Section 220500: General Plumbing Requirements for installation of piping, valves and other requirements.

3.2 PERFORMANCE OF WORK
   A. Examine areas, physical conditions and phasing requirements under which materials are to be installed. Layout the system to suit the different types of construction and equipment as indicated on the drawings.
   B. Work shall start immediately after authorization has been given to proceed so that the overall progress of the construction is not delayed. No foundry items to be installed until submittals have been approved.
   C. Coordinate with other trades as necessary to properly interface components of the plumbing system.
   D. Follow manufacturer’s directions and recommendations in all cases where the manufacturers of articles used on this Contract furnish directions covering points not shown on the drawings or covered in these Specifications.
   E. The omission from the drawings or Specifications of any details of construction, installation, materials, or essential specialties shall not relieve the Contractor from furnishing the same in place for a complete system.
3.3 PIPING INSTALLATION

A. The word “piping” shall mean all pipes, fittings, nipples, valves and all accessories connected thereto.

B. Run piping generally parallel to the axis of the building, arranged to conform to the building requirements and to suit the necessities of clearance for other mechanical ducts, flues, conduits and work of other trades and close to ceiling or other construction as practical, free of unnecessary traps or bends.

C. Run horizontal sanitary drainage at uniform pitch of not less than 1/8” per foot, unless otherwise indicated. Pitch horizontal vent piping downward from stack to fixtures.

D. Run drainage piping as straight as possible with long radius turns. Offsets shall be made at an angle of 45° or less.

E. Grade water supply piping for complete drainage of the system. Install hose bibbs at low points.

F. Piping connections to all equipment shall be made up with unions.

G. Provide sufficient elbows, swings and offsets to permit free expansion and contraction.

H. Use reducers or increasers. Use no bushings.

I. Ream or file each pipe to remove burrs. Inspect each length of pipe and each fitting for workmanship and clear passageway.

J. Vent pipes to terminate at least 6” above the roof. Provide vandal proof hood assembly.

K. Cover, cap or otherwise protect open ends of all piping during construction to prevent damage to threads or flanges and prevent entry of foreign matter. Disinfect water supply piping as specified.

L. Exposed connections to equipment shall be installed with special care, showing no tool marks or threads at fittings and piping. No bowed or bend piping to be permitted.

M. All ferrous to non-ferrous connections shall be made by means of dielectric fittings. Submit shop drawings for approval.

N. Use extra heavy pipe for nipples, where unthreaded portion is less than 1½”. Use no close nipples. Use only shoulder nipples.

O. All piping shall be inspected for defects and flaws prior to installation. Remove any damaged piping from job site. Piping shall be thoroughly cleaned of dirt, debris or rust.

P. Cleanouts to be provided at each change in direction greater than 135° or 100’ maximum intervals on underground piping.

Q. Revise existing cleanout elevations to be flush with new floor elevation.

R. Cleanouts to be same size as pipe except cleanout plugs larger than 4” shall not be required.

S. Cleanouts on concealed piping to be extended through and terminate flush with the finished wall or floor. Cover plates to be provided on all cleanout plugs in finished areas.

T. The bodies of cleanout ferrules to conform in thickness to that required for pipe and fittings of the same metal.

U. Route piping on roof on manufactured polyethylene pipe pier supports “Pipe Pier” by Erico.
3.4 TESTING AND DISINFECTING - PLUMBING SYSTEMS

A. General: The Contractor to perform all field tests and provide all labor, equipment, and incidentals required for the tests. Owner to witness all field tests and conduct all field inspections. The Contractor to give the Owner ample notice of the dates and times scheduled for tests. Any deficiencies to be completely retested at no additional cost.

1. Inspection: Inspection to continue during installation and testing. Perform a final inspection of the equipment prior to installation to determine conformity to the type, class, grade, size, capacity, and other characteristics specified herein or indicated. Correct or replace all rejected equipment prior to installation.

2. Water Distribution Piping Test: Before fixtures are set, subject the entire hot and cold piping system to a hydrostatic pressure test of 150 pounds per square inch with water for not less than 8 hours in order to permit inspection of all joints with no evidence of leakage. Where a portion of the water distribution piping is to be concealed before completion, test this portion separately as specified for the entire system.

3. Sanitary, Waste, Storm, Rainwater, and Vent Piping Test: Before the installation of any fixtures or drains, cap the ends of the system and fill all lines with water to the roof level and allow to stand for at least 30 minutes without leakage. Make tests within building with piping exposed. If the system is tested in sections, tightly lug each opening, except the highest opening of the section under test, and fill each section with water and test with at least a 10' head of water.

4. Sanitary Drainage Vent, Storm, Rainwater and Fixture System Final Test: Give sanitary, drainage vent, and fixture systems an in-service test after complete installation. After all fixtures are installed, test the entire vent and sewer system and prove gas and water tight. Final test shall be with air. Before proceeding with test, fill all traps with water. Close all stacks and line openings during test, for a minimum period of 24 hours. If test reveals leakage of air at any point, repair and retest the system.

5. Disinfection of Water Distribution System: After pressure tests have been made thoroughly flush the entire domestic water distribution system with water until all entrained dirt and mud have been removed, and sterilize by chlorinating material. The chlorinating material shall be liquid chlorine. The chlorinating material shall provide a dosage of not less than 50 parts per million and shall be introduced into the system or part thereof in an approved manner. Retain the treated water in the pipe for 24 hours, or, fill the system or part thereof with a water-chlorine solution containing at least 200 parts per million of chlorine and allow to stand for three hours. Open and close all valves in the system being disinfected three times during the contact period. Then flush the system with clean potable water until the residual chlorine is reduced to less than 1.0 ppm. During the flushing period open and close all valves and faucets three times. From at least three divergent points in the system, take samples of water in properly sterilized containers for bacterial examination. Repeat the disinfecting until tests indicate that satisfactory bacteriological results have been obtained.

   a. Taking of samples shall be witnessed by Architect or Owner’s representative. Samples are to be taken and tested by an independent analytical testing laboratory. Written reports shall be supplied to Architect for approval.

3.5 OPERATING TESTING AND CERTIFICATION - PLUMBING SYSTEMS

A. Upon completion and disinfection, and prior to acceptance of the installation, the Contractor to subject the plumbing system to operating tests to demonstrate satisfactory, functional, and operating efficiency. Such operating tests to include the following information in a report with conclusions as to the adequacy of the system.

1. Time, date, and duration of tests
2. Water pressures at most remote location
3. Operation of all valves and hydrants
4. Operation of all floor drains by flooding with water
5. Quality of domestic water
PLUMBING

6. Read all indicating instruments at half-hour intervals unless otherwise directed. Supply four copies of the test report to the Owner.

3.6 CLEANING EQUIPMENT AND MATERIALS

A. In addition to the requirements of Section 220500, provide for the safety and good condition of all materials and equipment until final acceptance by the Owner. Protect all materials and equipment from damage. Provide adequate and proper storage facilities during the progress of the work. Special care to be taken to provide protection for bearings, open connections, pipe coils, pumps, compressors, and similar equipment.

B. All piping, finished surfaces, and equipment to have all grease, adhesive labels, and foreign materials removed.

C. All piping to be drained and flushed to remove grease and foreign matter. Pressure regulating assemblies, traps, flush valves, and similar items shall be thoroughly cleaned. Remove and thoroughly clean and reinstall all liquid strainer screens after the system has been in operation for ten days.

D. When connections are to be made to existing systems, the Contractor is to do all cleaning and purging of the existing systems required to restore them to the condition existing prior to the start of work.

3.7 OPERATION MANUALS, START-UP SERVICE, WARRANTIES, ACCEPTANCE AND GUARANTEES

A. General: Refer to Section 220500 for details.

END OF SECTION
PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS
   A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, and Section 220500 - Basic Materials and Methods, and other Sections in Division 22 specified herein.

1.2 SCOPE
   A. All work to be furnished and installed under this Section shall include, but not necessarily be limited to, providing insulation for the following:
      1. Piping:
         a. Domestic hot water supply and return
         b. Domestic cold water
         c. Horizontal roof and overflow drain piping
         d. Underground water piping
         e. Sanitary vent piping in unheated spaces
         f. Horizontal pipe runs from fixtures receiving cold condensate
         g. All valves, separators, strainers and fittings for systems listed above
      2. Drains:
         a. All roof and overflow drain bodies
   B. Types of mechanical insulation specified in this Section include the following:
      1. fiberglass pipe insulation
      2. cellular glass pipe insulation
      3. calcium silicate pipe insulation
      4. flexible elastomeric closed cell insulation
      5. fiberglass equipment insulation
      6. calcium silicate equipment insulation
      7. cellular glass equipment insulation
      8. flexible unicellular equipment insulation
      9. insulation jackets
      10. insulation accessories

1.3 RELATED WORK SPECIFIED ELSEWHERE
   A. Section 220500: Basic Materials and Methods
   B. Section 220501: Plumbing

1.4 DEFINITIONS
   A. Ambient: The air temperature to be maintained in a conditioned room. Typically between 70°F and 78°F.
   B. Insert: Spacer placed between the pipe support system and the piping to allow for the space required for insulation.
   C. Insulation Group (IG): Definition of Insulation Materials and Operating Temperatures.
   D. Insulation Shield: Buffer material placed between the pipe support system and the insulation to prevent the insulation material from crushing.
   E. Jacket: Protective covering over the pipe insulation; may be factory applied such as “all service jacket” or field applied to provide additional protection; of such materials as canvas, PVC, aluminum or stainless steel.
   F. Piping Insulation: Thermal insulation applied to prevent heat transmission to or from a piping system.
PLUMBING INSULATION

G. Vapor Barrier Jacket: Insulation jacket material that impedes the transmission of water vapor.

H. Freezing Climate: Where outdoor design temperature is less than 33°F, as stated in ASHRAE fundamentals under 99% column for winter design conditions.

1.5 QUALITY ASSURANCE

A. Codes and Standards: Provide products conforming to the requirements of the following:

1. American Society for Testing and Materials (ASTM): Manufacture and test insulation in accordance with the ASTM Standards, including:
   a. B209 - Specification for Aluminum and Aluminum-Alloy Sheet and Plate
   b. C165 - Recommended Practice for Measuring Compressive Properties of Thermal Insulation
   c. C167 - Test Methods for Thickness and Density of Blanket or Batt Thermal Insulations
   d. C177 - Test Method for Steady-State Heat Flux Measurements and Thermal Transmission
   e. Properties by Means of the Guarded-Hot-Plate Apparatus
   g. C196 - Specification for Expanded or Exfoliated Vermiculite Thermal Insulating Cement
   h. C302 - Test Method for Density of Preformed Pipe-Covering-Type Thermal Insulation
   i. C303 - Test Method for Density of Preformed Block-Type Thermal Insulation
   j. C305 - Test for Thermal Conductivity of Pipe Insulation
   k. C356 - Test for Linear Shrinkage of Preformed High-Temperature Thermal Insulation
   l. C411 - Test for Hot-Surface Performance of High Temperature Thermal Insulation
   m. C423 - Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
   p. C533 - Specification for Calcium Silicate Block and Pipe Thermal Insulation
   q. C534 - Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
   r. C547 - Specification for Mineral Fiber Preformed Pipe Insulation
   s. C552 - Specification for Cellular Glass Block and Pipe Thermal Insulation
   t. C553 - Specification for Mineral Fiber Blanket-Type Pipe Insulation (Industrial Type)
   u. C592 - Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered)
   v. C612 - Specification for Mineral Fiber Block and Board Thermal Insulation
   w. C916 - Standard Specification for Adhesives for Duct Thermal Insulation
   x. C921 - Practice for Determining Properties of Jacketing Materials for Thermal Insulation
   bb. E84 - Test Method for Surface Burning Characteristics of Building Materials
   cc. E119 - Test for Fire Resistance
   dd. G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi
NOTICE OF ALTERNATE BILLING CYCLE: The Contract will allow the Owner to require the submission of billings or estimates in billing cycles other than 30-day cycles. Billing or statements shall be submitted monthly ending on the last day of the month.

NOTICE OF EXTENDED CERTIFICATION PROVISION: The Contract will allow the Owner to certify billings and estimates within 20 days after the billings and estimates are received from the original contractor.

NOTICE OF EXTENDED PAYMENT PROVISION: The Contract will allow the Owner to make payment within 30 days after the date a billing or estimate is received.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Johns Manville, Owens-Corning, Knauf, Armstrong, Pittsburgh-Corning, Certainteed, Halstead, Rubatex, 3M FireMaster, Pabco, Reflectix, or approved equal. Manufacturer and insulation types listed below indicate a minimum acceptable level of quality required for each classification.

2.2 PIPE INSULATIONS

A. Glass Fiber: Molded fibrous glass pipe insulation shall comply with the requirements of ASTM C 547 and meet ASTM C 585 for sizes required in the particular system. For all fluid distribution temperatures below 45°F the system shall be of a wicking type.
1. Manufacturers:
   a. Johns Manville Micro-Lok Meeting ASTM C547; or Micro-Flex (pipe sizes larger than 18"), Knauf insulation.
2. Applications: Insulation of piping up to 18" in diameter and 3" thick insulation.
3. 'K' Value: 0.23 at 75°F
4. Maximum Service Temperature: 850°F
5. Vapor Retarder Jacket: AP-T PLUS white kraft paper reinforced with glass fiber yarn and bonded to aluminum foil, secure with self sealing longitudinal laps and butt strips or AP jacket with outward clinch expanding staples or vapor barrier mastic as needed.

B. Cellular Glass: Pittsburgh-Corning Foamglas Meeting ASTM C522: Cellular Glass Thermal Insulation:
1. 'K' Value: 0.35 at 75°F
2. Density: 8.0 lbs./cu. ft.
3. Maximum Service Temperature: 900°F
4. Provide with Pittsburgh Corning Pittwrap jacketing.

1. ‘K’ Value: 0.27 at 75°F
2. Density: 3.0 to 6.0 lbs./cu.ft.
3. Maximum Service Temperature: 260°F
4. Seal all seams and joints with contact adhesive.

D. Field Applied Jackets (For Interior Applications):
1. All longitudinal seams shall be located on bottom of pipes.
4. Aluminum Jacket: 0.016” thick sheet, [smooth/embossed] finish, with longitudinal slip joints and 2” laps, die shaped fitting covers with factory attached protective liner.
5. Secure aluminum jackets with 3/8” or ½” stainless steel bands on 12” centers.

E. Removable Covers:
1. Provide removable covers on pumps, valves, air separators, vents, fittings, flanges, strainers, traps, etc., where periodic maintenance or removal of insulation may be required.
2. Use of premolded fittings with PVC covers is acceptable.
3. Use of lace-on type insulating blankets is acceptable.
PLUMBING INSULATION

2.3 EQUIPMENT INSULATIONS

A. Flexible Fiberglass Blanket: Johns Manville Microlite Type 75 Flexible Blanket:
   1. 'K' Value: ASTM C518, 0.27 Btu•in./(hr•ft²•ºF) at 75°F installed full thickness.
   2. Maximum Service Temperature: 250°F.
   3. Density: 0.75 lb/cu ft.
   4. Vapor Barrier Jacket: FSK (Foil-Scrim-Kraft) aluminum foil faced reinforced with fiberglass yarn and laminated to fire-resistant kraft, secured with UL listed pressure sensitive tape and/or outward clinched expanded staples and vapor barrier mastic as needed.

B. Cellular Glass: Pittsburgh-Corning Foamglas Meeting ASTM C552; Cellular Glass Thermal Insulation:
   1. 'K' Value: 0.35 at 75°F.
   2. Density: 8.0 lb/cu. ft.
   3. Maximum Service Temperature: 900°F.

PART 3 - EXECUTION

3.1 EXAMINATION AND PREPARATION

A. Verify that piping has been tested for leakage in accordance with specifications before applying insulation materials. All piping shall be inspected by Owner's Representative prior to installation of insulation. Any insulation applied prior to inspection shall be removed and new insulation applied at no additional cost to Owner. Notify Owner's Representative five (5) working days prior to insulation installation.

B. Verify that all surfaces are clean, dry and free of foreign material.

3.2 INSTALLATION

A. General:
   1. Install materials in accordance with manufacturer's recommendations, building codes and industry standards.
   2. Remove and replace any insulation that has become wet or damaged during the construction process.
   3. Continue insulation and vapor barrier at penetrations and supports, except where prohibited by code.

B. Piping Insulation:
   1. Locate insulation and cover seams in least visible locations unless otherwise specified.
   2. Neatly finish insulation at supports, protrusions, and interruptions.
   3. Provide insulated dual temperature pipes or cold pipes conveying fluids below ambient temperature with vapor retardant jackets with self sealing laps. Insulate complete system.
   4. For insulated pipes conveying fluids above ambient temperature, secure jackets with self sealing lap or outward clinched, expanded staples. Bevel and seal ends of insulation at equipment, flanges, and unions.
   5. Provide minimum 1 inch air space between insulation and casing.
   6. Provide insert between support shield and piping on piping 1½” diameter or larger. Fabricate of Johns Manville Thermo-12, or other heavy density insulating material suitable for temperature. Insulation inserts shall not be less than the following lengths:
      a. 1½” to 2½” pipe size 10” long
      b. 3” to 6” pipe size 12” long
      c. 8” to 10” pipe size 16” long
      d. 12” and over 22” long
   7. Use of metal saddles is acceptable as specified in Section 15050. Fill interior voids with segments of insulation matching adjoining pipe insulation.
PLUMBING INSULATION

8. Use of pipe hangers designed as an insulation coupling is acceptable in lieu of saddles and other devices. Klo-Shure coupling or equal.

9. For pipe exposed in mechanical equipment rooms or in finished spaces below 7 feet above finished floor, finish with Johns Manville Zeston 2000 PVC jacket and fitting covers, or aluminum or stainless steel jacket.

10. Where pumps, valves, strainers, etc., with insulation require periodic opening for maintenance, repair, or cleaning, install insulation in such a manner that it can be easily removed and replaced without damage. Use of premolded covers or lace-on type insulation blankets is required.

11. For exterior applications:
   a. Provide weather protection jacket. Insulated pipe lengths, pumps, fittings, joints, and valves shall be covered with aluminum jacket or stainless steel jacket. Jacket seams shall be located on bottom side of horizontal piping. All lateral joints shall be caulked with a minimum 20-year silicone sealant (clear). All longitudinal joints, except those at the bottom of a horizontal pipe run, shall be caulked with a minimum 20-year silicone sealant (clear).
   b. Apply weather-resistant protective finish such as WB Armaflex to flexible elastomeric insulation. Insulation seams shall be located on the bottom side of horizontal piping. All lateral and longitudinal joints to be sealed with low V.O.C., UV inhibitive adhesive, such as Armaflex 520 BLV adhesive.

12. For underground installations, install per manufacturer's written instructions and recommendations.

13. When maintenance or service access for equipment will result in foot traffic over floor mounted insulated piping the contractor is to fabricate a permanent removable walkway to prevent damage to the piping and insulation.

C. Equipment Insulation:
   1. See Piping Insulation above for additional requirements.
   2. Apply insulation as close as possible to equipment by grooving, scoring, and beveling insulation, if necessary. Secure insulation to equipment with studs, pins, clips, adhesive, wires, or bands, per manufacturer’s recommendations.
   3. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retardant cement.
   4. Provide insulated dual temperature equipment or cold equipment containing fluids below ambient temperature with vapor retardant jackets.
   5. For insulated equipment containing fluids above ambient temperature, provide jacket with or without vapor barrier.
   6. Cover insulation with metal mesh and finish with heavy coat of insulating cement, mastic, or aluminum jacket as indicated in the drawings.
   7. For equipment in mechanical equipment rooms or in finished spaces, finish with Johns Manville Zeston 2000 jacketing and fitting covers or aluminum or stainless steel jacketing.
   8. Do not insulate over nameplate or ASME stamps. Bevel and seal insulation around such.
   9. When equipment with insulation requires periodic opening for maintenance, repair, or cleaning, install insulation in such a manner that it can be easily removed and replaced without damage. Use of lace-on type insulation blankets is acceptable.

3.3 PIPING INSULATION SCHEDULE

A. All insulation thicknesses shall meet or exceed state energy code requirements as noted below. Increase thickness ½" if exposed to exterior ambient air. Minimum thermal resistance in range of 4.2 to 4.6 per inch of thickness. Insulation thicknesses are based on fiberglass insulation and may be adjusted for equivalent insulation values for materials with superior “K” factors.
NOTICE OF ALTERNATE BILLING CYCLE: The Contract will allow the Owner to require the submission of billings or estimates in billing cycles other than 30-day cycles. Billing or statements shall be submitted monthly ending on the last day of the month.

NOTICE OF EXTENDED CERTIFICATION PROVISION: The Contract will allow the Owner to certify billings and estimates within 20 days after the billings and estimates are received from the original contractor.

NOTICE OF EXTENDED PAYMENT PROVISION: The Contract will allow the Owner to make payment within 30 days after the date a billing or estimate is received.

### B. Fiberglass Insulation

<table>
<thead>
<tr>
<th>PIPE SIZE (inches)</th>
<th>THICKNESS (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic hot water</td>
<td>Up to 2 1/2 and over</td>
</tr>
<tr>
<td>Domestic hot water return</td>
<td>All Sizes</td>
</tr>
<tr>
<td>Domestic cold water</td>
<td>All Sizes</td>
</tr>
<tr>
<td>Roof and overflow drain bodies</td>
<td>All Sizes</td>
</tr>
<tr>
<td>Horizontal roof and overflow drainage</td>
<td>Up to 2 1/2 and over</td>
</tr>
<tr>
<td>Piping exposed to freezing</td>
<td>All Sizes</td>
</tr>
<tr>
<td>Plumbing vents within 10 feet of the exterior in freezing climates</td>
<td>All Sizes</td>
</tr>
</tbody>
</table>

### C. Elastometric Foam (Closed Cell):

<table>
<thead>
<tr>
<th>PIPE SIZE (inches)</th>
<th>THICKNESS (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condensate drain pipes</td>
<td>All Sizes</td>
</tr>
</tbody>
</table>
PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS
A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, and Section 220500 - Basic Materials and Methods, and other Sections in Division 22 specified herein.

1.2 SCOPE
A. All work to be furnished and installed under this section shall include but not necessarily be limited to the following:
   1. Solids Interceptor

1.3 RELATED WORK SPECIFIED ELSEWHERE
A. Section 220500: Basic Materials and Methods
B. Section 220501: Plumbing
C. Section 224000: Plumbing Fixtures
D. Section 222123: Plumbing Pumps

1.4 SUBMITTALS
A. Prior to construction submit for approval all materials and equipment in accordance with Division 01. Submit manufacturer's data, colors, installation instructions, and maintenance and operating instructions for all components of this section including, but not limited to, the following:
   1. Solids Interceptor
B. Electrical Work: Refer to Division 22, Section 220500 for requirements.
C. Shop Drawings: Submit rough-in drawings. Detail dimensions, rough-in requirements, required clearances, and methods of assembly of components and anchorages.
D. Wiring Diagrams: Submit manufacturer's electrical requirements for electrical power supply wiring. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring required for final installation. Differentiate between portions of wiring that are factory installed and portions that are to be field installed.
E. Maintenance Data: Submit maintenance data and parts lists for each type and size of water heater, control, and accessory, including "trouble-shooting" maintenance guide. Include this data, product data, shop drawings, and wiring diagrams in maintenance manual, in accordance with requirements of Division 01.
F. Certificates: Submit appropriate Certificates of Shop Inspection and Data Report as required by provisions of ASME Boiler and Pressure Vessel Code.
G. Start-up: Provide written report on start-up in accordance with Section 220500.

1.5 DELIVERY, STORAGE, AND HANDLING
A. Deliver units to the site in containers with manufacturer's stamp or label affixed.
B. Store and protect products against dirt, water, chemical, and mechanical damage. Do not install damaged products - remove from project site.

1.6 WARRANTY
A. Provide one year (12 months) warranty. The warranty shall include parts, labor, travel costs, and living expenses to repair or replace products or systems.
PART 2 - PRODUCTS

2.1 SOLIDS INTERCEPTOR, SI-1:
   A. Interceptor: J.R. Smith, 8878, 75gpm, 4" outlet, 30.5" x 37" deep, steel with non-skid bolted top. Provide extension as needed

SOLIDS INTERCEPTOR, SI-2:
   B. Interceptor: J.R. Smith, 8878, 75gpm, 4" outlet, 30.5" x 37" deep, steel with non-skid bolted top. Provide extension as needed

2.2 GENERAL
   A. Examine areas and conditions under which equipment is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.
   B. Install equipment in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.
   C. Orient so controls and devices needing service and maintenance have adequate access.
   D. Connect water piping to units with shutoff valves and unions as indicated.
   E. Start-Up: Start-up, test, and adjust equipment in accordance with manufacturer's start-up instructions. Check and calibrate controls. Start-up to be by authorized manufacturer's representative or agent.

2.3 OPERATION MANUALS, START-UP SERVICE, WARRANTIES, ACCEPTANCE AND GUARANTEES
   A. General: Refer to Section 220500 for details.

END OF SECTION
PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS

A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 220500 - Basic Materials and Methods, and other Sections in Division 22 specified herein.

1.2 SCOPE

A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to the following:

1. Pipe and Fittings
   a. Sanitary waste and vent
   b. Cold water
   c. Hot water
   d. Fuel gas

2. Valves
   a. Water valves
   b. Natural gas valves
   c. Balancing valves
   d. Gas pressure regulator valves
   e. Thermostatic mixing valves

3. Thermometers and gauges

4. Piping specialties
   a. Pipe escutcheons
   b. Strainers
   c. Drip pans
   d. Air vent
   e. Brass unions and flanges
   f. Unions
   g. Flanges
   h. Pipe sleeves
   i. Sleeve seals
   j. Valve boxes
   k. Pipe coating
   l. Gas connectors

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Section 220500: Basic Materials and Methods
B. Section 220501: Plumbing
C. Section 224000: Plumbing Fixtures
D. Section 221123: Plumbing Equipment
E. Division 26: Electrical

1.4 QUALITY ASSURANCE

A. Manufacturers Qualifications:
   1. Manufactured items furnished shall be the current, cataloged product of the manufacturer.
   2. Replacement parts shall be readily available and stocked in the USA.

B. Codes and Standards:
PLUMBING PIPING, VALVES AND SPECIALTIES

1. All work shall be in full accordance with all applicable codes, ordinances and code rulings.
2. The Contractor shall furnish without any extra charge the labor and material required for compliance of codes.
3. Perform all tests required by governing authorities and as required under all Division 22 Sections. Provide written reports on all tests.
4. Electrical devices and wiring shall confirm to the latest standards of NEC; all devices shall be UL listed and so identified.
5. All plumbing work shall comply with the Americans with Disabilities Act (ADA).
6. All excavation work must comply with all provisions of state laws including notification to all owners of underground utilities at least 48 business day hours, but not more than 10 business days, before commencing an excavation.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer’s technical product data for all piping, valves and specialties indicating dimensions, valve CV, tolerances etc.
B. Shop Drawings: Submit shop drawings indicating underground piping installation showing all fittings with inverters. Indicate all footings and grade beams.
C. Maintenance Data: Submit maintenance instructions on accordance with requirements of Division 01.

PART 2 - PRODUCTS

2.1 GENERAL

A. Furnish and install all new material, equipment, and apparatus hereinafter specified unless specifically noted otherwise. All material, equipment, and apparatus shall be identified by the manufacturer's name, nameplate, and pertinent data.
1. All pipe, pipe fittings and valves shall be manufactured in North America.
B. Type M copper piping is not acceptable for any pressure water piping unless specifically noted otherwise.
C. For all Grade B piping specified below grade provide a mill report with production identification numbers for piping submitted to permit tracking of pipe by mill and production lot.
D. All materials, equipment, and apparatus are mentioned as standards unless noted otherwise. The words "or approved equal" shall be considered to be subsequent to all manufacturer's names used herein, unless specifically noted that substitutes are not allowed.

2.2 STANDARD PIPE AND FITTING

A. Natural Gas Pipe & Fitting (Above Grade)
   b. Joints: 2" and smaller, threaded (except in the case of piping located in shafts or plenums which must be welded); all piping inside the building 2-1/2" and larger, ANSI B16.25 bevelweld, ANSI B16.5 flanges, or ANSI B16.11 socket weld.
B. Trap Primer Piping:
   1. Pipe: Domestic Only, ASTM B88, Type K, soft drawn copper water tube.
   2. Fittings: No joints below ground. For pipes below grade double wrap with Scotch Wrap #51 or PASCO Wrap, with 50% overlap.
C. Domestic Water Pipe & Fittings (Below Grade):
   1. Pipe: ASTM B88, Type K hard drawn copper water tube.

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NOTICE OF EXTENDED CERTIFICATION PROVISION: The Contract will allow the Owner to certify billings and estimate within 20 days after the billings and estimates are received from the original contractor.
NOTICE OF EXTENDED PAYMENT PROVISION: The Contract will allow the Owner to make payment within 30 days after the date a billing or estimate is received.
PLUMBING PIPING, VALVES AND SPECIALTIES

2. Fittings: Domestic Only, Elkhart, ANSI B16.22, wrought copper, 95%-5% tin-antimony solder joints. Wrap underground piping with Scotch Wrap or Pasco Wrap.

D. Condensate and indirect drains:
1. Pipe: ASTM B88, Type M, hard drawn copper water tube.
4. Insulate condensate drain pipes with minimum $\frac{1}{2}$" insulation to prevent moisture dripping from pipe.

E. Domestic Water Pipe & Fittings (Below Grade):
1. Pipe: ASTM B88, Type K hard drawn copper water tube.
2. Fittings: Domestic Only, Elkhart, ANSI B16.22, wrought copper, 95%-5% tin-antimony solder joints. Wrap underground piping with Scotch Wrap or Pasco Wrap.

F. Domestic Hot and Cold Water Pipe & Fittings (Above Grade):
1. Pipe: ASTM B88, Type L, hard drawn copper water tube.
2. Fittings: ANSI B16.22, wrought copper, 95%-5% tin-antimony solder joints.

G. Sanitary Sewer, Vent, Rainwater Pipe & Fittings:
1. Pipe: Tyler or AB&I or Charlotte Pipe and Foundry, ASTM A-74, ASTM A-888 cast iron, bituminous coated, "No-Hub". Pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute and manufactured by AB &I, Charlotte or Tyler. Pipe showing rust or cracks in coating shall be removed and replaced.
2. Fittings: No-hub, ASTM A-888.
3. Couplings Below Grade: Heavy Duty Type 304 stainless steel couplings conforming to FM 1680 with neoprene sealing sleeve conforming to ASTM C-1540 having minimum shield thickness of 28 gauge. Husky SD-4000 or Clamp All 125 only.
4. Couplings Above Grade: Type 304 stainless steel couplings conforming to ASTM C-1540 and neoprene sealing sleeve, having minimum shield thickness of 34 gauge. Anaco or Ideal.

H. Rainwater Leader Pipe and Fittings (Exposed, Above Grade):
1. Pipe: ASTM B306, DWV class, copper tube.
3. Joints: Lead free solder. Lead solder shall not be present at the job site.

2.3 VALVES: GENERAL

A. General: Valve ratings shall exceed respective system operating pressures by 50% (minimum). All valves shall be line size unless otherwise noted. No 125 lb valves.

B. Product Data: Submit manufacturer’s technical product data, including installation instructions for each type of valve. Include pressure drop curve or chart for each type and size of valve. Submit valve schedule showing manufacturer’s figure number, size, location, and valve features for each required valve.

C. Shop Drawings: Submit manufacturer’s assembly-type (exploded view) shop drawings for each type of valve, indicating dimensions, weights, materials, and methods of assembly of components.

D. Acceptable manufacturers (manufacturer and model number listed for individual valves indicates minimum acceptable by all manufacturers):
1. Gate, Ball, Check or Butterfly: Apollo, Hammond, Milwaukee.
2. Lubricated Plug Valves: Homestead, Resun, or Rockwell.
3. Backflow Preventers: Conbraco or Febco.
4. Pressure Reducing Valves: Apollo, Cash-Acme, Cla-Val or Wilkins.
5. Solenoid Valves: ASCO, Automatic or Magnatrol.
6. Circuit Setters: Griswold (Venturi with characterized ball valve only), Wheatley (Y-globe type only), Armstrong, or Tour & Anderson.

E. Valve Identification: Provide valves with manufacturer’s name (or trademark) and pressure rating clearly marked on the valve body.

F. Operators: Provide handwheels, fastened to valve stem, for valves other than quarter-turn. Provide lever handle for quarter-turn valves, other than plug valves. Provide one wrench for every 10 plug valves, and one in each size. Provide extended levers/stems for valves on insulated lines. For manual valves 2 ½” and larger located 8 feet above the floor in mechanical rooms provide chain operator to permit operating the valve from 4'-0” above floor.

G. Valve Features:
1. General: Provide valves with features indicated and, where not otherwise indicated, provide proper valve features. Comply with ASME B31.9 for building services piping, and ASME B31.1 for power piping.
2. Drain: Comply with MSS SP-45, and provide threaded pipe plugs.
6. Flangeless: Valve bodies manufactured to fit between flanges complying with ANSI B16.1 (cast iron), ANSI B16.5 (steel), or ANSI B16.24 (bronze).

2.4 DOMESTIC WATER SERVICE VALVES

A. Gate Valves:
1. 2” and Smaller: Class 125, MSS SP-80, ASTM B62 cast bronze body, soldered ends, bronze bonnet, bronze wedge, rising stem, brass packing gland, non-asbestos packing and aluminum hand-wheel.
2. 2-1/2” and Larger: Class 125, MSS SP-70, ASTM A126 Grade B cast iron body, flanged ends, cast iron bonnet, cast iron wedge, bronze trim, rising stem, brass packing gland, non-asbestos packing and cast iron hand-wheel.

B. Ball Valves:
1. 2 1/2” and Smaller: 600 psi, 2 piece, bronze body, threaded ends with union, chrome plated brass ball, Teflon seat, brass stem, steel handle, full port. Apollo 70 series.

C. Check Valves:
1. 2” and Smaller: Class 125, MSS SP-80, ASTM B62 and ASTM B16, cast bronze body, soldered ends for copper pipe, screwed cap, swing type, Teflon bronze disc.
2. 2-1/2” and Larger: Class 125, MSS SP-71, ASTM A126 class B cast iron body, bolted bonnet flanged ends, bolted cap, swing type, cast iron disc with bronze face rings.
3. Vertical or High Flow: Class 125, cast bronze, high-flow body, TFE seat, brass check, stainless steel guide and spring. Watt #6015.

2.5 NATURAL GAS VALVES

A. Gate Valves:
1. ½” and ¾”: Brass body, U.L. listed, CSA approved for pressure of system, bronze gate valve, 175 WOG. Apollo.
2. 1” thru 3”: 175 psi working pressure, CSA and UL approved, bronze body, welded ends.

2.6 BALANCING VALVES: MAXIMUM 125 PSIG SYSTEM WORKING WATER PRESSURE

A. Pressure Dependent Water Flow:
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1. ½” and Larger: Construction and attachment style as required by piping system. Ball or globe valve design with memory stop. Valves shall be field adjustable. Install in pipe with minimum length of unrestricted straight pipe equivalent to five pipe diameters upstream and two pipe diameters downstream. Presso Venturi B-Plus series, Armstrong, or Tour & Anderson.

2.7 BACKFLOW PREVENTION VALVES

A. General: All backflow prevention valves shall be State approved and listed.

B. Reduced Pressure Zone Backflow Preventer for High Hazard Applications:
   1. 2” and Smaller: Assembly shall consist of shutoff ball valves in inlet and outlet, and strainer on inlet. Assemblies shall include test cocks and pressure-differential relief valve located between two positive seating check valves and shall comply with requirements of ASSE Standard 1013 and AWWA C506. Bronze construction, threaded ends, stainless steel internal parts, and air gap fitting. Route pipe from air gap fitting to approved waste receptor.
   2. 2-1/2” and Larger: Assembly shall consist of shutoff OS&Y gate valves in inlet and outlet, and strainer on inlet. Assemblies shall include test cocks and pressure-differential relief valve located between two positive seating check valves and shall comply with requirements of ASSE Standard 1015 and AWWA C506. Epoxy coated cast iron body construction, flanged ends, stainless steel internal parts, bronze seats, and air gap fitting. Route pipe from air gap fitting to approved waste receptor.

C. Atmospheric Vacuum Breaker: Assembly shall consist of a bronze vacuum breaker body with silicone disc, and full size orifice. Device shall be IAPMO listed, meet ASSE std. 1001, and ANSI std. A113.1.1 Chrome plated in finish areas.

D. Pressure Vacuum Breaker: Assembly shall consist of a one piece bronze or stainless steel body, with stainless steel spring loaded check, rubber diaphragm, and atmospheric vent, breakaway set screw. Provide chrome plated in finish areas.

2.8 PRESSURE RELIEF VALVES

A. Pressure Relief Valves: Constructed in accordance with ASME, 125-pound setting, and so stamped. Size as required.

B. Temperature and Pressure Relief Valve: Constructed in accordance with ASME, 125-pound setting, and so stamped. Size as required.

2.9 GAS PRESSURE REGULATOR VALVES

A. Diaphragm operated, steel construction of size and capacity as indicated on drawings. Regulators shall be approved serving gas supplier, CSA and UL listed. Fisher, Sherwood, or approved equal.

2.10 THERMOSTATIC MIXING VALVES

A. General: Thermostatic valve constructed of brass and stainless steel, with screwdriver locking temp. regulator and adjustable check stops. Provide access door with cylinder lock. Finish as selected by Architect. Powers E480 or Leonard #210 SB.

B. Master: High-low master thermostatic assembly of size and capacity as indicated on drawings. Bimetal motor, adjustable checkstops, inlet and outlet pressure gauges, thermometer with full port outlet ball valves shutoffs, locking temperature regulator and surface mount stainless steel cabinet as specified. Powers 1432-RC-E-Q or Leonard type TM186-PRV-RF-LTR-STSTL.

2.11 SOLENOID VALVES
NOTICE OF ALTERNATE BILLING CYCLE: The Contract will allow the Owner to require the submission of billings or estimates in billing cycles other than 30-day cycles. Billing or statements shall be submitted monthly ending on the last day of the month.

NOTICE OF EXTENDED CERTIFICATION PROVISION: The Contract will allow the Owner to certify billings and estimates within 20 days after the billings and estimates are received from the original contractor.

NOTICE OF EXTENDED PAYMENT PROVISION: The Contract will allow the Owner to make payment within 30 days after the date a billing or estimate is received.

2.12 FIRE PROTECTION VALVES:
A. Refer to Section 211000.

2.13 THERMOMETERS AND GAUGES
A. General:
1. Certification: Provide meters and gauges whose accuracies, under specified operating conditions, are certified by manufacturer.
2. No mercury shall be used in thermometers due to hazardous material classification.

B. Pressure Gauge Cocks:
1. General: Provide pressure gauge cocks between pressure gauges and gauge tees on piping systems. Gauge cock constructed of brass with ¼" female NPT on each end, and "T" handle brass plug.
2. Syphon: ¼" straight coil constructed of brass tubing with ¼" male NPT on each end.
3. Snubber: ¼" brass bushing with corrosion resistant porous metal disc, through which pressure fluid is filtered. Select disc material for fluid served and pressure rating.

C. Pressure Gauge Connector Test Plugs:
1. Provide pressure gauge connector plugs pressure rated for 500 psi and 200°F (93°C). Constructed of brass and finish in nickel-plate, equip with ½" NPS fitting, with self-sealing valve core type neoprene gasketed orifice suitable for inserting 1/8" O.D. probe assembly from dial type insertion pressure gauge. Equip orifice with gasketed screw cap and chain. Provide extension, length equal to insulation thickness, for insulated piping.

2.14 PIPING SPECIALTIES
A. General:
1. Provide factory-fabricated piping specialties recommended by manufacturer for use in service indicated. Provide piping specialties of types and pressure ratings indicated for each service, or provide proper selection to comply with installation requirements. Provide sizes as indicated, and connections, which properly mate with pipe, tube, and equipment connections. Where more than one type is indicated, selection is installer's option.

B. Pipe Escutcheons:
1. Provide pipe escutcheons as specified herein with inside diameter closely fitting pipe outside diameter, or outside of pipe insulation where pipe is insulated. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls, or ceilings; and pipe sleeve extension, if any. Furnish pipe escutcheons with nickel or chrome finish for occupied areas, prime zinc base paint finish for unoccupied areas.
2. Pipe Escutcheons for Moist Areas: For waterproof floors, and areas where water and condensation can be expected to accumulate, provide stainless steel, cast brass or sheet brass escutcheons, solid or split hinged.
3. Pipe Escutcheons for Dry Areas: Provide stainless steel escutcheons, solid or split hinged.

C. Low Pressure Y-Type Pipeline Strainers:
1. Provide strainers full line size of connecting piping, with ends matching piping system.
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materials. Select strainers for 125% of the working pressure of piping system, with Type 304 stainless steel screens, with 3/64" perforations at 233 0.045" perforations per square inch.

2. Threaded ends, 2" and smaller: Cast-iron body, screwed screen retainer with centered blowdown fitted with ball valve with brass cap. Sarco, Wheatley or Mueller.

3. Flanged ends, 2-1/2" and larger: Cast-iron body, bolted screen retainer with off-center blowdown fitted with ball valve with brass cap. Sarco, Wheatley or Mueller.

D. Air Vent with Valves:
1. Install in all closed and open loop water systems at high points of systems and at any other point necessary to free system of air. A shut-off valve shall be provided in riser to each automatic vent valve to facilitate servicing. A 3/8" type "L" copper tubing drain line shall be run to drain receptor to carry away water that valve discharges. Manual type vent may be used in lieu of automatic type. Hoffman #79 or Dole.

E. Brass Unions:
1. Provide standard products recommended by manufacturer for use in service indicated, which effectively isolate ferrous from non-ferrous piping (electrical conductance), prevent galvanic action, and stop corrosion.

F. Brass Flanges: Provide brass flanges for flanged transitions between dissimilar metal piping.

G. Unions:
1. Unions shall be of type specified in following schedule:
   a. Black Steel, 2" and smaller: 250 lb. screwed malleable iron, ground joint, brass to iron seat.
   b. Black Steel, 2-1/2" and larger: 150 lb. cast iron screwed flanged, flat faced, full faced gasket.
   c. Soldered Copper or Brass Pipe, 2" and smaller: 150 lb. cast bronze or copper, ground joint, non-ferrous seat with soldered ends.
   d. Screwed Copper or Brass Pipe, 2" and smaller: 150 lb. cast brass, ground joint, brass to brass seat, with threaded ends.
   e. Flanged Copper or Brass Pipe, 2-1/2" and larger: two (2) 150 lb. cast bronze flanges.

H. Flanges:
1. Provide flanges at flanged connections to equipment, tanks and valves. Faces of flanges being connected shall be alike in all cases. Connection of raised-face flange to flat-faced flange not permitted.

2. Use ASTM A307, Grade B, bolts and nuts for cast iron flanges and ASTM A193 for steel flanges. Regular square head unfinished bolts with heavy semi-finished hex nuts ASTM A194. Cadmium plated where exposed to weather. Rating: 150 lb. or 300 lb. in high pressure portions.

3. Type of pipe and corresponding flanges as follows:
   a. Screwed Black Steel Pipelines: 125 lb. black cast iron screwed flange, flat faces.
   b. Welded Steel Pipe, 150 lb. black forge steel welding flanges, 1/16" raised fact ASTM A181 Grade I. Use flat face when connected to flat faced companion flange.

I. Pipe Sleeves:
1. Provide fire proof sleeve assemblies utilizing UL rated sealant systems at all fire rated penetrations. For non-rated sleeve penetrations pack the annular space between the pipe and sleeve with fiberglass and/or mastic.

2. Sleeves shall provide a minimum ½" annular clearance around pipe.

3. Sheet metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate from the following
PLUMBING PIPING, VALVES AND SPECIALTIES

gauges: 3” and smaller, 20 gauge; 4” to 6”, 16 gauge; over 6”, 14 gauge.
4. Steel pipe: Fabricate from Schedule 40 galvanized steel pipe; remove burrs.
5. Iron pipe: Fabricate from cast iron or ductile-iron pipe; remove burrs.
6. Plastic and copper pipe: Fabricate from Schedule 80 PVC plastic pipe; remove burrs.
7. Sleeves through interior concrete walls and floors: Telescopic, submerged, adjustable sleeves by Adjust-to-Crete, AMI or Shamrock. Floor sleeves to extend a minimum of 1” above finished floor.
8. Through exterior walls and floor on grade: 150-pound class cast-iron pipe sleeve. Where waterproof membranes are used, provide membrane clamps. For insulated piping, sleeve diameter shall not be less than diameter of insulated pipe.

J. Sleeve Seals:
1. All sleeves shall be sealed to prevent intrusion of moisture, dust or insects.
2. Underground: For sleeves passing through exterior or foundation walls, provide mechanical link seal assembly.
3. Aboveground: For sleeves passing through walls or floors provide a non-toxic 3-hour rated fire resistant silicone foam sealant with a Flame Spread Rating of 20. Sealant to be tested and approved under UL 263, ASTM E119, and NFPA 251 Standards. All fire rated penetrations shall be sealed with approved UL System.
4. Local Approvals: All seals to be provided shall be in accordance with the regulations of all governing agencies of the city, county, and State Fire Marshal's Office.

2.15 PIPE COATING

A. All underground steel and copper pipe fittings, and all above ground steel and copper pipe and fittings in corrosive air environments shall be covered with one of the following methods:
1. Twice Wrap 20 Mil. Scotch Wrap PVC No. 51, 50% overlap.
2. Prefabricated extruded plastic cover with joints sealed with two coats of 20 Mil. Scotch Wrap No. 51 or Pasco Wrap 20 mil weight.

B. Furnish corrugated stainless steel tubing (CSST) with factory-applied corrosion –resistant polyethylene jacket for use in corrosive atmosphere. Coating properties include the following:
1. Gastite corrugated stainless steel tube jacket shall be UV-Resistant polyethylene meeting the requirements of ASTM E84 for flame spread and smoke density.

2.16 GAS CONNECTORS

A. General Areas: CSA rated, UL listed, braided stainless steel gas hose of size and capacity to meet appliance input requirements.

B. Food Service Equipment: CSA rated, UL listed, plastic coated braided stainless steel gas hose with quick disconnect, swivel fitting and coiled restraining device. Dormont #1675BPQS or approved equal.

2.17 EXPANSION COMPENSATORS

A. General: Pipe expansion, in general, is to be absorbed in bends, swing joints, expansion loops, and offsets. All piping mains, branches and runouts shall be installed to allow for free expansion and contraction without developing leaks or undue stressing of pipe. Stresses shall be within allowable limits of ASME B31.1 for pressure piping. Vertical piping for domestic hot water, chilled water, heating water, steam and steam condensate shall be provided with expansion joints at each floor. Expansion products to conform to the standards of the Expansion Joint Manufacturer's Association. Expansion joints shall not required packing. Installer shall select materials and pressure/temperature ratings to suit intended service. Select packless expansion joints to provide 150% absorption capacity of calculated maximum piping expansion between anchors. All connections shall have ends to match piping system application.
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B. Expansion Compensators (Pipe Compression and Extension): Multiple stainless steel bellows and stainless steel liner with shroud and end fittings. Keflex #311 series or approved equal.

C. Flexible Expansion Joint/Seismic Connector for Steel Pipe: Stainless steel hose and braid, 180° return, CSA approved, and end fittings. Metraflex #Metraloop or approved equal.

D. Flexible Connection for Steel Pipe (Piping and Equipment Located Outside the Building): Stainless steel hose and braid, with threaded or flanged ends. Metraflex #SST or approved equal.

E. Flexible Connection for Copper Pipe: Bronze hose and braid, copper tube ends. Metraflex #BBS or approved equal.
   1. For non-critical pump connections. Furnish with fluorelastomer tube and cover to ASTM D2000 Grade 1HK710. The body shall be reinforced with rectangular body rings and six bias plies of fiberglass/kevlar fabric rated 190#/26” vacuum at 250°F. Provide galvanized flat (not L shaped) back up rings and control rods to limit maximum axial extension. Garlock #206 EZ-FLO or approved equal.
   2. Flexible Ball Pipe Joints: Provide flexible ball pipe joints where indicated for piping systems, with materials and pressure/temperature ratings selected by installer to suit intended service. Design joints for 360° rotation, and with minimum of 50° angular flexing movement for sizes ¼” to 4”. Provide two composition gaskets for each joint. Barco or approved equal.

F. Pipe Alignment Guides: Provide pipe alignment guides on both sides of expansion joints, and elsewhere as indicated on drawings. Guide shall be of carbon steel construction with split guiding cylinder and integral anchor base and internal four finger two-piece spider. Cylinder wall thickness shall be equal to schedule 40 wall thickness of pipe being guided. Spider shall be capable of clamping directly to pipe and moving only in an axial direction while inside cylinder. Anchoring directly to building substrate. Metraflex #Style IV or equal.

G. Expansion Loops: Provide field fabricated pipe expansion loops as detailed on the drawings or in place of mechanical expansion joints.

PART 3 - EXECUTION

3.1 GENERAL

A. Workmanship shall be performed by licensed journeymen or master mechanics and shall result in an installation consistent with the best practices of trades.

B. Install work uniform, level and plumb, in relationship to lines of building. Do not install any diagonal, or otherwise irregular work unless so indicated on Drawings or approved by Architect.

3.2 MANUFACTURER’S DIRECTIONS

A. Follow manufacturers’ directions and recommendations in all cases where the manufacturers of articles used on this Contract furnish directions covering points not shown on the Drawings or covered in these Specifications.

3.3 INSTALLATION

A. Coordinate the work between the various Plumbing Sections and with the work specified under other Divisions of the work or contracts toward rapid completion of the entire project. If any cooperative work must be altered due to lack of proper supervision or failure to make proper provisions in time, then the work hereunder shall include all expenses of such changes as are necessary in the work under other contracts, and such changes shall be directly supervised by and made to the satisfaction of the Engineer.

B. The cooperative work not included in the Plumbing Division related to the general construction work is as follows:

SERA Architects, Inc. Package 1 – PERMIT / CONSTRUCTION

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1. All formed concrete work.
2. Framed openings in masonry and other Architectural and Structural elements.
3. Wood grounds and nailing strips in masonry and concrete.
4. Sloping of floors to drains and floor sinks.
5. Sloping of roof-to-roof drains and overflow drains.

C. Inspect all material, equipment, and apparatus upon delivery and do not install any that may be subject to rejection as a result of damage or other defects. Provide tarps and visqueen cover to protect equipment and piping delivered to and stored at the site.

3.4 WORKING PRESSURES

A. All fittings, valves, pipe, specialties equipment shall be rated for the working pressure subjected in the installed locations.
B. Drawings indicate working pressure in each system. The rating of the equipment and material shall not be less than that of the system pressures.
C. Low pressure, 0.5 psig (14 inch Water Column) or less, Natural Gas Systems: Use 1/2 to 2-inch NPS: Gastite corrugated stainless steel tube and brass fittings.
D. Medium pressure, over 0.5 psig (14 inch Water Column) up to 5 psig, Natural Gas Systems: Use 1/2 to 2-inch NPS: Gastite corrugated stainless steel tube and brass fittings.

3.5 PIPES SIZES TO EQUIPMENT

A. General: Pipe sizes indicated shall be carried full size to equipment served. Any change of size to match equipment connection shall be made within one foot of equipment.
B. At temperature control valves with sizes smaller than connected lines, reduction shall be made immediately adjacent to valve.

3.6 PIPING INSTALLATION

A. General: Install pipes and pipe fittings in accordance with recognized industry practices which will achieve permanently leakproof piping systems, capable of performing each indicated service without piping failure. Install each run with minimum joints or couplings, but with adequate and accessible unions for disassembly and maintenance or replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings. Align piping accurately at connections, within 1/16” misalignment tolerance. Comply with ASME B31 Code for Pressure Piping.

B. Locate piping runs, except as otherwise indicated, vertically and horizontally (pitched to drain) and avoid diagonal runs wherever possible. Orient horizontal runs parallel with walls and column lines. Locate runs as shown or described by diagrams, details, and notations or, if not otherwise indicated, run piping in shortest route which does not obstruct space or block access for servicing building and its equipment. Hold piping close to walls, overhead construction, and other structural and permanent-enclosure elements of building. Limit clearance to 1/2” where furring is shown for enclosure or concealment of piping, but allow for insulation thickness, if any. Where possible, locate insulated piping for 1” clearance outside insulation. Whenever possible in finished and occupied spaces, conceal piping from view, by locating in column enclosures, in hollow wall construction, or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as indicated.

C. Elevator Machine Rooms, Switchgear, Generator, Telecommunications, Telephone Rooms, and Electrical Equipment Spaces: Do not run piping through transformer vaults and other electrical or electronic equipment spaces and enclosures unless unavoidable. Install drip pan under piping that must be run through electrical spaces. Route drip pan drain piping to floor drain, floor sink or other approved receptor.

3.7 WELDING
PLUMBING PIPING, VALVES AND SPECIALTIES

A. Qualifications of Welders: Welders performing work under this Contract shall be certified and qualified in accordance with tests prescribed by the National Certified Welding Bureau (NCWB) or by other approved test procedures using methodology and procedures covered in the ASME Boiler and Pressure Vessel Code, Section IX, "Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators". Installation shall conform to ANSI 31.1 "Power Piping".
   1. Submit for approval the names, identification, and welder's assigned number, letter or symbol of welders assigned to this project.
   2. The assigned identification symbol shall be used to identify the work of each welder and shall be indelibly stamped immediately upon completion of each weld.
   3. Welders shall be tested and certified for all positions.
   4. Submit identifying stenciled test coupons made by each operator.
   5. Any or all welders may be required to retake welding certification tests without additional expense.
   6. When so requested, a welder shall not be permitted to work as a welder on this project until he has been recertified in accordance with NCWB.
   7. Recertification of the welder shall be made after the welder has taken and passed the required tests.
   8. Where piping 1-1/2 inches and smaller is butt or socket welded, submit 3 samples of test welds for approval.

3.8 PIPING SYSTEM JOINTS

A. All piping shall be cut squarely, free of rough edges and reamed to full bore. Piping shall be mechanically cleaned prior to make-up of joints and fully inserted into fittings.

B. Provide joints of type indicated in each piping system.

C. Thread pipe in accordance with ANSI B2.1. Cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Remove excess cutting oil from piping prior to assembly. Apply pipe joint compound, or pipe joint tape (Teflon) where recommended by pipe/fitting manufacturer, on male threads at each joint and tighten joint to leave not more than 3 threads exposed.

D. Solder copper tube and fitting joints with lead free nickel/silver bearing solder meeting ASTM B-32, in accordance with IAPMO IS 3-93, ASTM B-828 and Copper Development Association recommended procedures. Joints shall be cleaned by other than chemical means prior to assembly. "Shock" cooling is prohibited. Fluxes shall be applied liberally to the outside of the pipe and the solder cup of the fitting. Fluxes shall be water soluble for copper and brass potable water applications, and shall meet CDA standard test method 1.0 and ASTM B813-91. Solder shall be applied until a full fillet is present around the joint. Solder and flux shall not be applied in such excessive quantities as to run down interior of pipe. Lead solder or corrosive flux shall not be present at the jobsite.
   1. Manufacturers:
      a. Solder: JW Harris "Bridgit" or Englehard "Silvabrite 100".
      b. Flux: Laco "Flux-Rite 90", MW Dunton "Nokorode CDA Flux", Hercules "Fluid Action Solder Flux".

E. Braze copper tube and fitting socket with BCUP series filler metal without flux. Listed brazing flux shall be used for joining of copper tube to brass or bronze fittings and shall meet AWS FB3A or FB3C. "Shock" cooling is prohibited. A continuous fillet shall be visible around the completed joint. After cooling, flux residue shall be thoroughly removed with warm water and a brush prior to testing. Do not use BCUP filler on copper alloys containing over 10% nickel.
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F. Corrugated stainless steel tube (CSST) fittings joints: Gastite® mechanical tube fittings manufactured from ASTM B16 type 360 brass whose design incorporates a double wall flare for gas-tight seal with Jacket Lock™, mechanical capture of the jacket for enhanced tubing protection.

G. Piping shall be capped during construction to prevent entry of foreign material.

H. Weld pipe joints in accordance with recognized industry practice and as follows:
   1. Weld pipe joints only when ambient temperature is above 0°F.
   2. Bevel pipe ends at a 37.5° angle where possible, smooth rough cuts, and clean to remove slag, metal particles, and dirt.
   3. Use pipe clamps or tack-weld joints with 1" long welds, 4 welds for pipe sizes to 10", 8 welds for pipe sizes 12" to 20".
   4. Build up welds with stringer-bead pass, followed by hot pass, followed by cover or filler pass. Eliminate valleys at center and at edges of each weld. Weld by procedures which will ensure elimination of unsound or unfused metal, cracks, oxidation, blow-holes, and non-metallic inclusions.
   5. Do not weld out piping system imperfections by tack-welding procedures. Refabricate to comply with requirements.
   6. At Installer's option, install forged branch-connection fittings whenever branch pipe is indicated, or install regular T-fitting.

I. Flanged Joints: Match flanges within piping system, and at connections with valves and equipment. Clean flange faces and install gaskets. Tighten bolts to provide uniform compression of gaskets.


3.9 VALVES

A. General: Except as otherwise indicated, comply with the following requirements:
   1. Install valves where required for proper operation of piping and equipment, including valves in branch lines where necessary to isolate sections of piping. Locate valves so as to be accessible and so that separate support can be provided as necessary.
   2. Install valves, except butterfly valves, with stems pointed up, in vertical position where possible, but in no case with stems pointed downward from horizontal plane without prior written approval. Install valve drains with hose-end adapter for each valve that must be installed with stem below horizontal plane.
   3. Install butterfly valves with stems mounted horizontally.
   4. All valves mounted higher than 7' above floor in mechanical rooms and where indicated shall be installed with stem horizontal and equipped with chain wheels and chains extending to 6' above floor.
   5. Provide Seismic shut off valve on gas main downstream of meter.

B. Insulation: Where insulation is indicated, install extended-stem valves, arranged in proper manner to receive insulation.

C. Selection of Valve Ends (Pipe Connections): Except as otherwise indicated, select and install valves with the following ends of types of pipe/tube connections:
   1. Copper Pipe, 2-1/2" and Smaller: Soldered-joint valves.
   2. Steel Pipe, 2" and Smaller: Threaded joint valves.
   3. Larger Pipe Sizes: One of the following, at installer's option:
      a. Flanged valves
      b. Lug valves

D. Non-Metallic Disc: Limit selection and installation of valves with non-metallic discs to locations indicated and where foreign material in piping system can be expected to prevent tight shutoff of metal seated valves.
PLUMBING PIPING, VALVES AND SPECIALTIES

E. Renewable Seats: Select and install valves with renewable seats, except where otherwise indicated.

F. Fluid Control: Except as otherwise indicated, install gate, ball, plug, circuit setter, globe, and butterfly valves to comply with ASME B31.9.

G. Swing Check Valves: Install in horizontal position with hinge pin horizontally perpendicular to center line of pipe. Install for proper direction of flow.

H. Wafer Check: Install between 2 flanges in horizontal or vertical position.

I. Ball Valve: Ball valve used on gas systems shall be UL listed, CSA approved for pressure of system, no exception.

J. Valve Adjustment: After piping systems have been tested and put into service, but before final testing, adjusting, and balancing, inspect each valve for possible leaks. Adjust or replace packing to stop leaks, replace valve if leak persists.

K. Valve Identification: Tag each valve in accordance with "Mechanical Identification" section.

L. Cleaning: Clean factory-finished surfaces. Repair marred or scratched surfaces with manufacturer's touch-up paint.

3.10 TEMPERATURE GAUGES

A. General: Install temperature gauges in vertical upright position, and tilted so as to be easily read by observer standing on floor without supplemental illumination. All gages to be installed with snubbers to absorb system shock.

B. Install in the following locations, and elsewhere as indicated:
   1. At outlet of hot water heaters
   2. At inlet and outlet of boilers

3.11 MECHANICAL SLEEVE SEALS

A. Loosely assemble rubber links around pipe with bolts and pressure plates located under each bolt head and nut. Push into sleeve and center. Tighten bolts until links have expanded to form a watertight seal.

B. Fire Barrier Penetration Seals: Fill entire opening with sealing compound in compliance approved and listed UL system number. Adhere to manufacturer's installation instructions.

3.12 SUPPORTS AND HANGERS (See 220500)

3.13 EQUIPMENT RAILS AND PIPE PORTALS

A. Install per manufacturer's instructions.

B. Coordinate with other trades so units are installed when roofing is being installed.

C. Verify roof insulation thickness and adjust raise of cant to match.

3.14 VIBRATION CONTROL ISOLATORS

A. Comply with minimum static deflections recommended by ASHRAE, for selection and application of vibration isolation materials and units as indicated.

B. Manufacturer's Recommendations: Except as otherwise indicated, comply with manufacturer's recommendations for selection and application of vibration isolation materials and units.
PLUMBING PIPING, VALVES AND SPECIALTIES

C. Except as otherwise indicated, comply with manufacturer's instructions for installation and load application to vibration control materials and units. Adjust to ensure that units have equal deflection, do not bottom out under loading, and are not short-circuited by other contacts or bearing points. Remove space blocks and similar devices intended for temporary support during installation.

D. Install units between substrate and equipment as required for secure operation and to prevent displacement by normal forces, and as indicated.

E. Adjust leveling devices as required to distribute loading uniformly onto isolators. Shim units as required where substrate is not level.

F. Flexible Pipe Connectors: Install on equipment side of shutoff valves.

G. Upon completion of vibration control work, prepare report showing measured equipment deflections for each major item of equipment as indicated.

H. Clean each vibration control unit, and verify that each is working freely, and that there is no dirt or debris in immediate vicinity of unit that could possibly short-circuit unit isolation.

3.15 EXPANSION LOOPS

A. Expansion Loops: Fabricate expansion loops as indicated, in locations indicated, and elsewhere as determined by installer for adequate expansion of installed piping system. Subject loop to cold spring which will absorb 50% of total expansion between hot and cold conditions. Provide pipe anchors and pipe alignment guides as indicated, and elsewhere as determined by installer to properly anchor piping in relationship to expansion loops.

B. Expansion Compensation for Risers and Terminals: Install connection between piping mains and risers with at least five pipe fittings including tee in main. Install connections between piping risers and terminal units with at least four pipe fittings including tee in riser.

3.16 EXPANSION COMPENSATORS

A. Install as noted on plans. Where plans do not indicate spacing of guides or other pertinent information, install per manufacturer's recommendations.

3.17 PIPE INSPECTIONS

A. It is the intent of the Contract Documents that systems be inspected at completion of each phase while under tests required for administrative authorities, and prior to concealment, i.e. “Rough-in” “top-out” and final.

B. Inspection – Below Grade: All piping installed below grade shall be inspected prior to burial by the Architect, the Owner’s Representative or the Engineer. Contractor must notify Architect no less than 24 working hours prior to inspection time. Should the piping be buried prior to inspection the contractor may be requested to uncover the piping at no delay to the project and at no additional cost to the Owner.

C. Inspection – Above Grade: All piping installed above grade shall be made available for inspection upon completion and prior to finish of walls and ceilings. Notify the Architect, the Owner's Representative or the Engineer. Contractor must notify Architect no less than 24 working hours prior to the desired inspection time. Should the piping be hidden within the structure prior to inspection the contractor may be requested to uncover the piping at no delay to the project and at no additional cost to the Owner.

3.18 CLEANING, FLUSHING, DISINFECTING

A. General: Clean exterior surfaces of installed piping systems of superfluous materials, and prepare for application of specified coatings (if any).
3.19 TESTING

A. Provide all tests specified hereinafter and as otherwise required. Provide all test equipment, including test pumps, gauges, instruments, and other equipment required. Test all rotational equipment for proper direction of rotation. Upon completion of testing, certify to the Architect, in writing, that the specified tests have been performed and that the installation complies with the specified requirements and provide a report of the test observations signed by qualified inspector.

B. Piping: Remove from the system, during testing, all equipment which would be damaged by test pressure. Replace removed equipment when testing has been accomplished. The system may be tested in sections as the work progresses; however, any previously tested portion shall become a part of any latter test of a composite system. Correct leaks by remaking joints with new material.

C. Test time will be accrued only while full test pressure is on the system, unless indicated otherwise. “Tolerance” shall be no pressure drop, except that due to temperature change in a 24-hour period. Inspect and test all work prior to burying or concealing. Test pressure shall be one and one-half times the system operating pressure or the listed test pressure below, whichever is greater:

<table>
<thead>
<tr>
<th>System</th>
<th>Test Medium</th>
<th>Test Pressure</th>
<th>Tolerance-Test Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic Water</td>
<td>Water</td>
<td>150 psig</td>
<td>None – 8 hours</td>
</tr>
<tr>
<td>Soil and Waste</td>
<td>Water</td>
<td>10 ft head, 5 psi</td>
<td>No leaks – 8 hours</td>
</tr>
<tr>
<td>Vent</td>
<td>Water</td>
<td>Top of Vent Terminal</td>
<td>No leaks – 8 hours</td>
</tr>
<tr>
<td>Storm</td>
<td>Water</td>
<td>Top of Roof Drain</td>
<td>No leaks – 8 hours</td>
</tr>
<tr>
<td>Automatic Fire</td>
<td>Water</td>
<td>200 psig</td>
<td>None – 8 hours</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>Air</td>
<td>100 psig</td>
<td>None – 24 hours</td>
</tr>
</tbody>
</table>

D. Final Drainage, Waste and Vent Test: Upon project closeout, Contractor shall perform and certify that the DWV system has passed the following test:
1. After all plumbing fixtures have been installed and their traps filled with water, all vent terminals and building drains shall be closed and a U-tube water manometer shall be inserted into the trap of water closet and an air compressor testing apparatus shall be attached to any suitable opening. An air pressure of 1” water column as indicated on the manometer shall be introduced into the system. The pressure shall hold constant for a period of 15 minutes without the introduction of additional air. Leaks revealed during this test may be located by smoke test of other recognition methods.

E. Valves: Test all valve bonnets for tightness. Test operate all valves at least once from closed-to-open-to-closed position while valve is under test pressure. Test all automatic valves, including solenoid valves, and temperature and pressure relief valves, safety valves, and temperature and pressure relief valves not less than three (3) times.

F. Piping Specialties: Test all thermometers, pressure gauges, and water meters for accurate indication; automatic water feeders, air vents, trap primers, and vacuum breakers for proper performance. Test all air vent points to ensure that all air has been vented.

G. Backflow Preventers: Each testable backflow prevention device shall be tested and approved by certified testers after installation. Submit test results.
PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS

A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, and Section 220500 - Basic Materials and Methods, and other Sections in Division 22 specified herein.

1.2 SCOPE

A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to, the following:
   1. Domestic hot water recirculating pumps

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Section 220500: Basic Materials and Methods
B. Section 220501: Plumbing
C. Section 224000: Plumbing Fixtures
D. Division 26: Electrical

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Provide systems that are the standard product of an equipment manufacturer regularly engaged in the production of such units who issues complete catalog information on such products.

B. Codes and Standards: Provide pumps which conform to the requirements of:
   1. Hydraulic Institute (HI): Manufacturer pumps in accordance with "Standards for Centrifugal Rotary and Reciprocating Pumps."
   2. National Electrical Manufacturers Association (NEMA): Provide electrical components which comply with NEMA Standards.
      a. 70: National electrical Code
   4. Underwriters Laboratories (UL):
      a. UL-778: Motor Operated Water Pumps

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data for units showing dimensions, weights (shipping, installed, and operating), capacities, ratings, performance with operating point clearly indicated, motor electrical characteristics, finishes of materials, and installation instructions.
   1. Parallel pump plots: For all parallel and series pump applications submit a combined pump curve showing parallel pump operation and single pump non-overloaded operation verifying that the pump selections operate non-overloading on curve in a single pump operation.
   2. Submittal information to verify all scheduled characteristics are met including efficiency.

B. Shop Drawings: Submit manufacturer's shop drawings indicating dimensions, weight (shipping, operating), required clearances, methods of assembly of components, and location and size of each field connection.
NOTICE OF ALTERNATE BILLING CYCLE: The Contract will allow the Owner to require the submission of billings or estimates in billing cycles other than 30-day cycles. Billing or statements shall be submitted monthly ending on the last day of the month.

NOTICE OF EXTENDED CERTIFICATION PROVISION: The Contract will allow the Owner to certify billings and estimate within 20 days after the billings and estimates are received from the original contractor.

NOTICE OF EXTENDED PAYMENT PROVISION: The Contract will allow the Owner to make payment within 30 days after the date a billing or estimate is received.

C. Maintenance Data:
   1. Submit maintenance instructions, including instructions for lubrication, tube replacement, motor and drive replacement, and spare parts lists.
   2. Include this data, product data, shop drawings, and wiring diagrams in operating and maintenance manuals.

D. Wiring Diagrams:
   1. Submit manufacturer's ladder-type wiring diagrams for power and control wiring required.
   2. Differentiate between factory-installed and field-installed wiring.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver units to the site in containers with manufacturer's stamp or label affixed.

B. Store and protect products and units against dirt, water, chemical, and mechanical damage. Do not install damaged units - remove from project site.

C. Rigging: Comply with the manufacturer's rigging and installation instructions.

1.7 WARRANTY

A. Provide general one year (12 months) warranty. The warranty shall include parts, labor, travel costs, and living expenses incurred by the manufacturer to provide factory authorized service.

PART 2 - PRODUCTS

2.1 HOT WATER RECIRCULATING PUMPS

A. Furnish and install pumps with capacities as shown on plans.
   1. Pumps shall be in-line type for installation in vertical or horizontal piping.
   2. Pump must be capable of being serviced without disturbing piping connections.

B. Pump body shall be of all bronze construction, rated 175 psi working pressure, with gauge ports at nozzles, and with vent and drain ports.

C. Impeller shall be non-ferrous material, enclosed type, dynamically balanced, keyed to the shaft and secured by a locking capscrew or nut.

D. The liquid cavity shall be sealed off at the motor shaft by an internally-flushed mechanical seal with ceramic seal seat, and carbon seal ring, suitable for continuous operation at 225°F. A non-ferrous shaft sleeve shall completely cover the wetted area under the seal.

E. Pump bearing bracket shall have oil lubricated bronze journal and thrust bearings. Bracket shaft shall be alloy steel having ground and hardened thrust bearing faces. A flexible coupling to dampen starting torque and torsional vibration shall be employed.

F. Motor shall meet NEMA specifications and shall be the size, voltage and enclosure called for on the plans.

G. Each pump shall be factory tested. It shall then be thoroughly cleaned and painted with at least one coat of high-grade machinery enamel prior to shipment.

H. Provide H-O-A switch with overload protection. Pump shall be controlled by an aquastat on the return line and a flow switch on the cold water makeup. Wiring between switch and pump provided under Division 22, as stated in Section 220500.

I. Manufacturer: ITT Bell and Gossett Series 60, TACO, Thrush or Grundfos.
PART 3 - EXECUTION

3.1 INSTALLATION

A. All equipment, unless otherwise shown or noted on the Drawings, is to be installed in accordance with industry standards and manufacturer's recommended installation instructions.

B. Provide vibration isolation, inertia bases, seismic snubber, flexible pipe connections, etc, as specified in related specification sections.

C. For variable flow pumping applications, see Section 230593 for additional requirements.

D. Contractor to assist testing and balancing contractor in verifying correct pump rotation and system operation.

E. Flush and clean equipment, in accordance with manufacturer's start-up instructions, and in presence of manufacturer's representative. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls.

F. Isolation for Service: Provide pump installations with a discrete isolation valve on both the supply and intake side of the pump to permit service of the pump and any related strainer, check or balancing valves. Triple duty valves are not equivalent for this shut-off service.

G. Balancing Coordination and Impeller Trimming: Coordinate final pump flow with test and balance contractor. For pumps larger than 5 horsepower, if the system tests and balance indicate that flow exceeds the specified flow by greater than 20%, it is not acceptable to reduce flow merely by adjusting balance valves to create additional head or reducing VFD peak flows. Excess system flow must be reduced by trimming the impeller to match the load.

3.2 MANUFACTURER’S START-UP SERVICES

A. The manufacturer shall provide start-up service in the form of a factory trained service technician. The service technician shall verify correct installation, verify pump systems mounting, verify piping installation, verify control wiring, verify power wiring, and check for proper operation. The service technician shall provide final adjustments to meet the specified performance requirements. Fully staffed parts and service personnel shall be within four hours travel from the jobsite.

END OF SECTION
PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS
   A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, and Section 220500 - Basic Materials and Methods, and other Sections in Division 22 specified herein.

1.2 SCOPE
   A. All work to be furnished and installed under this section shall include, but not necessarily be limited to, the installation of plumbing fixtures and trim.

1.3 RELATED WORK IN OTHER SECTIONS
   A. Section 220500: Basic Materials and Methods
   B. Section 220501: Plumbing
   C. Section 221123: Plumbing Equipment

1.4 SUBMITTALS
   A. Prior to construction submit for approval all materials and equipment in accordance with Division 01. Submit manufacturer's data, colors, installation instructions, and maintenance and operating instructions for all components of this section including, but not limited to, the following:
   1. Plumbing fixtures
   2. Piping specialties
   3. Sinks
   B. Shop Drawings: Submit rough-in drawings. Detail dimensions, rough-in requirements, required clearances, and methods of assembly of components and anchorages. Coordinate requirements with Architectural Woodwork shop drawings specified in Division 06 for fixtures installed in countertops and cabinets. Furnish templates for use in woodwork shop.
   C. Samples: Submit samples of any piece of equipment requested by Architect for review and approval.
   D. Wiring Diagrams: Submit manufacturer's electrical requirements and wiring diagrams for power supply to units. Clearly differentiate between portions of wiring that are factory installed and field installed portions.

1.5 CODES AND STANDARDS
   A. Uniform Plumbing Code (UPC) with State Amendments
   B. State of Oregon Plumbing Specialty Code – SOPSC
   C. All fixtures and faucets must meet all requirements of the State of Oregon Structural Specialty Code – SOSSC
   D. All fixtures and accessories must be approved for use by the State of Oregon
   E. All fixtures and faucets must meet all requirements of Americans with Disabilities Act (ADA).
   F. State Energy Code

1.6 DELIVERY, STORAGE, AND HANDLING
   A. Deliver units to the site in containers with manufacturer's stamp or label affixed.
   B. Store and protect products against dirt, water, chemical, and mechanical damage. Do not install damaged products. Remove damaged products from project site.
1.7 MAINTENANCE

A. Extra Stock:
1. Furnish special wrenches and other devices necessary for servicing plumbing fixtures, flush valves, and trim to Owner with receipt in a quantity of one device for each 10 fixtures.
2. Furnish faucet repair kits complete with all necessary washers, springs, pins, retainers, packings, o-rings, sleeves, and seats in a quantity of 1 kit for each 10 faucets.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide fixtures as specified. Fixtures in any secure or public areas shall be vandal proofed.

B. Architect/Engineer shall review and approve any substitution requested by Contractor prior to bid submittal.

C. Provide fixture as specified, acceptable manufacturers:
2. Stainless Steel Sinks: Elkay or Just
   a. All stainless steel is 18 gauge, type 304 unless otherwise specified.
3. Drinking Fountains: Elkay or Haws.
4. Terrazzo Service Sinks: Florestone or Stern Williams.

D. Provide faucet as specified. Acceptable manufacturers: Chicago Faucets, Zurn, Symmons, T and S or as indicated.

E. Provide a thermostatic mixing valve conforming to ASSE 1070 for all public lavatories.

F. Provide flush valve as specified. Acceptable manufacturers: Sloan or Zurn.

G. Provide commercial grade toilet seat as specified. Acceptable manufacturers: Beneke, Bemis, Church or Olsonite.

H. Provide heavy-duty cast iron commercial grade carrier as specified. Provide compact carriers where space is limited. Acceptable manufacturers: Ancon, Jay R. Smith, Wade or Zurn. No plastic parts on foundry items.

I. Provide heavy duty commercial grade 17-gauge P-Trap and supplies with stops as specified. Provide heavy duty commercial grade lavatory supplies. Provide supplies meeting AB1953 no lead requirements. Supplies shall be ½"x 3/8" x 12" ground joint flexible riser with loose key angle stop with chrome plates I.P.S. brass nipple. Sink supplies shall be ½" x 12" ground joint flexible riser with loose-key angle stop with chrome plated I.P.S. brass nipple. Provide bell type escutcheons for both P-trap and supplies. Acceptable manufacturers: Zurn, Brasscraft, Chicago, or McGuire.
1. P-trap - Lav: McGuire C8902-DF or Zurn Z-8701.
2. Supply for Lavatory: McGuire LFH2165LK or Zurn ZH88-XL-LK.
3. Offset supply for barrier free lavatory: McGuire 158 W/C.
4. Supply for Water Closet: McGuire H2169LK or Zurn ZH-8807-CR.
5. Escutcheons: McGuire WE000D Series, wrought brass, bell type.
7. Barrier-free lavatory offset grid strainer: McGuire 155WC or Zurn 8746.

J. Insulation: provide white molded closed cell vinyl pre-fab insulation on P-Trap and on both hot and cold water supply for barrier free lavatories and sinks. Acceptable manufacturers: Plumberex, True-Bro, and Zurn. Bag type insulators are not acceptable.
PART 3 - EXECUTION

3.1 GENERAL

A. Verify all dimensions by field measurements. Verify that all plumbing fixtures may be installed in accordance with pertinent codes and regulations, the original design, and the referenced standards.

B. Examine rough-in for potable water and waste piping systems to verify actual locations of piping connections prior to installing fixtures.

C. Examine walls, floors and cabinets for suitable conditions where fixtures are to be installed.

D. Install plumbing fixtures level and plumb, in accordance with fixture manufacturer's written instructions, rough-in drawings, and pertinent codes and regulations, the original design, and the referenced standards.

E. Comply with the installation requirements of ADA with respect to plumbing fixtures for the physically handicapped.

F. Fasten plumbing fixtures securely to supports or building structure. Secure supplies behind or within wall construction to provide rigid installation.

G. Install a stop valve in an accessible location in the water connection to each fixture.

H. Install escutcheons at each wall, floor, and ceiling penetration in exposed finished locations and within cabinets and millwork.

I. Seal fixtures to walls and floors using silicone sealant as specified in Division 07. Match sealant color to fixture color.

J. Test fixtures to demonstrate proper operation upon completion of installation and after units are water pressurized. Replace malfunctioning units, then retest.

K. Inspect each installed unit for damage. Replace damaged fixtures.

L. Adjust water pressure at drinking fountains, faucets, shower valves, and flush valves to provide proper flow stream.

M. Replace washers or cartridges of leaking or dripping faucets and stops.

N. Clean fixtures, trim, and strainers using manufacturer's recommended cleaning methods and materials.

O. During construction cover all installed fixtures, sinks, and water coolers with cardboard boxes and wrap with Visqueen.

P. Provide flush valve and faucet support behind wall.

END OF SECTION
PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS

A. All work under this Section shall comply with the requirements of General Conditions, Supplemental Conditions, Special Conditions and Division 01 - General Requirements, and shall include all Mechanical Sections specified herein.

1.2 SCOPE OF THIS SECTION

A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to, the following:
   1. Compliance with all codes and standards applicable to this jurisdiction
   2. Shop Drawings for Equipment
   3. Coordination Documents
   4. Record Drawings
   5. Start-up Service and Building Commissioning
   6. Instruction, Maintenance, and O & M Manuals
   7. Work associated with Delivery, Storage, and Handling of products
   8. Work associated with provision of Temporary Facilities
   9. Preparation of Posted Operating Instructions
   10. Meeting Project Safety and Indemnity requirements
   11. Proper Cleaning and Closing
   12. Supplying proper Warranty information
   13. Supply specified Guarantee documentation
   14. Design and provision of Supports and Anchors
   15. Pipe Portals
   16. Pipe Supports
   17. Equipment Rails
   18. Access Panels and Doors
   19. Identification Markers
   20. Coordination of Electrical requirements for equipment provided

1.3 DESCRIPTION OF WORK

A. The Contract Documents, including Specifications and Construction Drawings, are intended to provide all material and labor to install complete heating, ventilating, air conditioning systems for the building and shall interface with all existing building systems affected by new construction.

B. The Contractor shall refer to the architectural interior details, floor plans, elevations, and the structural and other Contract Drawings and he shall coordinate his work with that of the other trades to avoid interference. The plans are diagrammatic and show generally the locations of the fixtures, equipment, and pipe lines and are not to be scaled; all dimensions and existing conditions shall be checked at the building.

C. The Contractor shall comply with the project closeout requirements as detailed in General Requirements of Division 01.

D. Where project involves interface with existing building and site systems, every effort has been made to note existing utilities and services. However, the Contractor should thoroughly familiarize themselves with existing conditions and be aware that in some cases information is not available as to concealed conditions, which exist in portions of the existing building affected by this work.
NOTICE OF ALTERNATE BILLING CYCLE: The Contract will allow the Owner to require the submission of billings or estimates in billing cycles other than 30-day cycles.
Billing or statements shall be submitted monthly ending on the last day of the month.

NOTICE OF EXTENDED CERTIFICATION PROVISION: The Contract will allow the Owner to certify billings and estimates within 20 days after the billings and estimates are received from the original contractor.

NOTICE OF EXTENDED PAYMENT PROVISION: The Contract will allow the Owner to make payment within 30 days after the date a billing or estimate is received.
BASIC HVAC MATERIALS AND METHODS

P. “Shall”: An exhortation or command to complete the specified task.

Q. “Similar” or “Equal”: Of base bid manufacture, equal in materials, weight, size, design, and efficiency of specified products.

R. “Supply”: To purchase, procure, acquire and deliver complete with related accessories.

S. “Typical” or “Typ”: Exhibiting the qualities, traits, or characteristics that identify a kind, class, number, group or category. Of or relating to a representative specimen. Application shall apply to all other similarly identified on plan or detail.

T. “Will”: A desire to complete the specified task. Allows some flexibility in application as opposed to “Shall”.

U. “Wiring”: Raceway, fittings, wire, boxes and related items.

V. “Work”: Labor, materials, equipment, apparatus, controls, accessories, and other items required for proper and complete installation.

1.6 RELATED WORK SPECIFIED ELSEWHERE

A. All Division 23 Mechanical sections included herein.

B. Division 33: Utility Site Work.
   1. Coordination of excavation of trenches and the installation of mechanical systems and piping on site.

C. Division 03: Concrete.
   1. All concrete work for Mechanical Division shall be included in Division 23 under the appropriate Sections and shall include:
      a. Concrete curbs and housekeeping pads for the mechanical equipment.
      b. Thrust blocks, pads, and boxes for mechanical equipment.
      c. Coordination of floor drain and floor sink installations in sloped floors.

D. Division 07: Thermal and Moisture Protection.
   1. Flashing and sheet metal
   2. Sealants and caulking
   3. Firestopping

E. Division 09: Painting.
   1. Division 23 installers shall perform all painting, except where specifically stated otherwise in Division 09.
   2. Painting of all exposed steel, piping, ductwork, insulation, equipment and materials.
   3. Paint all exposed gas piping, interior and exterior to the building, yellow.

F. Division 10: Miscellaneous Metals.
   1. Exterior louvers and grilles shall be included in this Section.

G. Division 26: Electrical is related to work of:
   1. Power connections to all mechanical equipment

H. Division 28: Electronic Safety and Security is related to work of:
   1. Fire protection alarms and relays
   2. Smoke detector and monitoring
   3. Life Safety Systems

1.7 CODES AND STANDARDS

A. The Contractor is cautioned that code requirements not explicitly detailed in these specifications or drawings, but which may be reasonably inferred or implied from the nature of the project, must be provided as part of the contract.
NOTICE OF ALTERNATE BILLING CYCLE: The Contract will allow the Owner to require the submission of billings or estimates in billing cycles other than 30-day cycles. Billing or statements shall be submitted monthly ending on the last day of the month.

NOTICE OF EXTENDED CERTIFICATION PROVISION: The Contract will allow the Owner to certify billings and estimates within 20 days after the billings and estimates are received from the original contractor.

NOTICE OF EXTENDED PAYMENT PROVISION: The Contract will allow the Owner to make payment within 30 days after the date a billing or estimate is received.

B. Perform all tests required by governing authorities and required under all Division 23 Sections. Provide written reports on all tests.

C. Electrical devices and wiring shall conform to the latest standards of NEC; all devices shall be UL listed and labeled.

D. All mechanical work shall comply with the Americans with Disabilities Act (ADA).

E. All excavation work must comply with all provisions of state laws including notification to all owners of underground utilities at least 48 business day hours, but not more than 10 business days, before commencing an excavation.

F. Provide in accordance with rules and regulations of the following:
   1. Building Codes enforced by the Authority Having Jurisdiction in Oregon:
      b. 2007 Oregon Mechanical Specialty Code (OMSC) based on 2009 International Mechanical Code (IMC) and 2009 International Fuel Gas Code (IFGC) with State Amendments
      c. 2008 Oregon Plumbing Code (OPC) based on 2006 Uniform Plumbing Code (UPC) with State Amendments
      d. 2010 Oregon Fire Code (Based on the 2009 International Fire Code)
      e. 2008 Oregon Electric Specialty Code (Based on the 2008 National Electric Code (NEC) with State Amendments
   2. Building Codes enforced by the Authority Having Jurisdiction for International Code Council (ICC) Codes:
      a. 2009 International Building Code (IBC) with State Amendments
      b. 2009 International Mechanical Code (IMC) with State Amendments
      c. 2006 International Plumbing Code (IPC) with State Amendments 2009 International Fire Code (IFC) with State Amendments
      d. 1999 National Electric Code (NEC) with State Amendments
   3. Local, city, county and state codes and ordinances
   4. Local Bureau of Buildings
   5. Local Health Department
   6. Local and State Fire Prevention Districts
   7. State Administrative Codes

G. Provide in accordance with appropriate referenced standards of the following:
   1. NFPA - National Fire Protection Association
   2. AABC - Associated Air Balance Council
   3. CSA - Canadian Standards Association
   4. ADC - Air Diffuser Council
   5. AMCA - Air Moving and Conditioning Association
   6. ANSI - American National Standards Institute
   7. ARI - Air Conditioning and Refrigeration Institute
   8. ASHRAE - American Society of Heating, Refrigerating & Air Conditioning Engineers
   9. ASME - American Society of Mechanical Engineers
   10. ASTM - American Society for Testing Materials
   11. AWS - American Welding Society
   12. FM - Factory Mutual
   13. MSS - Manufacturer's Standardization Society
   14. NEMA - National Electrical Manufacturer's Association
   15. SMACNA - Sheet Metal and Air Conditioning Contractors National Association
   16. UL - Underwriter's Laboratories
   17. ADA - Americans with Disabilities Act
   18. ETL - Electrical Testing Laboratories
1.8 QUALITY ASSURANCE

A. Manufacturer’s Nameplates: Nameplates on manufactured items shall be aluminum or Type 304 stainless steel sheet, not less than 20 USG (0.0375"), riveted or bolted to the manufactured item, with nameplate data engraved or punched to form a non-erasable record of equipment data.

B. Current Models. All work shall be as follows:
   1. Manufactured items furnished shall be the current, cataloged product of the manufacturer.
   2. Replacement parts shall be readily available and stocked in the USA.

C. Experience: Unless more stringent requirements are specified in other sections of Division 23, manufactured items shall have been installed and used, without modification, renovation or repair, on other projects for not less than one year prior to the date of bidding for this project.

1.9 GENERAL REQUIREMENTS

A. Examine all existing conditions at building site.

B. Review contract documents and technical specifications for extent of new work to be provided.

C. Provide and pay for all permits, licenses, fees and inspections.

D. Prepare a Construction IAQ Management Plan meeting the SMACNA IAQ guidelines. See Section 233113 Air Distribution for a summary of requirements.

E. Install equipment and materials to provide required access for servicing and maintenance. Coordinate the final location of concealed equipment and devices requiring access with final location of required access panels and doors. Allow ample space for removal of all parts that require replacement or servicing. This work shall include furnishing and installing all access doors required for mechanical access.

F. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected. Refer to Equipment Specifications in Divisions 02 through 48 for rough-in requirements.

G. Coordinate mechanical equipment and materials installation with other building components.

H. Verify all dimensions by field measurements.

I. Arrange for chases, slots, and openings in other building components to allow for mechanical installations.

J. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.

K. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing-in the building.

L. Coordinate the cutting and patching of building components to accommodate the installation of mechanical equipment and materials. Contractor to provide for all cutting and patching required for installation of his work unless otherwise noted.

M. Where mounting heights are not detailed or dimensioned, install mechanical services and overhead equipment to provide the maximum headroom possible.

N. Install mechanical equipment to facilitate maintenance and repair or replacement of equipment components. Connect equipment for ease of disconnecting, without interference with other installations.
O. Coordinate the installation of mechanical materials and equipment above ceilings with ductwork, piping, conduits, suspension system, light fixtures, cable trays, sprinkler piping and heads, and other installations.

P. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

Q. Coordinate with Owner in advance to schedule shutdown of existing systems to make new connections. Provide valves in new piping to allow existing system to be put back in service with minimum down time.

R. All materials (such as insulation, ductwork, piping, wiring, controls, etc.) located within air plenum spaces, air shafts, and occupied spaces shall have a flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E84 (NFPA 255) Method. In addition, the products, when tested, shall not drip flame particles, and flame shall not be progressive. Provide Underwriters Laboratories, Inc., label or listing, or satisfactory certified test report from an approved testing laboratory to prove the fire hazard ratings for materials proposed for use do not exceed those specified.

S. Coordinate installation of floor drains and floor sinks with work of other trades, such that finished floor slopes to drains and floor sinks are flush with surrounding floor.

T. Products made of or containing lead, asbestos, mercury or other known toxic or hazardous materials are not acceptable for installation under this Division. Any such products installed as part of the work of the Division shall be removed and replaced and all costs for removal and replacement shall be borne solely by the installing Contractor.

1.10 MINOR DEVIATIONS

A. The Drawings are diagrammatic and show the general arrangements of all mechanical work and requirements to be performed. It is not intended to show or indicate all offsets, fittings, and accessories which will be required as a part of the work of this Section.

B. The Contractor shall review the structural and architectural conditions affecting his work. It is the specific intention of this section that the contractor's scope of work shall include:
   1. Proper code complying support systems for all equipment whether or not scheduled or detailed on drawings or in these specifications
   2. Minor deviations from the mechanical plans required by architectural and structural coordination.

C. The Contractor shall study the operational requirements of each system, and shall arrange his work accordingly, and shall furnish such fittings, offsets, supports, accessories, as are required for the proper and efficient installation of all systems from the physical space available for use by this section. This requirement extends to the Contractor's coordination of this section's work with the "Electrical Work". Should conflicts occur due to lack of coordination, the time delay, cost of rectification, demolition, labor and materials, shall be borne by the Contractor and shall not be at a cost to the Owner.

D. Minor deviations in order to avoid conflict shall be permitted where the design intent is not altered.

E. Advise the Architect, in writing, in the event a conflict occurs in the location or connection of equipment. Bear all costs for relocation of equipment, resulting from failure to properly coordinate the installation or failure to advise the Architect of conflict.
1.11 PRODUCT SUBSTITUTIONS
A. The Contractor shall certify the following items are correct when using substituted products other than those scheduled or shown on the drawings as a basis of design:
1. The proposed substitution does not affect dimensions shown on drawings.
2. The Contractor shall pay for changes to building design, including engineering design, detailing, structural supports, and construction costs caused by proposed substitution.
3. The proposed substitution has no adverse effect on other trades, construction schedule, or specified warranty requirements.
4. Maintenance and service parts available locally are readily obtainable for the proposed substitute.
B. The Contractor further certifies function, appearance, and quality of proposed substitution are equivalent or superior to specified item.
C. The Contractor agrees that the terms and conditions for the substituted product that are found in the contract documents apply to this proposed substitution.

1.12 SHOP DRAWINGS AND EQUIPMENT SUBMITTALS
A. Prior to construction submit for review all materials and equipment in accordance with Division 01 requirements.
B. After approval of preliminary list of materials, the Contractor shall submit Shop Drawings and manufacturer's Certified Drawings to the Architect for approval.
C. The Contractor shall submit approved Shop Drawings and manufacturer's equipment cuts, of all equipment requiring connection by Division 26, to the Electrical Contractor for final coordination of electrical requirements. Contractor shall bear all additional costs for failure to coordinate with Division 26.
D. Submittals and Shop Drawings:
   1. Submitting contract drawings to demonstrate compliance with the requirement for preparation of shop drawing will not be accepted.
   2. Electronic Submittals: Provide electronic submittals as a coordinated package.
   3. The approved submittals shall be converted into Operations & Maintenance Manuals at the completion of the project. Refer to Division 01 for additional requirements.

1.13 UNIT PRICING SUBMITTALS
A. Prior to construction submit for review all materials and equipment in accordance with Division 01 requirements.
B. Preliminary List of Materials and Unit Price Items: Within thirty (30) days after awarding of the Contract, submit to architect for preliminary approval a complete list of manufacturer's names and model numbers of proposed materials and equipment. Also include proposed list of unit price items for review.
   1. Indicate substituted items.
   2. Identify test and balancing agency.
   3. Identify independent testing laboratory for water analysis.
C. The Contractor shall submit with preliminary list of materials a unit price list for each item furnished on this project. Included with price shall be labor cost index.
D. Submittals and Shop Drawings shall be submitted as a complete package bound in a 3-ring binder with tabs for each specification section. Submit six (6) typed copies of submittals. Refer to Division 01 for additional requirements.
1.14  COORDINATION DOCUMENTS

A. The Contractors shall prepare coordinated Shop Drawings or electronic versions thereof to coordinate the installation and location of all HVAC equipment, ductwork, grilles, diffusers, piping, fire sprinklers, lights, audio/video systems, electrical services and all system appurtenances. The Drawings shall include all mechanical rooms and floor plans. The Drawings shall be coordinated drawings using either Overlay Drawings showing each discipline on a single sheet or electronic documents intended for the same purpose. The Drawings shall be keyed to the structural column identification system, and shall be progressively numbered. Prior to completion of the Drawings, the Contractor shall coordinate the proposed installation with the Architect and the structural requirements, and all other trades (including HVAC, Plumbing, Fire Protection, Electrical, Ceiling Suspension, and Tile Systems), and provide reasonable maintenance access requirements. When conflicts are identified, modify system layout as necessary to resolve. Do not fabricate, order or install any equipment or materials until coordination documents are approved by the General Contractor, Architect, and Owner. Within thirty (30) days after award of Contract, submit proposed coordination document Shop Drawing schedule, allowing adequate time for review and approval by parties mentioned above. Drawings or electronic coordination should be prepared and submitted for approval on a floor-by-floor basis to phase with building construction.

B. The coordination work shall be prepared as follows:

1. Two dimensional paper or AutoCad based documents:
   a. The Sheet Metal (Mechanical) Contractor shall prepare Drawings to an accurate scale of 1/4" = 1'-0" or larger, on reproducible media sheets or AutoCAD files. Provide a “Hold Harmless Release” to obtain paper or AutoCAD files of the HVAC design from the Architect, or Engineer. Drawings are to be same size as Contract Drawings and shall indicate location, size and elevation above finished floor, of all HVAC equipment, ductwork, and piping. Plans shall also indicate proposed ceiling grid and lighting layout, as shown on electrical plans and reflected ceiling plans.
   b. The Plumbing Contractor shall obtain reproducible plans or AutoCAD files from the Mechanical Contractor, and indicate all plumbing lines including fittings, hangers, access panels, valves, and bottom of pipe elevations above finished floor.
   c. The Fire Protection Contractor shall obtain reproducible plans or AutoCAD files with the detailed mechanical and plumbing work shown. The Sprinkler Contractor shall indicate location of all sprinkler heads and piping, including valves and fittings, dimensions from column lines, and bottom of pipe elevations above finished floor.
   d. Plans are to incorporate all addenda items and change orders.
   e. Distribute plans to all trades and provide additional coordination as needed.

2. Three dimensional or BIM based documents:
   a. The Sheet Metal (Mechanical) Contractor shall prepare a three dimensional model of the work using the project BIM model. Provide a “Hold Harmless Release” to obtain the BIM model of the project structural, architectural, and HVAC design from the Architect. If a BIM model is not available use the available two-dimensional CAD files to construct a three dimensional model for coordination purposes.
   b. The Plumbing Contractor shall provide BIM input to indicate all major plumbing lines exceeding 3" in diameter including fittings, hangers, access panels, valves, and bottom of pipe elevations above finished floor.
   c. The Fire Protection Contractor shall provide BIM input information locating all sprinkler heads and piping, including valves and fittings, dimensions from column lines, and bottom of pipe elevations above finished floor.
   d. BIM models are to incorporate all addenda items and change orders.

C. Advise the Architect in the event a conflict occurs in the location or connection of equipment. Bear all costs for relocation of equipment, resulting from failure to properly coordinate the installation or failure to advise the Architect of conflict.
D. Provide means of access to all valves, dampers, controllers, operable devices, and other apparatus that may require adjustment or servicing.

E. Verify in field exact size, location, invert, and clearances regarding all existing material, equipment and apparatus, and advise the Architect of any discrepancies between those indicated on the Drawings and those existing in the field prior to any installation related thereto.

F. Final Coordination Drawings with all appropriate information added are to be submitted as Record Drawings at completion of project.

G. Provide copy of Record Drawings to Testing and Balancing Contractor for their use when doing their work.

1.15 RECORD DRAWINGS

A. Before commencing installation, obtain an extra set of prints from Architect, marked “Record”. Keep this set of Drawings at the job site at all times, and use it for no other purpose but to mark on it all the changes and revisions to the Contract Drawings resulting from coordination with other trades. At the completion of the project:
   1. Obtain a clean set of reproducibles from the Architect or Engineer, at cost plus, and transfer the revisions to these reproducibles in a neat and orderly fashion.

OR

2. Edit project AutoCAD files to incorporate all site markups, changes, and revisions to the Contract Drawings. Submit plots of Record Drawings and six copies CD Roms labeled with all record AutoCAD drawing files.

B. Provide copy of Record Drawings to Testing and Balancing Contractor for use when doing his work.

C. Mark Drawings to indicate revisions to piping and ductwork, size and location both exterior and interior; including locations of coils, dampers and other control devices, filters, boxes and similar units requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned to column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e. – valves, traps, strainers, expansion compensators, tanks, etc.); Change Orders; concealed control system devices.

D. Mark Specifications to indicate approved substitutions; Change Orders; actual equipment and materials used.

E. Refer also to Special Conditions in Division 01 for full scope of requirements.

1.16 START-UP SERVICE AND BUILDING COMMISSIONING

A. Prior to start-up, be assured that systems are ready, including checking the following: Proper equipment rotation, proper wiring, auxiliary connections, lubrication, venting, controls, and installed and properly set relief and safety valves.

B. Provide services of factory-trained technicians for start-up of air conditioning units, temperature controls, chillers, boilers, pumps, and other major pieces of equipment. Certify in writing compliance with this Paragraph, stating names of personnel involved and the date work was performed.

C. Provide certificates of calibration for all sensors required for control and monitoring including temperature and pressure.

D. Refer to other Division 23 Sections for additional requirements.
1.17 INSTRUCTION, MAINTENANCE, AND O&M MANUALS

A. O&M Manuals: Upon completion of the work, and prior to training of Owner's personnel, the Contractor shall submit to the Architect complete set of operating instructions, maintenance instructions, part lists, and all other bulletins and brochures pertinent to the operation and maintenance for equipment furnished and installed as specified in this section, bound in a durable binder. Refer to Division 01.

B. Contractor shall be responsible for providing proper instruction of the of Owner's personnel for operation and maintenance of equipment, and apparatus installed as specified in Division 23 to be no less than two hours for each piece of equipment. The Contractor shall develop and submit training materials prior to this training. These materials shall include qualifications of the trainer, training agenda, learning objectives, and a written test to be administered at the end of the training session. Operation and Maintenance manuals must present, incorporated and referenced in the training sessions.

1.18 DELIVERY, STORAGE AND HANDLING

A. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage, and handling.

B. Store equipment and materials in an environmentally controlled area at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage. Piping shall be stored in bundles covered with visqueen. Piping showing signs of rust shall be removed from site and replaced.

C. Coordinate deliveries of mechanical materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.

1.19 TEMPORARY FACILITIES

A. Refer to Division 01 for the requirements of temporary water and sewer for construction and safety. Provide temporary heating, air conditioning, ventilation, water, and sewer, etc. services as necessary during the construction period and as required to maintain operation of existing systems.

B. Temporary Heating for Commissioning Tests:
1. Provide temporary heating where needed to provide false load for commissioning tests.
2. Temporary heating may be from the permanent heating system of the project or from a dedicated temporary heating system. If temporary system is necessary, select facilities known to be safe and without deleterious effect upon what work in place or being installed.

C. Temporary Cooling for Commissioning Tests:
1. Provide temporary cooling where needed to provide false load for commissioning tests.
2. Temporary cooling may be from the permanent cooling system of the project or from a dedicated temporary cooling system. If temporary system is necessary, select facilities known to be safe and without deleterious effect upon the work in place or being installed.

1.20 POSTED OPERATING INSTRUCTIONS

A. Furnish approved operating instructions for systems and equipment indicated in the technical sections for use by operation personnel. The operating instructions shall include wiring diagrams, control diagrams, and control sequence for each principal system and equipment. Print or engrave operating instructions and frame under glass or in approved laminated plastic. Post instructions where directed. Attach or post operating instructions adjacent to each principal system and equipment including start-up, operating, shutdown, safety precautions and procedure in the event of equipment failure. Provide weather-resistant materials or weatherproof enclosures for operating
instructions exposed to the weather. Operating instructions shall not fade when exposed to sunlight and shall be secured to prevent easy removal.

1.21 SAFETY AND INDEMNITY

A. The Contractor shall be solely and completely responsible for conditions of the job site including safety of all persons and property during performance of the work. This requirement will apply continuously and not be limited to normal hours of work.

B. No act, service, Drawing, review, or Construction Review by the Owner, Architect, the Engineers or their consultants, is intended to include the review of the adequacy of the Contractor's safety measures, in, on, or near the construction site.

C. The Contractor performing work under this Division of the Specifications shall hold harmless, indemnify and defend the Owner, the Architect, the Engineers and their consultants, and each of their officers, employees and agents from any and all liability claim, losses or damage arising, or alleged to arise from bodily injury, sickness, or death of a person or persons, and for all damages arising out of injury to or destruction of property arising directly or indirectly out of, or in connection with, the performance of the work under the Division of the Specifications, and from the Contractor's negligence in the performance of the work described in the Construction Contract Documents; but not including the sole negligence of the Owner, the Architect, the Engineers, and their consultants or their officers, employees and agents.

1.22 CLEANING AND CLOSING

A. All work shall be inspected, tested, and approved before being concealed or placed in operation.

B. Upon completion of the work, all equipment installed as specified in this section, and all areas where work was performed, shall be cleaned to provide operating conditions satisfactory to the Architect.

1.23 WARRANTIES

A. All equipment shall be provided with a minimum one-year warranty to include parts and labor. Refer to individual Equipment Specifications for extended or longer-term warranty requirements.

B. Provide complete warranty information for each item, to include product or equipment, date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, telephone numbers and procedures for filing a claim and obtaining warranty services.

C. Service during warranty period: Contractor shall provide maintenance as specified elsewhere during the 12-month warranty period.

1.24 GUARANTEE

A. The Contractor shall guarantee and service all workmanship and materials to be as represented by him and shall repair or replace, at no additional cost to the Owner, any part thereof which may become defective within the period of one (1) year after the Date of Final Acceptance, ordinary wear and tear excepted.

B. Contractor shall be responsible for and pay for any damages caused by or resulting from defects in his work.

PART 2 - PRODUCTS

2.1 GENERAL

A. Furnish and install all new material, equipment, and apparatus hereinafter specified unless specifically noted otherwise. All material, equipment, and apparatus shall be identified by the manufacturer's name, nameplate, and pertinent data.
B. All materials, equipment, and apparatus are mentioned as standards unless noted otherwise. The words “or approved equal” shall be considered to be subsequent to all manufacturers’ names used herein, unless specifically noted that substitutes are not allowed.

2.2 SUPPORTS AND ANCHORS

A. General: Comply with applicable codes pertaining to product materials and installation of supports and anchors, including, but not limited to, the following:

1. UL and FM Compliance: Provide products, which are UL listed and FM approved.
2. ASCE 7-05: “American Society of Civil Engineers.”
3. 2009 International Building Code (IBC)
4. MSS Standard Compliance: Manufacturer’s Standardization Society (MSS).
6. NFPA: Pamphlet number 13 and 14 for fire protection systems.
7. Provide copper plated or plastic coated supports and attachment for copper piping systems. Field applied coatings or tape is unacceptable.

B. Horizontal Piping Hangers and Supports: Except as otherwise indicated, provide factory-fabricated hangers and supports of one of the following MSS types listed.

1. Adjustable Steel Clevis Hangers: MSS Type 1.
2. Adjustable Steel Swivel Band Hangers: MSS Type 10.
4. Pipe Slides and Slide Plates: MSS Type 35, including one of the following plate types:
   a. Plate: Unguided type.
   b. Plate: Guided type.
   c. Plate: Hold-down clamp type.
5. Pipe Saddle Supports: MSS Type 36, including steel pipe base support and cast iron floor flange.
6. Pipe Saddle Supports with U-Bolt: MSS Type 37, including steel pipe base support and cast iron floor flange.
7. Adjustable Pipe Saddle Supports: MSS Type 38, including steel pipe base support and cast iron floor flange.
8. Single Pipe Roller with Malleable Sockets: MSS Type 41.
9. Adjustable Roller Hangers: MSS Type 43.
10. Pipe Roll Stands: MSS Type 44.
11. Pipe Guides: Provide factory-fabricated guides of cast semi-steel or heavy fabricated steel, consisting of a bolted two-section outer cylinder and base with a two-section guiding spider bolted tight to pipe. Size guide and spiders to clear pipe and insulation (if any), and cylinder. Provide guides of length recommended by manufacturer to allow indicated travel.

C. Horizontal Cushioned Pipe Clamp: Where pipe hangers are called out to absorb vibration or shock install a piping clamp with thermoplastic elastomer insert. Cush-A-Clamp or equal.

D. Vertical Piping Clamps: Provide factory-fabricated two-bolt vertical piping riser clamps, MSS Type 8.

E. Hanger-Rod Attachments: Except as otherwise indicated, provide factory-fabricated hanger-rod attachments of one of the following MSS types listed.

1. Steel Turnbuckles: MSS Type 13.
2. Steel Clevises: MSS Type 14.
3. Swivel Turnbuckles: MSS Type 15.
5. Steel Weldless Eye Nuts: MSS Type 17.
F. Building Attachments: Except as otherwise indicated, provide factory-fabricated building attachments of one of the following types listed.
   1. Concrete Inserts: MSS Type 18 or Blue Banger Hanger by Simpson Strong-Tie Co. Inc.
   2. Steel Brackets: One of the following for indicated loading:
      b. Medium Duty: MSS Type 32.
      c. Heavy Duty: MSS Type 33.
   3. Horizontal Travelers: MSS Type 58.
   4. Internally Threaded Expansion Shell Anchors: Drop-In by Simpson Strong-Tie Co. Inc. or approved equal.
   5. Concrete Screw Anchors: Titen HD (or Rod Hanger version) by Simpson Strong-Tie Co. Inc. or approved equal.

G. Saddles and Shields: Except as otherwise indicated, provide saddles or shields under piping hangers and supports, factory-fabricated, for all insulated piping. Size saddles and shields for exact fit to mate with pipe insulation.
   1. Pipe Covering Protection Saddles: MSS Type 39; fill interior voids with segments of insulation matching adjoining insulation.
   2. Insulation Protection Shields: MSS Type 40, 18” minimum, or of the length recommended by manufacturer to prevent crushing of insulation. High-density insulation insert lengths shall match or exceed shield length.
   3. Thermal Hanger Shields: Constructed of 360° insert of waterproofed calcium silicate (60 psi flexural strength minimum) encased in 360° sheet metal shield. Provide assembly of same thickness as adjoining insulation. Shield length shall match or exceed length of calcium silicate insert. Alternately Polyisocyanurate Urethane with a minimum flexural strength of 60psi, fully encased in 360 PVC (1.524 mm thick)SNAPPITZ. Provide assembly of same thickness as adjoining insulation.
   4. Thermal Hanger Couplings: Constructed of high strength plastic coupling to retain tubing and join insulation at clevis hangers and strut-mounted clamps. Klo-Shure Insulation Coupling or equal.

H. Miscellaneous Materials:
   1. Metal Framing: Provide products complying with NEMA STD ML1.
   2. Steel Plates, Shapes, and Bars: Provide products complying with ASTM A36.
   3. Cement Grout: Portland Cement (ASTM C150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C404, Size No. 2). Mix at a ratio of 1.0 part cement to 3.0 parts sand by volume, with minimum amount of water required for placement and hydration.
   4. Heavy-Duty Steel Trapezes: Fabricate from steel shapes selected for loads required. Weld steel in accordance with AWS standards.
   5. Pipe Brackets: “HoldRite” copper plated brackets. Insulate brackets attached to metal studs with felt.

2.3 PIPE PORTALS

A. Where pipe portals are not provided by other sections of Specification, provide prefabricated insulated pipe portals as required for piping penetrating through the roof where shown on plans. Field built pipe portals are acceptable alternatives - provide detail of construction for review.

B. Standard pipe portals, unless otherwise noted, shall be constructed as follows:
   1. Curb shall be constructed of heavy gauge galvanized steel with continuous welds on shell seams.
   2. Insulation to be 1-½” thick, 3 lb density rigid fiberglass.
3. Curb to have a raised 3” (minimum), 45° cant.
4. Curb to have 1-1/2” x 1-1/2” wood nailer (minimum).
5. Curb height to be 8” (minimum) above roof deck.
6. Cant shall be raised to match roof insulation thickness.
7. Cover or flashing to be constructed of galvanized steel or other suitable material to provide sturdy weather tight closure. Provide collars and rubber nipples with draw bands of sizes required by piping. Size curb, cover and nipples per manufacturer’s recommendations.
8. Manufacturer: Roof Products Systems or Pate.

2.4 PIPE STANDS

1. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

2. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

3. Low-Type, Single-Pipe Stand: One-piece plastic or stainless steel base unit with plastic roller, for roof installation without membrane penetration.

4. High-Type, Single-Pipe Stand:
   a. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
   b. Base: Plastic or stainless steel.
   c. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
   d. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

5. High-Type, Multiple-Pipe Stand:
   a. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
   b. Bases: One or more; plastic.
   c. Vertical Members: Two or more protective-coated-steel channels.
   d. Horizontal Member: Protective-coated-steel channel.
   e. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

6. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

7. Manufacturer: Pate, Roof Products Systems, Portable Pipe Hangers, Roof Top Blox, or Erico Caddy Pyramid.

2.5 EQUIPMENT/PIPING RAILS

A. Where equipment/pipe rails are not provided by other sections of Specification, provide prefabricated reinforced equipment rails as required for support of equipment and piping. Field built curbs are acceptable alternatives - provide detail of construction for review.

B. Standard equipment rail, unless otherwise noted, shall be constructed as follows:
   1. Construct of heavy gauge galvanized steel with continuous welds on shell seams.
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2. Provide internal reinforcing supports welded as required to meet application requirements.
3. Equipment rails to have raised 3" (minimum), 45° cant.
4. Equipment rails to have 1 1/2" x 1 1/2" wood nailer (minimum) and counterflashing.
5. Equipment rail height to be 6" (minimum) above roof deck.
6. Cant shall be raised to match roof insulation thickness.

C. Equipment rails to be constructed to meet equipment size and weight requirements. Provide tapered rails to match roof pitch where required.

D. Manufacturer: Pate, Vent Products, Thy Curb or Roof Products Systems.

2.6 ACCESS PANELS AND ACCESS DOORS

A. Provide all access doors and panels to serve equipment under this work, including those which must be installed, in finished architectural surfaces. Frame of 16-gauge steel, door of 20 gauge steel. 1" flange width, continuous piano hinge, key operated, prime coated. Refer to Architectural Specifications for the required product Specification for each surface. Contractor is to submit schedule of access panels for approval. Exact size, number and location of access panels are not shown on Plans. Access doors shall be of a size to permit removal of equipment for servicing. Access door shall have same rating as the wall or ceiling in which it is mounted. Provide access panel for each trap primer or concealed valve, for fire and combination fire/smoke dampers, and for volume dampers. Use no panel smaller than 12" x 12" for simple manual access, or smaller than 24" x 24" where personnel must pass through. Provide cylinder lock for access door serving mixing or critical valves in public areas.

B. Included under this work is the responsibility for verifying the exact location and type of each access panel or door required to serve equipment under this work and in the proper sequence to keep in tune with construction and with prior approval of the Architect. Access doors in fire rated partitions and ceilings shall carry all label ratings as required to maintain the rating of the rated assembly.

C. Acceptable Manufacturers: Milcor, Karp, Nystrom, or Elmdor/Stoneman.

D. Submit markup of architectural plans showing size and location of access panels required for equipment access for approval by Architect.

2.7 IDENTIFICATION MARKERS

A. Mechanical Identification Materials: Provide products of categories and types required for each application as referenced in other Division 23 Sections. Where more than single type is specified for application, selection is installer's option, but provide single selection for each product category. Stencils are not acceptable.

B. Plastic Pipe Markers:
2. Pressure Sensitive Type: Provide pre-printed, permanent adhesive, color coded, pressure sensitive vinyl pipe markers, complying with ANSI A13.1. Secure both ends of markers with color coded adhesive vinyl tape.
3. Insulation: Furnish 1" thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125°F (52°C) or greater. Cut length to extend 2" beyond each end of plastic pipe marker.
4. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastic.

C. Plastic Duct Markers:
1. Provide 4 1/2" x 6" laminated plastic, ANSI A13.1 color coded duct markers with white core lettering.
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2. Nomenclature: Include the following:
   a. Direction of air flow
3. Duct service (supply, return, exhaust, etc.).
   a. Duct origin (from)
   b. Duct destination (to)
   c. Design cfm
4. Provide a minimum of every 20 feet on all ducts with a diameter or width greater than 12”.

D. Underground-Type Plastic Line Markers: Provide 6” wide x 4 mils thick multi-ply tape, consisting of solid metallic foil core between 2 layers of plastic tape. Markers to be permanent, bright colored, continuous printed, intended for direct burial service.

E. Valve Tags:
1. Brass Valve Tags: Provide 1 1/2” diameter 19-gauge polished brass valve tags with stamp-engraved piping system abbreviation in 1/4” high letters and sequenced valve numbers 1/2” high, and with 5/32” hole for fastener. Fill tag engraving with black enamel.
2. Plastic Laminate Valve Tags: Provide 3/32” thick engraved plastic laminate valve tags, with piping system abbreviations in 1/4” high letters and sequenced valve number 1/2” high, and with 5/32” hole for fasteners.
3. Valve Tag Fasteners: Provide solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.
4. Access Panel Markers: Provide 1/16” thick engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve. Include 1/8” center hole to allow attachment.
5. Non-potable Water Tags: 1/16” thick, engraved, plastic tags as indicated on Drawings.

F. Plastic Equipment Signs:
1. Provide 4-1/2” x 6” plastic laminate sign, ANSI A.13 color coded with engraved white core lettering.
2. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.
3. Nomenclature: Include the following, matching terminology on schedules as closely as possible:
   a. Name and plan number.
   b. Equipment service.
   c. Design capacity.
   d. Other design parameters, such as pressure drop, entering and leaving conditions, rpm, etc.

G. Acceptable Manufacturers: Craftmark, Seton, Brady, Marking Services, Inc., or Brimar.

2.8 ELECTRICAL

A. General:
1. All electrical material, equipment, and apparatus specified herein shall conform to the requirements of Division 26.
2. Provide all motors for equipment specified herein. Provide motor starters, controllers, and other electrical apparatus and wiring which are required for the operation of the equipment specified herein.
3. Set and align all motors and drives in equipment specified herein.
4. Provide expanded metal or solid sheet metal guards on all V-belt drives to totally enclose the drive on all sides. Provide holes for tachometer readings. Support guards separately from rotating equipment.
5. Provide for all rotating shafts, couplings, etc., a solid sheet metal, inverted "U" cover over the entire length of the exposed shaft and support separately from rotating equipment. Cover shall extend to below the bottom of the shaft and coupling, and shall meet the requirements of the State Industrial Safety Regulations.

6. Specific electrical requirements (i.e., horsepower and electrical characteristics) for mechanical equipment are scheduled on the Drawings.

B. Quality Assurance:

1. Electrical components and materials shall be UL or ETL listed/labeled as suitable for location and use - no exceptions.

C. Motors:

1. The following are basic requirements for simple or common motors. For special motors, more detailed and specific requirements are specified in the individual equipment Specifications.

2. Torque characteristics shall be sufficient to satisfactorily accelerate the driven loads.

3. Motor sizes shall be large enough so that the driven load will not require the motor to operate in the service factor range. Unless otherwise noted on plans, all motors ½ HP or larger shall be rated for 208 or 460 volt, 3-phase, operation. Unless otherwise noted on plans, all motors less than 1/2 HP shall be rated for 120 volt, single phase operation.

4. Temperature Rating: Motor meets class B rise with class F insulation.

5. Service Factor: 1.15 for poly-phase motors and 1.35 for single phase motors.


   a. Frames: NEMA Standard No. 48 or 56; use driven equipment manufacturer's standards to suit specific application.

   b. VFD driven motors to be provided as inverter ready and equipped with a shaft grounding device, or inverter duty complying with NEMA Standard MG-1, Part 31 as supplied by same manufacturer as VFD.

   c. Bearings:

      1) Ball or roller bearings with inner and outer shaft seals.

      2) Re-greasable, except permanently sealed where motor is normally inaccessible for regular maintenance.

      3) Designed to resist thrust loading where belt drives or other drives produce lateral or axial thrust in motor.

      4) For fractional horsepower, light duty motors, sleeve type bearings are permitted.

      5) Enclosure Type:

         a) Open drip-proof (ODP) motors for indoor use in clean air environments.

         b) Totally enclosed fan cooled (TEFC) motors for outdoor use and indoor application in dirty environments.

         c) Totally enclosed air over (TEAO) motors for motors in the airstream of cooling towers and fluid coolers.

         d) Guarded drip-proof motors where exposed to contact by employees or building occupants.

         e) Weather protected Type I for outdoor use, Type II where not housed.

   d. Overload Protection: Built-in thermal overload protection where external overload protection is not provided and, where indicated, internal sensing device suitable for signaling and stopping motor at starter.

   e. Noise Rating: “Quiet.”
f. Efficiency:
   1) Motors shall have a minimum efficiency per governing State or Federal codes, whichever is higher.
   2) Motors shall meet the NEMA premium efficiency standard

   g. Nameplate: Indicate the full identification of manufacturer, ratings, characteristics, construction, special features and similar information.

D. Starters and Electrical Devices:

1. Motor Starter Characteristics:
   a. Enclosures: NEMA 1, general purpose enclosures with padlock ears, except in wet locations shall be NEMA 3R with conduit hubs.
   b. Type and size of starter shall be as recommended by motor manufacturer and the driven equipment manufacturer for applicable protection and start-up condition.

2. Manual switches shall have pilot lights and all required switch positions for multi-speed motors. Overload Protection: Melting alloy or bi-metallic type thermal overload relays, sized according to actual operating current (field measured).

3. Magnetic Starters:
   a. Heavy duty, oil resistant, hand-off-auto (HOA), or as indicated, and pilot lights, properly arranged for single speed or multi-speed operation as indicated.
   b. Trip-free thermal overload relays, each phase, sized according to actual operating current (field measured).
   c. Interlocks, pneumatic switches and similar devices as required for coordination with control requirements of Division 23 Controls sections.
   d. Built-in primary and secondary fused control circuit transformer, supplied from load side of equipment disconnect.
   e. Externally operated manual reset.
   f. Under-voltage release or protection for all motors over 20 hp.

4. Motor Connections: Liquid tight, flexible conduit, except where plug-in electrical cords are specifically indicated.

E. Low Voltage Control Wiring:

1. General: 14 gauge, Type THHN, color coded, installed in conduit.

2. Manufacturer: General Cable Corp., Alcan Cable, American Insulated Wire Corp., Senator Wire and Cable Co., or Southwire Co.

F. Disconnect Switches:

1. Fusible Switches: For equipment 1/2 HP or larger, provide fused, each phase; heavy duty; horsepower rated; spring loaded quick-make, quick-break mechanism; dead front line side shield; solderless lugs suitable for copper or aluminum conductors; spring reinforced fuse clips; electro silver plated current carrying parts; hinged doors; operating lever arranged for locking in the “OPEN” position; arc quenchers; capacity and characteristics as indicated.

2. Non-Fusible Switches: For equipment less than 1/2 horsepower, switch shall be horsepower rated; toggle switch type with thermal overload quantity of poles and voltage rating as required.

PART 3 - EXECUTION

3.1 GENERAL

A. Workmanship shall be performed by licensed journeymen or master mechanics and shall result in an installation consistent with the best practices of trades.

B. Install work uniform, level and plumb, in relationship to lines of building. Do not install any diagonal, or otherwise irregular work unless so indicated on Drawings or approved by Architect.
3.2 MANUFACTURER’S DIRECTIONS

A. Follow manufacturers’ directions and recommendations in all cases where the manufacturers of articles used on this Contract furnish directions covering points not shown on the Drawings or covered in these Specifications.
   1. If the contractor must deviate from the manufacturer’s recommendations provide a letter from the manufacturer indicating the clearance to be provided is acceptable for scheduled performance and maintenance.

3.3 INSTALLATION

A. Coordinate the work between the various Mechanical Sections and with the work specified under other Divisions. If any cooperative work must be altered due to lack of proper supervision or failure to make proper and timely provisions, the alternations shall be made to the satisfaction of the Engineer and at the Contractor’s cost. Coordinate wall and ceiling work with the General Contractor, and his subcontractors in locating ceiling air outlets, wall registers, etc.

B. Inspect all material, equipment, and apparatus upon delivery and do not install any damaged or defected materials.

3.4 SUPPORTS AND HANGERS

A. Prior to installation of hangers, supports, anchors, and associated work, installer shall meet at project site with Contractor, installer of each component of associated work, inspection and testing agency representatives, (if any), installers of other work with requirements specified.

B. Installation of Building Attachments: Install building attachments at required locations within concrete or on structural steel for proper piping support. Install additional building attachments where support is required for additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed. Fasten insert securely to forms. Where concrete with compressive strength less than 2,500 psi is indicated, install reinforcing bars through opening at top of inserts.

C. Proceed with installation of hangers, supports, and anchors only after required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including, but not limited to, proper placement of inserts, anchors, and other building structural attachments.

D. Install hangers, supports, clamps, and attachments to support piping properly from building structure. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping.

E. Install hangers within 12 inches of every change in piping direction, end of pipe run or concentrated load, and within 36 inches of every major piece of equipment. Hangers shall be installed on both sides of flexible connections. Where flexible connection connects directly to a piece of equipment only one hanger is required.

F. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.

G. Support sprinkler piping and gas independently of other piping.

H. Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper plated, or by other recognized industry methods.
I. Hanger Spacing in accordance with following minimum schedules for support of individual pipes (other spacings and rod sizes may be used in accordance with the SMACNA Seismic Restraint Manual using a safety factor of five):

1. Steel Pipe (Water Filled):
   - Pipe Size | Max. Hanger Spacing | Rod Size
   - 1/2" to 1 1/4" | 5 feet | 3/8"
   - 1 ½" to 2" | 7 feet | 3/8"
   - 2 ½" to 3" | 10 feet | 1/2"
   - 4" to 12" | 12 feet | 5/8"

2. Steel Pipe (Gas/Air Filled):
   - Pipe Size | Max. Hanger Spacing | Rod Size
   - 1/2" to 1 1/4" | 6 feet | 3/8"
   - 1 ½" and larger | 10 feet | 1/2"

3. Copper Pipe:
   - Pipe Size | Max. Hanger Spacing | Rod Size
   - 1/2" to 2" | 6 feet | 3/8"
   - 2 ½" and larger | 8 feet | 1/2"

4. Glass Pipe:
   - Pipe Size | Max. Hanger Spacing | Rod Size
   - 1/2" to 2" | 6 feet | 3/8"
   - 2 ½" and larger | 8 feet | 1/2"

5. Plastic/Fiberglass Pipe:
   - Pipe Size | Max. Hanger Spacing | Rod Size
   - 1/2" to 2" | 4 feet | 3/8"
   - 2 ½" and larger | 6 feet | 1/2"

6. Caulked Bell and Spigot and Glass Pipe: Provide hanger for each section of pipe, located at shoulder of bell. Where an excessive number of fittings are installed between hangers, provide additional reinforcing.

7. Trapeze support: Provide details stamped by a registered structural engineer for the project state indicating trapeze channels, support rod sizes, and spacing.

J. Sloping, Air Venting, and Draining:

1. Steam:
   a. Slope steam piping as specified and as indicated, true to line and grade, and free of traps and air pockets downward a minimum of ¼ inch per 10 ft of run in the direction of flow.
   b. Where horizontal piping must be reduced in size, use eccentric reducers that allow continuous uniform pitch along the bottom of the piping. Avoid concentric reducers in horizontal piping.
   c. Takeoffs from steam mains are to be taken from the top of the main preferably at a 45 degree angle.
   d. Where branch takeoffs are less than 10 feet in length, the branch line is to be pitched back ½ inch per 10 feet providing drip legs.

2. Chilled, heating, and condensing water:
   a. Connect all heating and chilled water branch piping to the bottom or side of their respective mains. Where connection must be made to the top of the main piping, make provision for venting of air.
   b. Provide drain valves and hose adapters at all low points in piping.
   c. Provide vents at all high points in water piping.

K. Provisions for Movement:

1. Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

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NOTICE OF ALTERNATE BILLING CYCLE: The Contract will allow the Owner to require the submission of billings or estimates in billing cycles other than 30-day cycles. Billing or statements shall be submitted monthly ending on the last day of the month.

NOTICE OF EXTENDED CERTIFICATION PROVISION: The Contract will allow the Owner to certify billings and estimates within 20 days after the billings and estimates are received from the original contractor.

NOTICE OF EXTENDED PAYMENT PROVISION: The Contract will allow the Owner to make payment within 30 days after the date a billing or estimate is received.
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2. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connecting equipment.

3. Insulated Piping: Comply with the following installation requirements:
   a. Clamps: Attach clamps, including spacers, (if any), to piping with clamps projecting through insulation.
   b. Shields: Where low compressive strength insulation or vapor barriers are indicated on cold or chilled water piping, install shields or inserts.
   c. Saddles: Where insulation without vapor barrier is indicated install protection saddles.

L. Installation of Anchors:
   1. Install anchors at proper locations to prevent excessive stresses and to prevent transfer of loading and stresses to connected equipment.
   2. Fabricate and install anchor by welding steel shapes, plates and bars to piping and to structure.
   3. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions, to limit movement of piping and forces to maximums recommended by manufacturer for each unit.
   4. Anchor Spacings: Where not otherwise indicated, install anchors at ends of principal pipe runs, at intermediate points in pipe runs between expansion loops and bends.

M. Equipment Supports:
   1. Provide all concrete bases, unless otherwise furnished as work of Division 03. Furnish to Division 03 Contractor scaled layouts of all required bases, with dimensions of bases, and location to column centerlines. Furnish templates, anchor bolts, and accessories necessary for base construction.
   2. Provide structural steel stands to support equipment not floor mounted or hung from structure. Construct of structural steel members or steel pipe and fittings. Provide factory-fabricated tank saddles for tanks.

N. Adjusting:
   1. Hanger Adjustment: Adjust hangers so as to distribute loads equally on attachments.
   2. Support Adjustment: Provide grout under supports so as to bring piping and equipment to proper level and elevations.
   3. Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

3.5 ROOF CURBS, EQUIPMENT RAILS, PIPE PORTALS

A. Install per manufacturer's instructions.

B. Coordinate with other trades so units are installed when roofing is being installed.

C. Verify roof insulation thickness and adjust raise of cant to match.

3.6 ELECTRICAL REQUIREMENTS

A. Mechanical Contractor shall coordinate with Division 26 work to provide complete systems as required to operate all mechanical devices installed under this Division of work.

B. Installation of Electrical Connections: Furnish, install, and wire (except as may be otherwise indicated) all heating, ventilating, air conditioning, etc., motors and controls in accordance with the following schedule and in accordance with equipment manufacturer's written instructions and with recognized industry practices, and complying with applicable requirements of UL, NEC, and NECA's "Standard of Installation" to ensure that products fulfill requirements. Carefully coordinate with work performed under the Mechanical Division of these Specifications.
C. Division 23 has responsibilities for electrically powered or controlled mechanical equipment which is specified in Division 23 Specifications or scheduled on Division 23 Drawings. The specific division of responsibilities between Division 23 and 26 for furnishing or wiring this equipment is as follows:

1. Division 23 Mechanical Responsibilities:
   a. MOTORS: Furnish and install all motors necessary for mechanical equipment.
   b. MAGNETIC STARTERS: Furnish all magnetic starters whether manually or automatically controlled which are necessary for mechanical equipment. Furnish these starters with all control relays or transformers necessary to interface with mechanical controls. If the starter is factory installed on a piece of Division 23 equipment, also furnish and install the power wiring between starter and motor.
   c. VARIABLE FREQUENCY DRIVES: Provide all VFD’s associated with mechanical equipment. If the drive is installed on a piece of factory assembled equipment the wiring between motor and drive is to be provided as part of the factory equipment.
   d. DISCONNECTS: Provide the disconnects which are part of factory wired Division 23 equipment. Factory wiring to include wiring between motor and disconnect or combination starter/disconnect.
   e. CONTROLS: Division 23 Contractor (including the temperature controls subcontractor) is responsible for the following equipment in its entirety. This equipment includes but is not limited to the following:
      1) Control relays necessary for controlling Division 23 equipment.
      2) Control transformers necessary for providing power to controls for Division 23 equipment.
      3) Line voltage thermostats.
      4) Low or non-load voltage control components.
      5) Remote bulb thermostats.
      6) Non-life safety related valve or damper actuators.
      7) Float switches.
      8) Solenoid valves, EP and PE switches.
      9) Refrigeration controls. (Division 26 provides power to refrigeration panels.)
   f. FIRE AND LIFE SAFETY EQUIPMENT:
      1) Fire/Smoke Dampers: Division 23 is responsible for providing and physically installing the damper and for installing any required control interface wiring to Division 23 controls.
         a) Where fire/smoke dampers are part of an integrated smoke control system, Division 23 is responsible for providing dampers with necessary end switches for proof of closure. (See Section 233113.)
         b) Where these dampers are not part of an integrated area wide smoke detection system, Division 23 is responsible for providing each fire/smoke damper with a dedicated duct detector installed per the requirements of the building code. (See Section 233113). If not integral with the damper assembly, the detector is to be installed by Div. 23 but wired for damper control by Div. 26.
      2) Fire Sprinkler System: Division 23 is responsible for providing necessary controls including flow switches and alarm bells.
      3) Specialized fire suppression systems: Division 23 is responsible for providing necessary system controls and any required control interface wiring to these controls. Division 26 is responsible for bringing power to point of connection with the system.

D. Division 26 has responsibilities for electrically powered or controlled mechanical equipment, which is specified in Division 23 Specifications or scheduled on Division 23 Drawings. The specific division of responsibilities between Division 23 and 26 for furnishing or wiring this equipment is as follows:

1. Division 26 Electrical Responsibilities:
   a. MOTORS: Provide the power wiring for the motors.
b. MAGNETIC STARTERS: Except where magnetic starters are factory installed on Division 23 factory assembled equipment, Division 26 is to install magnetic starters furnished by Division 23 and install the necessary power wiring to the starter and from the starter to the motor. In the case of factory installed starters, Division 26 is to install the necessary power wiring to the starter.

c. VARIABLE FREQUENCY DRIVES: Physically mount all VFD’s, which are not specified to be installed on Division 23 factory assembled equipment. Provide the necessary power wiring to the VFD and from the VFD to the motor except in the case of factory installed VFD’s where wiring between the motor and VFD is to be by Division 23. Where disconnects are installed between a VFD and a motor provide the interlocking wiring between the disconnect and VFD to insure that the drive is shutdown simultaneously with motor.

d. DISCONNECTS: Provide all disconnects necessary for Division 23 mechanical equipment which are not provided as part of factory wired Division 23 equipment. Provide power wiring to all disconnects. In addition provide power wiring between motor and disconnect when the disconnect is not factory installed. See also Variable Frequency Drive above for special wiring requirements.

e. CONTROLS: Division 26 Contractor is responsible for providing power to control panels and control circuit outlets.

f. FIRE AND LIFE SAFETY EQUIPMENT:

1) Fire/Smoke Dampers: Division 26 is responsible for power wiring to the damper and as follows:

   a) Where these dampers are part of an integrated smoke control system Division 26 is responsible for providing the detectors and for all fire detection system wiring necessary to integrate dampers and related end switches into the system.

   b) Where these dampers are not part of an integrated area wide smoke detection system, Division 23 is responsible for providing each fire/smoke damper with a dedicated duct detector installed per the requirements of the building code. (See Section 233113). If not integral with the damper assembly, the detector is to be installed by Div. 23 but wired for damper control by Div. 26.

2) Fire Sprinkler System: Division 26 is responsible for providing power wiring to fire protection controls including flow switches and alarm bells.

3) Specialized fire suppression systems: Division 26 is responsible for providing power wiring to suppression system and its controls.

2. Coordinate with other work, including wires/cables, raceway and equipment installation, as necessary to properly interface installation of electrical connections for equipment with other work.

3. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer’s written instructions and wiring diagrams. Mate and match conductors of electrical connections for proper interface between electrical power supplies and installed equipment.

4. Maintain existing electrical service and feeders to occupied areas and operational facilities, unless otherwise indicated, or when authorized otherwise in writing by Owner, or Architect/Engineer. Provide temporary service during interruptions to existing facilities. When necessary, schedule momentary outages for replacing existing wiring systems with new wiring systems. When that “cutting-over” has been successfully accomplished, remove, relocate, or abandon existing wiring as indicated.

5. Cover splices with electrical insulating material equivalent to, or of greater insulation resistivity rating, than electrical insulation rating of those conductors being spliced.

6. Prepare cables and wires, by cutting and stripping covering armor, jacket, and insulation properly to ensure uniform and neat appearance where cables and wires are terminated.
Exercise care to avoid cutting through tapes which will remain on conductors. Also avoid “ringing” copper conductors while skinning wire.

E. Motors and Motor Control Equipment: Conform to the standards of the NEMA. Equip motors with magnetic or manual line starters with overload protection. Motor starters and line voltage controls shall be installed under Electrical Section but located and coordinated as required under this Section of the work. Starters shall be combination type with non-fusible disconnect switches. All single phase fractional horsepower motors shall have built-in overload protection.

3.7 PAINTING

A. All painting shall be provided under this Division work, unless otherwise specified under Section 099100: Painting. Painting schemes shall comply with ANSI A13.1. Paint all exposed materials such as piping, ductwork, equipment, insulation, steel, etc. Exposed gas piping inside and outside the building shall be painted with two coats of “Rust-O-Leum” Yellow. The inside surface of visible ductwork above diffusers/grilles shall be painted flat black. Exposed copper indirect waste piping serving food service equipment shall be painted metallic chrome.

B. All exposed work under Division 23 shall receive either a factory finish or a field prime coat finish, except:
   1. Exposed copper piping.
   2. Aluminum jacketed outdoor insulated piping.

3.8 IDENTIFICATION MARKERS

A. General: Where identification is to be applied to surfaces which require insulation, painting, or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

B. Piping System Identification:
   1. Install pipe markers on each system indicated to receive identification, and include arrows to show normal direction of flow.
   2. Locate pipe markers as follows:
      a. Near each valve and control device.
      b. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
      c. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.
      d. At access doors, manholes, and similar access points which permit view of concealed piping.
      e. Near major equipment items and other points of origination and termination.
      f. Spaced horizontally at maximum spacing of 20’ along each piping run, with minimum of one in each room. Vertically spaced at each story transversed.

C. Underground Piping Identification: During backfilling/topsoiling of each exterior underground piping system, install continuous underground-type plastic line marker, located directly over buried line at 6” to 8” below finished grade. Where multiple small lines are buried in common trench and do not exceed overall width of 16”, install single line marker.

D. Ductwork Identification: A minimum of every 20’ for all ductwork 12" or more in diameter or width.

E. Mechanical Equipment Identification: Locate engraved plastic laminate signs on or near each major item of mechanical equipment and each operational device. Provide signs for the following:
   1. Main control and operating valves, including safety devices.
   2. Meters, gauges, thermometers, and similar units.
   3. Pumps, compressors, chillers, and similar motor-driven units.
   4. Hot water system mixing valves and similar equipment.
5. Boilers, heat exchangers and similar equipment.
6. Fans, blowers, primary balancing dampers, and mixing boxes.
7. Packaged HVAC central-station and zone-type units.
8. Tanks and pressure vessels.
9. Strainers, filters, treatment systems and similar equipment.
10. Sprinkler and standpipe equipment.

F. Text of Signs: In addition to name of identified unit, provide lettering to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations. Equipment signs shall include an identification of the area or other equipment served by the equipment being labeled.

3.9 VIBRATION AND DYNAMIC BALANCING

A. Vibration tolerances shall be as specified by the “International Research and Development Corporation”, Worthington, Ohio, measured by the displacement, peak to peak, as follows:
1. All Fans: Below severity chart labeled “FAIR”, maximum velocity of 0.0786 in/sec, peak.
2. Pump and Electric Motors: Below severity chart labeled “SLIGHTLY ROUGH”, maximum vibration velocity of 0.157 in/sec, peak.
3. Compressors: Same as pumps.

B. Correction shall be made to all equipment, which exceeds vibration tolerances specified above. Final vibration levels shall be reported as described above.

3.10 TESTING

A. Provide all tests specified hereinafter and as otherwise required. Provide all test equipment, including test pumps, gauges, instruments, and other equipment required. Test all rotational equipment for proper direction of rotation. Upon completion of testing, certify to the Architect, in writing, that the specified tests have been performed and that the installation complies with the specified requirements and provide a report of the test observations signed by qualified inspector.

B. Ductwork: Test all air quantities as specified in Section 230593 - Testing, Adjusting and Balancing. Pressure tests per SMACNA.

C. Registers and Diffusers: Test for proper operation of manually operated control feature. Test all air quantities as specified in Section 230593 – Testing, Adjusting and Balancing.

D. Ductwork Specialties: Test all operable ductwork specialties for proper operation. Check all fire, smoke and fire/smoke dampers to ensure that they are 100% open.

E. Temperature Control: Test all control functions to assure that all systems are controlling as specified or as otherwise necessary and that all controls are adjusted to maintain proper room temperatures. The manufacturer’s representative shall perform all tests.

END OF SECTION
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. This Section includes the following:
1. Vibration Isolation pads.
2. Vibration Isolation mounts.
3. Restrained uni-directional seismic isolation snubber mounts.
4. Spring isolators.
5. Housed seismic spring vibration mounts.
6. Elastomeric hangers.
7. Spring hangers.
8. Spring hangers with vertical-limit stops.
9. Pipe riser resilient supports.
10. Resilient pipe guides.
11. Air-mounting system.
12. Restrained vibration isolation roof-curb rails.
14. Seismic Restraining braces and cable systems for equipment, piping, and ductwork.
15. Vibration isolation equipment bases.
16. Flexible piping connectors
17. Flexible ductwork connectors

1.3 DEFINITIONS

1.4 PERFORMANCE REQUIREMENTS
A. Wind-Restraint Loading:
   1. Reference project Structural drawings for Requirements.
B. Seismic-Restraint Loading:

1.5 REFERENCE PROJECT STRUCTURAL DRAWINGS FOR REQUIREMENTS.SUBMITTALS
A. Product Data: For the following:
   1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
   2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
      a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service or agency acceptable to authorities having jurisdiction.
      b. Annotate to indicate application of each product submitted and compliance with requirements.
   3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.
VIBRATION ISOLATION AND SEISMIC RESTRAINT FOR PIPING, DUCTWORK, AND EQUIPMENT

B. Delegated-Design Submittal: For vibration isolation and seismic-restraint details 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 static and dynamic loading due to equipment weight and operation, seismic and where required wind forces required to select vibration isolators, seismic and wind restraints, and for designing vibration isolation bases.
   a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Division 23 Sections for equipment mounted outdoors.

2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.

3. Vibration Isolation Base Details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.

4. Seismic and Wind-Restraint Details:
   a. Design Analysis: To support selection and arrangement of seismic and wind restraints include calculations of combined tensile and shear loads.
   b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
   c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Division 23 Sections for equipment mounted outdoors.
   d. Preapproval and Evaluation Documentation: By an evaluation service or agency acceptable to the authorities having jurisdiction showing maximum ratings of restraint items and the basis for approval (tests or calculations).

C. Coordination Drawings: Show coordination and plan locations of seismic bracing for HVAC piping, ductwork, and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.

D. Qualification Data: Devices shall be selected to meet seismic and support requirements by a registered professional Civil or Structural Engineer licensed in the State of the project.

E. Field quality-control Special Inspections:
1. Required for anchorage of equipment in structures assigned to Seismic Design Category C,D,E, or F including
   a. Electrical equipment for emergency or standby power systems
   b. Piping systems intended to carry flammable, combustible or highly toxic contents in structures.
   c. Ductwork intended to contain hazardous materials.
   d. Special inspections of mechanical and electrical components
      1) Manufacturers of components defined with a component importance factor of 1.5 shall test or analyze the component and its mounting system or anchorage for the design forces experienced in the facility. The manufacturer shall submit a certificate of compliance. Components required to meet this requirement are:
         a) Equipment using combustible energy sources (boilers).
         b) Motors, transformers, switchgear unit substations, and MCC.
         c) Reciprocating and rotating-type machinery.
VIBRATION ISOLATION AND SEISMIC RESTRAINT FOR PIPING, DUCTWORK, AND EQUIPMENT

d) Piping distribution systems 3 inch and larger.
e) Tanks, heat exchangers, and pressure vessels.

e. Isolation system: Shall be part of the special inspection if used as part of the seismic isolation system of components meeting importance factor as defined in the code.

F. Operation and Maintenance Data: For air-mounting systems to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.


D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall be preapproved by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

E. Building Structural Limits:

PART 2 - THE DESIGN OF THE SEISMIC RESTRAINTS SHALL NOT EXCEED THE BUILDING STRUCTURE ALLOWABLE POINT LOADS AS REVIEWED AND APPROVED BY THE PROJECT STRUCTURAL ENGINEER. THE RESTRAINT DESIGN, WHETHER PERMANENT GRAVITY INDUCED LOADS OR SHORT TERM EARTHQUAKE LOADS, SHALL NOT EXCEED THE WEAKEST COMPONENT OR CONFIGURATION OF COMPONENTS WITHIN THE RESTRAINT ASSEMBLY AND/OR THE BUILDING STRUCTURE PRODUCTS

2.1 GENERAL REQUIREMENTS AND APPLICATION

A. Factory Finishes:
1. Standard paint applied to factory-assembled and -tested equipment before shipping.
2. Powder coating on springs and housings.
3. All hardware shall be galvanized. Hot-dip galvanized metal components for exterior use.
4. Baked enamel or powder coat for metal components on isolators for interior use.

B. Key to Device Schedule: Part 3 of this Section schedules the application of devices described in Part 2 for use with mechanical equipment found on this project. The designation of devices is as follows:

<table>
<thead>
<tr>
<th>TAG</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>P-1</td>
<td>Vibration isolation waffle pad</td>
</tr>
<tr>
<td>P-2</td>
<td>Double Deflection Neoprene mount</td>
</tr>
<tr>
<td>P-3</td>
<td>Uni-directional Restrained Neoprene snubber mount</td>
</tr>
<tr>
<td>S-1</td>
<td>Open spring vibration isolator</td>
</tr>
<tr>
<td>S-2</td>
<td>Steel housed seismic spring isolator</td>
</tr>
<tr>
<td>H-1</td>
<td>Spring and rubber in shear vibration isolation hanger</td>
</tr>
<tr>
<td>Na</td>
<td>Resilient pipe riser support and guide</td>
</tr>
</tbody>
</table>
2.2 VIBRATION ISOLATORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:

1. Amber/Booth Company, Inc.
2. California Dynamics Corporation.
5. Vibration Eliminator Co., Inc.
7. Vibration Mountings & Controls, Inc
8. Vibro-Acoustics, Inc
9. Vibrex

B. "Waffle" Pads (P-1): Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel base plates, and factory cut to sizes that match requirements of supported equipment.

1. Resilient Material: Oil- and water-resistant rubber.
2. Product Selection Basis: Mason SW or Vibro-Acoustics N.

C. Mounts (P-2): Double-deflection type, with molded, oil-resistant rubber, hermetically sealed compressed fiberglass, or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with base plate 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 rubber or 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.
3. Product Selection Basis: Mason ND or Vibro-Acoustics RD.

D. Restrained Mounts (P-3): All-directional snubber mountings with seismic restraint.

1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or 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.
3. Product Selection Basis: Mason BR

E. Spring Vibration Isolators (S-1): 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.

SERA Architects, Inc.
VIBRATION ISOLATION AND SEISMIC RESTRAINT FOR PIPEG, DUCTWORK, AND EQUIPMENT

4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

5. Base plates: Factory drilled for bolting to structure and bonded to 1/4-inch- (6-mm-) thick, rubber isolator pad attached to base plate underside. Base plates shall limit floor load to 500 psig (3447 kPa).

6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

7. Product Selection Basis: Mason SLF or Vibro-Acoustics FS.

F. Seismic Restrained Spring Vibration Isolators (S-2): Freestanding, steel, captured spring isolators with seismic or limit-stop restraint.

1. Housing: Steel or cast iron with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled base plate bonded to 1/4-inch- (6-mm-) thick, neoprene or rubber isolator pad attached to base plate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.

2. Restraint: Seismic or limit stop as required for equipment and authorities having jurisdiction.

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.

7. Product Selection Basis: Mason SLR, SSLFH or Vibro-Acoustics SFS.

G. Spring Vibration Hangers (H-1): 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 rubber or 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.

8. Product Selection Basis: Mason 30N or Vibro-Acoustics SHR.

2.3 PIPE GUIDES AND SUPPORTS

A. Pipe Riser Resilient Support: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch- (13-mm-) 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 (3.45 MPa) and for equal resistance in all directions.

B. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes or post and sleeve arrangement separated by a minimum of 1/2-inch- (13-mm-) 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.
2.4 **SEISMIC RESTRAINED SPRING VIBRATION ISOLATION ROOF-CURB (C-1) (HVAC UNITS 20 TON AND UNDER CAPACITY)**

A. Curb mounted rooftop equipment shall be mounted on vibration isolation curbs. Curbs shall consist of continuous steel frames above and below isolators. Isolators shall be adjustable, freestanding and laterally stable and include a 1/4-inch acoustical neoprene cup and leveling bolts.

B. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load with 50% additional travel to solid.

C. A continuous sheet metal flashing shall be attached to the upper frame and be separated from the lower frame by a neoprene weather seal. Sheet metal flashing shall incorporate removable cover plates for adjustment and inspection of isolators after the unit is set. The unit must be solidly fastened to the top steel frame and the lower sheet metal curb must be attached to the roof structure.

D. Product Selection Basis: Curb shall be type ISC as manufactured by Mason Industries, Inc. or type VCR by Vibro-Acoustics, Inc.

2.5 **SEISMIC RESTRAINED SPRING VIBRATION ISOLATION ROOF-CURB (C-2) (HVAC UNITS OVER 20 TON CAPACITY)**

A. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:

1. Amber/Booth Company, Inc.
2. California Dynamics Corporation.
3. Isolation Technology, Inc.
5. Mason Industries.
6. Thybar Corporation.
7. Vibration Eliminator Co., Inc.
8. Vibration Isolation.

B. General Requirements for Restrained Vibration Isolation Roof-Curb Rails:

1. Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment and to withstand seismic and wind forces.

C. Lower Support Assembly: Formed sheet-metal section containing adjustable and removable steel springs that support upper frame. Upper frame shall provide continuous support for equipment and shall be captive to resiliently resist seismic and wind forces. Lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials, and shall be insulated with a minimum of 2 inches (50 mm) of rigid, glass-fiber insulation on inside of assembly.

D. Spring Isolators: Adjustable, restrained spring isolators shall be mounted on 1/4-inch- (6-mm-) thick, elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.

1. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic and/or wind restraint.
   a. Housing: Steel with resilient vertical-limit stops and adjustable equipment mounting and leveling bolt.
   b. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   c. Minimum Additional Travel: 50 percent of the required deflection at rated load.
VIBRATION ISOLATION AND SEISMIC RESTRAINT FOR PIPING, DUCTWORK, AND EQUIPMENT

d. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

e. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel base plates, and factory cut to sizes that match requirements of supported equipment.

a. Resilient Material: Oil- and water-resistant

E. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch (6 mm) thick.

F. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.

G. Acoustic Option: The upper floating frame of the roof curb shall have a steel framework that supports 2 layers of 5/8" thick waterproof gypsum board. Gypsum board must surround ducts to provide a continuous sound break. This acoustical barrier shall be caulked to minimize sound transmission. A 4" thick layer of 1.5-density fiberglass shall cover the entire solid roof surface under the unit. Gypsum board and insulation provided in field by contractor.

H. Product Selection Basis: Curb shall be type RSC-db as manufactured by Mason Industries, Inc. or type VCR w/Acoustic Package by Vibro-Acoustics, Inc.

2.6 SEISMIC RESTRAINED ROOF-CURB (C-3)

A. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:

1. Amber/Booth Company, Inc.
2. California Dynamics Corporation.
3. Isolation Technology, Inc.
5. Mason Industries.
6. Thybar Corporation.
7. Vibration Eliminator Co., Inc.
8. Vibration Isolation.
9. Vibration Mountings & Controls, Inc

B. General Requirements for Restrained Roof-Curb Rails:

1. Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment and to withstand seismic and wind forces.

C. Lower Support Assembly: Formed sheet-metal. Upper frame shall provide continuous support for equipment and shall be captive to resiliently resist seismic and wind forces. Lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials, and shall be insulated with a minimum of 2 inches (50 mm) of rigid, glass-fiber insulation on inside of assembly.

1. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel base plates, and factory cut to sizes that match requirements of supported equipment.

a. Resilient Material: Oil- and water-resistant

D. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.

E. Product Selection Basis: Thycurb TC-3 or Vibro-Acoustics RTR
2.7 VIBRATION ISOLATION STEEL EQUIPMENT BASES

A. 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:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

C. Basis-of-Design Product: Subject to compliance with requirements provide a comparable product by one of the following:

1. Amber/Booth Company, Inc.
2. California Dynamics Corporation.
3. Isolation Technology, Inc.
5. Mason Industries.
7. Vibration Isolation.
8. Vibration Mountings & Controls, Inc

D. Steel Base (B-1): Factory-fabricated, welded, structural-steel bases and rails.
   1. Design Requirements: Lowest possible mounting height with not less than 1-inch (25-mm) clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
   a. Include supports for suction and discharge elbows for pumps.
   2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Bases shall have shape to accommodate supported equipment.
   3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
   4. Product Selection Basis: Mason MSL or Vibro-Acoustics SB

   1. Design Requirements: Lowest possible mounting height with not less than 1-inch (25-mm) clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
   a. Include supports for suction and discharge elbows for pumps.
   2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Bases shall have shape to accommodate supported equipment.
   3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
   4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.
   5. Product Selection Basis: Mason KSL or Vibro-Acoustics CIB

2.8 SEISMIC-BRACING/RESTRAINT DEVICES/SYSTEMS FOR EQUIPMENT, PIPING, AND DUCTWORK.

A. 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:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Amber/Booth Company, Inc.
2. California Dynamics Corporation
3. Cooper B-Line, Inc.
4. Hilti, Inc.
5. Kinetics Noise Control
VIBRATION ISOLATION AND SEISMIC RESTRAINT FOR PIPING, DUCTWORK, AND EQUIPMENT

7. Mason Industries
8. Tolco Incorporated
9. Unistrut
10. ISAT, Inc

C. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by 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.

D. Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
3. Maximum 1/4-inch (6-mm) air gap, and minimum 1/4-inch- (6-mm-) thick resilient cushion.

E. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

F. Sway Bracing: All suspended piping, ductwork, conduit and cable trays shall be provided with seismic sway braces in accordance with the applicable codes.

1. Seismic sway braces shall consist of galvanized steel aircraft cables or steel angles/strut channels. Steel aircraft cables shall be pre-stretched to establish a certified minimum modulus of elasticity. Cables braces shall be designed to resist seismic tension loads and steel braces shall be designed to resist both tension and compression loads with a minimum safety factor of 2. Brace end connections shall be steel assemblies that swivel to the final installation angle. Do not mix cable and steel braces to brace the same system. Steel angles or strut channels, when required, shall be clamped to the threaded hanger rods at the seismic sway brace locations utilizing a minimum of two ductile iron clamps. Basis of Design: Cable brace assemblies shall be Type SCB, steel brace assemblies shall be Type SSBS, rod clamps shall be either Type SRC or UC, pipe clevis braces shall be Type CCB and multiple anchor load distribution brackets shall be Type SLDB all as manufactured by Mason Industries, Inc. or Type RSK cable brace assemblies and Type VAC rod clamps by Vibro-Acoustics.

G. Hanger Rod Stiffener: Steel tube, steel slotted support system sleeve or reinforcing steel angle clamped to hanger rod are acceptable.

H. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

I. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

J. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.
VIBRATION ISOLATION AND SEISMIC RESTRAINT FOR PIPING, DUCTWORK, AND EQUIPMENT

K. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.

L. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.9 FLEXIBLE PIPING CONNECTORS

A. Flexible Spherical Joint (F-1): Flexible spherical joints shall employ peroxide cured EPDM in the covers, liners and Kevlar tire cord frictioning. Solid steel rings shall be used within the raised face rubber ends to prevent pullout. Flexible cable bead wire is not acceptable. Sizes 2" and larger shall have two spheres reinforced with a ring between spheres to maintain shape and complete with split ductile iron or steel flanges with hooked or similar interlocks. Sizes 16" to 24" may be single sphere. Sizes 3/4" to 1 1/2" may have threaded bolted flange assemblies, one sphere and cable retention. 14" and smaller connectors shall be rated at 250 psi up to 190°F with a uniform drop in allowable pressure to 190 psi at 250°F. 16" and larger connectors are rated 180 psi at 190°F and 135 psi at 250°F. Safety factors to burst and flange pullout shall be a minimum of 3/1. All joints must have permanent markings verifying a 5 minute factory test at twice the rated pressure. Concentric reducers to the above specifications may be substituted for equal ended expansion joints. Expansion joints shall be installed in piping gaps equal to the length of the expansion joints under pressure. Control rods need only be used in unanchored piping locations where the manufacturer determines the installation exceeds the pressure requirement without control rods, as control rods are not desirable in seismic work. If control rods are used, they must have 1/2" thick Neoprene washer bushings large enough in area to take the thrust at 1000 psi maximum on the washer area. Expansion joints shall be installed on the equipment side of the shut-off valves. Submittals shall include two test reports by independent consultants showing minimum reductions of 20 DB in vibration accelerations and 10 DB in sound pressure levels at typical blade passage frequencies on this or a similar product by the same manufacturer. All expansion joints shall be installed on the equipment side of the shut off valves. Manufacturer: Mason Industries #SFDEJ, SFEJ, SFDCR, SFU and CR or Vibro-Acoustics EED.

B. Stainless Hoses: (F-2) Flexible stainless steel hose shall have stainless steel braid and carbon steel fittings. Sizes 3" and larger shall be flanged. Smaller sizes shall have male nipples. Hoses must have sufficient length to accept 1/2" intermittent motion without failure. Hoses shall be installed on the equipment side of the shut-off valves horizontally and parallel to the equipment shafts wherever possible. Manufacturer: Mason Industries #BSS or Vibro-Acoustics SMP.

2.10 FLEXIBLE DUCTWORK CONNECTORS

A. Flexible ductwork connection (F-3): Flexible fiberglass canvas with fire resistant rated neoprene and UV resistant coating. Stainless steel metal edge banding. Minimum 4" width: DuroDyne “Durolon” or “Neoprene”.

2.11 AIR-MOUNTING SYSTEMS (A-1)

A. 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:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
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CRAFTS CENTER – PACKAGE 1

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C. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:
   2. Firestone Industrial Products Company.
   5. Vibration Eliminator Co., Inc.

D. Restrained Air Mounts: Housed compressed-air bellows.
   1. Assembly: Upper and lower steel sections connected by a replaceable, flexible, nylon-reinforced neoprene bellows and spring, with angle-iron frame having vertical-limit stops and channel-section top with leveling adjustment and attachment screws.
   2. Maximum Natural Frequency: 3 Hz.
   3. Operating Pressure Range: 25 to 100 psig (172 to 690 kPa).
   4. Burst Pressure: At least three times manufacturer's published maximum operating pressure.
   5. Leveling Valves: Minimum of 3 required to maintain leveling within plus or minus 1/8 inch (3 mm).

PART 3 - EXECUTION

3.1 LOCATION AND APPLICATION OF VIBRATION ISOLATION EQUIPMENT

Table 1 below is a tool for selecting appropriate isolators, bases, and deflection. The engineer should edit the table to include equipment tags for all isolated equipment then edit the table to delete equipment types not found on the project. Alternately, incorporate the isolator, deflection, and base information found in the table on the equipment schedules on drawings and delete here.

A. Chart Table 1 schedules vibration devices required for isolation of mechanical equipment provided on the project. Refer to Part 2 above for device specifications.

B. Air Handling Units Equipment Isolation

<table>
<thead>
<tr>
<th>EQUIPMENT TYPE</th>
<th>A’ LOCATION</th>
<th>B’ LOCATION</th>
<th>C’ LOCATION</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>MINIMUM DEFLECTION (IN)</td>
<td>BASE TYPE</td>
<td>MINIMUM DEFLECTION (IN)</td>
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<tr>
<td>Floor Mounted</td>
<td>S-1 (1)</td>
<td>1.5 B-1 (1)</td>
<td>S-1 (1)</td>
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<tr>
<td>Up to 15 HP</td>
<td>S-1 (1)</td>
<td>2.5 B-1 (1)</td>
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<td>20 HP &amp; Over</td>
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<td>1.75 B-1 (1)</td>
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<td>Suspended (4)</td>
<td>H-1</td>
<td>2.5 B-1 (1)</td>
<td>H-1</td>
</tr>
<tr>
<td>HIGH PRESSURE FAN SECTIONS (≥5 ESP)</td>
<td>S-2</td>
<td>2.5 B-2</td>
<td>S-2/S-1</td>
</tr>
<tr>
<td>Up to 30 HP</td>
<td>3.5 B-2</td>
<td>S-2/S-1</td>
<td>2.5 B-2</td>
</tr>
<tr>
<td>40 HP &amp; Over</td>
<td>3.5 B-2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes:

SERA Architects, Inc.

Package 1 – PERMIT / CONSTRUCTION

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**TABLE 1: EQUIPMENT ISOLATION SCHEDULE - UNHOUSED FANS, BUILT-UP SYSTEMS, OR CABINET FANS**

<table>
<thead>
<tr>
<th>EQUIPMENT</th>
<th>LOCATION</th>
<th>A' CRITICAL (35' - 50' SPAN)</th>
<th>B' UPPER STORY (20' - 35' SPAN)</th>
<th>C' ON GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>CENTRIFUGAL FANS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CL I &amp; II Up to 54-1/2&quot; WD</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Up to 15 HP</td>
<td>S - 2/S - 1</td>
<td>1.5</td>
<td>B-1</td>
<td>S-2/S-1</td>
</tr>
<tr>
<td>20 – 50 HP</td>
<td>S-2</td>
<td>2.5</td>
<td>B-2</td>
<td>S-2/S-1</td>
</tr>
<tr>
<td>60 HP &amp; Over</td>
<td>S-2</td>
<td>3.5</td>
<td>B-2</td>
<td>S-2</td>
</tr>
<tr>
<td>CL I &amp; II 60&quot;W.D &amp; OVER/ALL CL III FANS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Up to 15 HP</td>
<td>S-2</td>
<td>2.5</td>
<td>B-2</td>
<td>S-2/S-1</td>
</tr>
<tr>
<td>20 – 50 HP</td>
<td>S-2</td>
<td>2.5</td>
<td>B-2</td>
<td>S-2</td>
</tr>
<tr>
<td>60 HP &amp; Over</td>
<td>S-2</td>
<td>3.5</td>
<td>B-2</td>
<td>S-2</td>
</tr>
<tr>
<td>AXIAL FLOWFANS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Floor Mtd.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Up to 15 HP</td>
<td>S-1/S-2</td>
<td>1.5</td>
<td>B-1</td>
<td>S-1</td>
</tr>
<tr>
<td>20 HP &amp; Over</td>
<td>S-2</td>
<td>3.5</td>
<td>B-2</td>
<td>S-1</td>
</tr>
<tr>
<td>Suspended</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Up to 15 HP</td>
<td>H - 1</td>
<td>1.75</td>
<td>B-1</td>
<td>H-2</td>
</tr>
<tr>
<td>20 HP &amp; Over</td>
<td>H - 1</td>
<td>2.5</td>
<td>B-1</td>
<td>H-1</td>
</tr>
<tr>
<td>UTILITY FAN SETS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Floor Mounted</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S - 2/S - 1</td>
<td>1.5</td>
<td>B-1</td>
<td>S-1</td>
<td>0.75</td>
</tr>
<tr>
<td>Suspended</td>
<td>H-1</td>
<td>1.75</td>
<td>B-1</td>
<td>H-1</td>
</tr>
<tr>
<td>CABINET FANS and FAN SECTIONS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Floor Mounted</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Up to 15 HP</td>
<td>S-1(1)</td>
<td>1.5</td>
<td>NA</td>
<td>S-1</td>
</tr>
<tr>
<td>20 HP &amp; Over</td>
<td>S-2(1)</td>
<td>2.5</td>
<td>B-2</td>
<td>S-1</td>
</tr>
<tr>
<td>Suspended</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### TABLE 1: EQUIPMENT ISOLATION SCHEDULE - PUMPS

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>A' CRITICAL (35’ - 50’ SPAN)</th>
<th>B' UPPER STORY (20' - 35' SPAN)</th>
<th>C' ON GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISOLATOR TYPE</td>
<td>MINIMUM DEFLECTION (IN)</td>
<td>BASE TYPE</td>
<td></td>
</tr>
<tr>
<td>PUMPS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Base Mtd.type</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Up to 5 HP</td>
<td>S–2/S-1</td>
<td>0.75 B-2</td>
<td>S–2/S-1 0.4 B-1</td>
</tr>
<tr>
<td>7- ½ HP &amp; Over</td>
<td>S–2/S-1</td>
<td>1.5 B-2</td>
<td>S–2/S-1 0.75 B-2</td>
</tr>
<tr>
<td>Vertical Inline</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>floor mounted</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Up to 5 HP</td>
<td>P-1</td>
<td>0.15 NA</td>
<td>P-1 0.15 NA</td>
</tr>
<tr>
<td>7- ½ HP &amp; Over</td>
<td>S–2/S-1</td>
<td>1.5 B-2</td>
<td>P-1 0.15 NA</td>
</tr>
<tr>
<td>Suspended</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inline Pump</td>
<td>H-1</td>
<td>1.75 NA</td>
<td>H-1 1.0 NA</td>
</tr>
</tbody>
</table>

**Notes:**
1. Provided by equipment manufacturer factory installed.
2. Provide full perimeter steel welded frame below equipment
3. Provide support per manufacturer’s recommendation
4. Where internally isolated, hard pipe and duct connections to fan are allowed. If not internally isolated, provide F-2 pipe and F-3 duct connectors.

---

### TABLE 1: EQUIPMENT ISOLATION SCHEDULE - REFRIGERATION/COOLING PLANT EQUIPMENT

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>A' CRITICAL (35’ - 50’ SPAN)</th>
<th>B' UPPER STORY (20' - 35' SPAN)</th>
<th>C' ON GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISOLATOR TYPE</td>
<td>MINIMUM DEFLECTION (IN)</td>
<td>BASE TYPE</td>
<td></td>
</tr>
</tbody>
</table>

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VIBRATION ISOLATION AND SEISMIC RESTRAINT FOR PIPING, DUCTWORK, AND EQUIPMENT

SERA Architects, Inc.  Package 1 – PERMIT / CONSTRUCTION

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---

TABLE 1: EQUIPMENT ISOLATION SCHEDULE - MISCELLANEOUS EQUIPMENT

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>A’ CRITICAL (35’ - 50’ SPAN)</th>
<th>B’ UPPER STORY (20’ - 35’ SPAN)</th>
<th>C’ ON GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ISOLATOR TYPE</td>
<td>MINIMUM DEFLECTION (IN)</td>
<td>ISOLATOR TYPE</td>
</tr>
<tr>
<td></td>
<td>TYPE</td>
<td>(IN)</td>
<td>TYPE</td>
</tr>
<tr>
<td>ROOFTOP AIR CONDITIONING UNITS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Up to 20 Ton</td>
<td>S-2</td>
<td>1.5</td>
<td>C-1</td>
</tr>
<tr>
<td>Over 20 Ton</td>
<td>S-2</td>
<td>2.5</td>
<td>C-2</td>
</tr>
<tr>
<td>BOILER (PACKAGE TYPE)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All Sizes</td>
<td>P-1</td>
<td>0.15</td>
<td>(3)</td>
</tr>
<tr>
<td>ENGINE DRIVEN GENERATORS</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

F. Miscellaneous Equipment Isolation

Notes:
(1) Provided by equipment manufacturer factory installed.
(2) Provide full perimeter steel welded frame below equipment
(3) Provide support per manufacturer’s recommendation
(4) Provide F-2 pipe connections to unit.
VIBRATION ISOLATION AND SEISMIC RESTRAINT FOR PIPING, DUCTWORK, AND EQUIPMENT

<table>
<thead>
<tr>
<th>Up to 60 HP</th>
<th>S-2</th>
<th>2.5</th>
<th>B-2</th>
<th>S-2</th>
<th>1.5</th>
<th>B-2</th>
<th>S-2</th>
<th>0.75</th>
<th>NA</th>
</tr>
</thead>
<tbody>
<tr>
<td>75 HP &amp; Over</td>
<td>S-2</td>
<td>3.5</td>
<td>B-2</td>
<td>S-2</td>
<td>2.5</td>
<td>B-2</td>
<td>S-2</td>
<td>0.75</td>
<td>NA</td>
</tr>
</tbody>
</table>

Notes:
1. Provided by equipment manufacturer factory installed.
2. Provide full perimeter steel welded frame below equipment
3. Provide support per manufacturer’s recommendation
4. Where internally isolated, hard pipe and duct connections to unit are allowed. If not internally isolated, provide F-2 pipe and F-3 duct connectors.

3.2 EXAMINATION
A. Examine areas and equipment to receive vibration isolation and seismic and wind-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.
B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 APPLICATIONS
A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service or agency acceptable to authorities having jurisdiction. Indicate on Drawings, by details, schedules, or a combination of both, the locations where hanger rods for individual pipes and hanger rods for trapeze hangers require hanger rod stiffeners.
B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.4 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION
A. Comply with requirements in Division 07 Section “Roof Accessories” for installation of roof curbs, equipment supports, and roof penetrations.
B. Comply with manufacturer’s recommendations for selection and application of vibration isolation materials and units except as otherwise indicated. Comply with minimum static deflections recommended by ASHRAE, of vibration isolation materials and units where not otherwise indicated.
C. Comply with manufacturer’s instructions for installation and load application to vibration control materials and units except as otherwise indicated. Adjust to ensure that units have equal deflection, do not bottom out under loading, and are not short-circuited by other contacts or bearing points. Remove space blocks and similar devices intended for temporary support during installation.
D. Install units between substrate and equipment as required for secure operation and to prevent displacement by normal forces, and as indicated.
E. Adjust leveling devices as required to distribute loading uniformly onto isolators. Shim units as required where substrate is not level.
F. Flexible Pipe Connectors: Install on equipment side of shutoff valves.
G. Upon completion of vibration control work, prepare report showing measured equipment deflections for each major item of equipment as indicated. Clean each vibration control unit, and verify that each is working freely, and that there is no dirt or debris in immediate vicinity of unit that could possibly short-circuit unit isolation.
VIBRATION ISOLATION AND SEISMIC RESTRAINT FOR PIPING, DUCTWORK, AND EQUIPMENT

H. Equipment Restraints:
   1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
   2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
   3. Install seismic-restraint devices using methods approved by an evaluation service or agency acceptable to the authorities having jurisdiction. Provide required submittals for components.

I. Piping Restraints:
   1. Comply with requirements in MSS SP-127.
   2. Space lateral supports a maximum of [40 feet (12 m)., and longitudinal supports a maximum of 80 feet (24 m).
   3. Brace a change of direction longer than 12 feet (3.7 m).

J. Install cables so they do not bend across edges of adjacent equipment or building structure.

K. Install seismic-restraint devices using methods approved by an evaluation service or agency acceptable to the authorities having jurisdiction, providing required submittals for component.

L. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolts and mounting hole in concrete base.

M. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

N. 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.

O. 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 pre-stressed 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. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
   5. Set anchors to manufacturer’s recommended torque, using a torque wrench.
   6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.5 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Division 23 Section “Hydronic Piping” for piping flexible connections.

3.6 ADJUSTING
VIBRATION ISOLATION AND SEISMIC RESTRAINT FOR PIPING, DUCTWORK, AND EQUIPMENT

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 air-spring leveling mechanism.

D. Adjust active height of spring isolators.

E. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.7 AIR MOUNTING SYSTEM DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-mounting systems. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION
PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS
A. Testing, Adjusting and Balancing work specified in Specification section 23 0593 is to be provided by Owner. General and Mechanical Contractor to coordinate with Owner’s TAB contractor in completion of this work as specified in 23 0593-1.04-G.

B. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 230500 - Basic Materials and Methods, and other Sections in Division 23 specified herein.

1.2 WORK RELATED IN OTHER SECTIONS
A. Section 230500: Basic Materials and Methods
B. Section 230900: Controls and Instrumentation
C. Section 233113: Air Distribution
D. Division 26: Electrical.

1.3 SUMMARY
A. Scope: Extent of testing, adjusting and balancing work required by this Section is indicated on the drawings, in schedules, and by the requirements of this Section, and Section 230500 - Basic Mechanical Requirements.

B. Systems: Testing, adjusting and balancing specified in this Section shall include, but not be limited to, the following systems:
1. Air handling systems including supply, return and exhaust.
2. Hydronic system including heating, chilled water and condenser water.
3. Air distribution ductwork including supply, return and exhaust.
4. Smoke control system.
5. Automatic temperature control system.
6. General exhaust systems.
7. Domestic hot water recirculation piping.
8. Underfloor air distribution system air leakage.
9. Instruction of Owner’s personnel for future balancing of systems.

C. Reference Standards
4. AABC-National Standards for Total System Balance.
5. NEBB-Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.
9. American National Standards Institute (ANSI): Comply with the following:
   a. S1.4 Specification For Sound Level Meters.
   b. S1.11 Specification For Octave-Band and Fractional-Octave-Band Analog and Digital Filters

10. Chapter 4 of applicable Mechanical Code.

1.4 QUALITY ASSURANCE

A. Contractor’s Qualifications: A specialist certified by the National Environmental Balancing Bureau (NEBB) or Associated Air Balance Council (AABC) with at least 5 years of experience in those testing, adjusting and balancing requirements similar to those required for this project, who is not the installer of the system to be tested and is otherwise independent of the project. Testing, adjusting, and balancing shall be performed by a certified NEBB technician or a certified AABC technician under direct field supervision of a Certified NEBB Supervisor or a Certified AABC Supervisor. Testing and balancing agency must submit qualifications for review and approval prior to acceptance for work.

B. Penalty: The Contractor shall submit the name of the organization he proposes to employ for approval within 30 days after contract award. If the Contractor fails to submit the name of an acceptable agency within the specified time, a firm may be selected to accomplish the work, and this selection shall be binding upon the Contractor at no additional cost.

C. Retainages: In addition to any other sums retained or withheld pursuant to the provisions of this Contract, the amount of dollars will be withheld from payments to the contractor until such time as the work has been completed and accepted. In no event will this amount be paid to the Contractor prior to 60 days following acceptance of the project; during such time, the Contractor shall investigate and correct any reported deficiencies unless such deficiencies are a result of unauthorized tampering by building occupants.

D. Calibration of Testing Instruments: All measurement instruments used for testing, adjusting, balancing, and commissioning shall be calibrated. The time between the most recent calibration data and the final test report date shall not be over 6 months.

E. Testing and balancing agency, as part of its contract, shall act as authorized inspection agency responsible to Consulting Engineer and Owner, and shall list all items that are installed incorrectly, require correction, or have not been installed in accordance with contract Drawings and Specifications, pertaining to air distribution, cooling and heating systems. The testing and balancing agency is required to provide written reports of all deficiencies and proposed recommendations to the Owner’s Representative, Contractor, Architect and Engineer.

F. The testing and balancing agency shall provide with his bid a performance guarantee covering all phases of the work as herein specified.

G. The General and Mechanical Contractors shall cooperate with the selected testing and balancing agency in the following manner:
   1. Provide sufficient time before final completion dates so that tests and balancing can be accomplished.
   2. The various system installers, suppliers and contractors shall provide all required materials, labor and tools to make corrections when required without undue delay. Install balancing dampers as required by testing and balancing agency.
   3. The contractor shall put all heating, ventilating and air conditioning systems and equipment into full operation and shall continue the operation of the same during each working day of testing and balancing.
   4. Testing and balancing agency shall be kept informed of any major changes made to the system during construction, and shall be provided with a complete set of Record Drawings.
TESTING, ADJUSTING AND BALANCING

5. The General Contractor shall make space and other facilities available to the testing and balancing agency to enable their work to progress. The General Contractor shall schedule the work of other trades to avoid conflicts with this work.

1.5 SUBMITTALS

A. Conform to the Submittals requirements of Division 01.

B. Forms: The Contractor shall deliver a complete copy of either NEBB or AABC standard forms for testing and balancing work associated with the project. These forms shall serve as specific guidelines for producing final test report. Hybrid or non-standards forms are not acceptable. Data shall include, but not be limited to, a title page with building information, instrument lists, air flows, water flows, temperatures, sound levels, capacities, nameplate data.

C. Test Reports: Provide six (6) certified test reports, signed by the test and balance supervisor who performed the work. The final reports shall include identification and types of instruments used, and their most recent calibration date, and key plans identifying all inlets and outlets. Final test reports shall be typed. Hand written reports are not acceptable.

D. Maintenance Data: Include, in maintenance manuals, copies of certified test reports and identification of instruments.

E. Qualifications: The Contractor shall submit the certified individual qualifications of all persons responsible for supervising and performing the actual work and the name of the certifying engineer. Provide a reference list of five (5) similar size projects with contact person and telephone number.

1.6 AGENDA

A. Agenda: A preliminary report and agenda shall be submitted and approved prior to the start of testing and balancing work.

1. Review plans and specifications prior to installation of any of the affected systems, and submit a report indicating any deficiencies in the systems that would preclude the proper adjusting, balancing, and testing of the systems.

2. The agenda shall include a general description of each air and water system with its associated equipment and operation cycles for heating and cooling.

3. The agenda shall include a list of all air and water flows to be performed at all mechanical equipment.

4. The agenda shall incorporate the proposed selection points for sound measurements, including typical spaces as well as sound sensitive areas such as conference rooms.

5. The agenda shall also include specific test procedures and parameters for determining specified quantities (e.g. flow, drafts, sound levels) from the actual field measurements to establish compliance with contract requirements. Samples of forms showing application of procedures and calculations to typical systems shall be submitted.

6. Specific test procedures for measuring air quantities at terminals shall specify type of instrument to be used, method of instrument application (by sketch) and factors for:
   a. Air terminal configuration.
   b. Flow direction (supply or exhaust).
   c. Velocity corrections.
   d. Effective area applicable to each size and type of air terminal.
   e. Density corrections.

7. The agenda shall include identification and types of measurement instruments to be used, and their most recent calibration date.
1.7 JOB CONDITIONS

A. General: Do not proceed with testing, adjusting and balancing work until the following conditions have been met.
1. Work has been completed and is operable. Ensure that there is no latent residual work yet to be completed on the tested equipment.
2. Work scheduled for testing, adjusting and balancing is clean and free from debris, dirt and discarded building materials.
3. All architectural openings (doors, windows, and other openings) which may affect the operation of the system to be tested, adjusted, and balanced shall be at their normal states.
4. All related mechanical systems which may affect the operation of the system to be tested, adjusted, and balanced shall be at their normal operating conditions.

PART 2 - PRODUCTS

2.1 TEST HOLES

A. Test holes shall be provided in ducts, housings and pipes as necessary for the proper air and water measurements and to balance systems. At each location where ducts or plenums are insulated, test holes shall be provided with an approved extension with plug fitting.

2.2 PATCHING MATERIALS

A. Material: Seal, patch and repair ductwork, piping and equipment drilled or cut for testing purposes.
1. Plastic plugs with retainers may be used to patch drilled holes in ductwork and housings.
2. Piping shall be capped with materials the same as the piping system.
3. Insulation shall be neatly hemmed with metal or plastic edging, leaving test points visible for future testing.

2.3 TEST INSTRUMENTS

A. Standards: Utilize instruments and equipment of type, precision, and capacity as recommended in the NEBB "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and AABC manual MN-1.
B. Test Instruments: All instruments used for measurements shall be accurate and calibration histories for each instrument shall be available for examination. Each test instrument shall be calibrated by an approved laboratory or by the manufacturer. A representative has the right to request instrument recalibration, or the use of other instruments and test methodology, where accuracy of readings is questionable.
C. Additional Instruments: Permanently installed measuring instruments, such as temperature and pressure gauges, shall be checked against transfer standard instruments. Any instrument which does not meet specification requirement shall be replaced or recalibrated.
D. Cone Instruments: The Contractor shall employ manufactured enclosure type cones, capable of air volume direct readings, for all diffuser/grille/register air flow measurements. The readout meters shall meet calibration requirements.

PART 3 - EXECUTION

3.1 PROCEDURES AND INSTRUMENTS, GENERAL

A. Requirements: All systems and components thereof shall be adjusted to perform as required by drawings and specifications.
TESTING, ADJUSTING AND BALANCING

B. Test Duration: Operating tests of heating and cooling coils, fans, and other equipment shall be of not less than four hours duration after stabilized operating conditions have been established. Capacities shall be based on temperatures and air and water quantities measured during such tests.

C. Instrumentation: Method of application of instrumentation shall be in accordance with the approved agenda.
   1. All instruments shall be applied in accordance with the manufacturer's certified instructions.
   2. All labor, instruments, and appliances required shall be furnished by the Contractor. Permanently installed instruments used for the tests (e.g., flow meters and Btu meters) shall not be installed until the entire system has been cleaned and ready for operation.

3.2 DUCT SMOKE DETECTORS

A. The testing and balancing agency shall direct the placement of all duct mounted smoke detectors.
   1. Obtain information from the Contractor who is to furnish the smoke detectors on the proper device placement and installation limitations and on the proper differential pressure across the sampling tubes of the duct detectors.
   2. Based on the submitted manufacturer's installation guidelines indicate the proper mounting location to the installing Contractor.

B. After the installation of all smoke detectors test them again in the final installation position and report differential pressures.

3.3 AIR SYSTEM PROCEDURES

A. Adjustments: Adjust all air handling systems to provide approximate design air quantity to or through, each component, and to maintain stable and comfortable interior temperatures, free of drafts or stagnant conditions. Adjusting and balancing of all systems shall be conducted during periods of the year approximating maximum seasonal operation.

B. Equalizers: Equalizing devices shall be adjusted to provide uniform velocity across the inlets (duct side for supply) of terminals prior to measuring flow rates.

C. Balance: Flow adjusting (volume control) devices shall be used to balance air quantities (i.e., proportion flow between various terminals comprising system) to the extent that their adjustments do not create objectionable air motion or sound (i.e., in excess of specified limits).
   1. Balancing between runs (submains, branch mains, and branches) generally shall be accomplished by flow regulating devices at, or in, the divided-flow fitting.
   2. Restriction imposed by flow regulating devices in or at terminals shall be minimal.
   3. Final measurements of air quality shall be made after the air terminal has been adjusted to provide the optimum air patterns of diffusion.

D. Fan Adjustment: Total air system quantities, generally, shall be varied by adjustment of fan speeds or axial-flow fan wheel blade pitch. Damper restriction of a system's total flow may be used only for systems with direct-connected fans (without adjustable pitch blades), provided system pressure is less than 1/2-inch W.G. and sound level criteria is met.

E. Air Measurement: Where air quantity measuring devices are specified in other sections such systems shall be used as a cross-check of portable measuring equipment.
   1. Except as specifically indicated herein, pitot tube traverses shall be made of each duct to measure air flow therein. Pitot tubes, associated instruments, traverses, and techniques shall conform to the ASHRAE "Handbook Fundamentals Inch Pound Edition."
   2. For ducts serving modular office areas with movable partitions, which are subject to change, pitot tube traverses may be omitted provided the duct serves only a single room or space and its design volume is less than 2000 cfm. In lieu of pitot tube traverses,
TESTING, ADJUSTING AND BALANCING

airflow in the duct shall be determined by totaling volume of individual terminals served, measured as described herein.

3. Where duct's design velocity and air quantity are both less than 1000 (fpm/cfm), air quantity may be determined by measurements at terminals served.

F. Test Holes: Test holes shall be in a straight duct, as far as possible downstream from elbows, bends, take-offs, and other turbulence generating devices, to optimize reliability of flow measurements.

G. Air Terminal Balancing: Generally, measurement of flow rates by means of velocity meters applied to individual terminals, with or without cones or other adapters, shall be used only for balancing. Measurement of air quantities at each type of air terminal (inlet and outlet) shall be determined by the method approved for the balancing agenda. Laboratory tests shall be conducted to prove of methodology when so directed. Such tests shall be conducted in conformance with applicable ASHRAE or American Society of Mechanical Engineers (ASME) codes and shall be made at no cost.

H. Air Motion: Air motion and distribution shall be as specified and indicated on drawings. The Contractor at no additional cost shall, in addition to air motion measurements, make smoke tests wherever requested to demonstrate the air distribution from air terminals.

I. Air system test and balance procedures shall include, but not be limited to the following requirements:
   1. Test and adjust blower RPM to design requirements.
   2. Test and record motor full load amperes.
   3. Make pitot tube traverse of main supply ducts and obtain design CFM at fans.
   4. Test and record system pressures, suction and discharge.
   5. Test and adjust system for design recirculated air, CFM.
   6. Test and adjust system for design CFM outside air.
   7. Test and record entering air temperatures.
   8. Test and record leaving air temperatures.
   9. Adjust all supply, return and exhaust air ducts to proper design CFM.
  10. Adjust all zones to proper design CFM, supply and return.
  11. Test and adjust duct systems and each diffuser, grille, and/or register to within 10% of design requirements.
  12. Each grille, diffuser and register shall be identified as to location and area.
  13. Size, type and manufacturer of VAV boxes, diffusers, grilles, registers and all tested equipment shall be identified and listed. Manufacturer's ratings on all equipment shall be used to make required calculations.
  14. Readings and tests of diffusers, grilles and registers shall include required FPM velocity and test resultant velocity, required CFM and test resultant CFM after adjustment.
  15. In cooperation with the control manufacturer's representative, setting adjustments of automatically operated dampers to operate as specified, indicated, and/or noted. Testing agency shall check all controls requiring adjustment by control installers. Room thermostats shall be checked for cooling and heating response.
  16. All diffusers, grilles and registers shall be adjusted to minimize drafts in all areas.
  17. Adjust overall system balances to allow all self-closing exterior doors to close from any open position. Maximum interior air pressure in all operational modes shall not exceed 0.05" static pressure relative to the outside air pressure. Comply with chapter 10 of the Building Code to assure that self-closing doors with release with a maximum force of 15 lbs.
  18. As part of the work of this contract, the HVAC contractor shall make any changes in the pulleys, belts and dampers or the addition of dampers required for correct balance as recommended by air balance agency, at no additional cost to Owner.
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19. After air balancing is completed and RPM determined, HVAC Contractor shall provide fixed pitch pulleys.
20. All mixing boxes, VAV air valves, control dampers, smoke dampers and similar devices which operate at 100% shut off shall be tested for leakage.
21. Variable Air Volume Fan Systems: The primary balancing mode is 100% outside air with all terminal boxes on a full call for cooling. Also check and record performance at minimum outside air with all terminal boxes on call for full cooling and at minimum outside air with all terminal boxes on call for full heating. Verify that the systems are operating on a stable part of the fan curves in each mode. Record final duct static controller settings
22. Editor-remove the following if no UFAD.
23. Provide testing of underfloor air distribution plenum floor mock-ups and final floor installation to document that plenum does not exceed 5% air leakage rate at maximum 0.10" w.g. positive differential pressure.Editor-remove the following if no stairwells.
24. Stairwell pressurization balancing including doors and vestibule differential pressures and forces as required by the local ordinances and fire marshal.
25. Editor-remove the following if no smoke control system.
26. Smoke control systems per chapter 9 of the Building Code and as required by the local ordinances and fire marshal.

3.4 AIR SYSTEM DATA

A. Report: The certified report shall include for each air handling system the data listed below.

1. Equipment (Fan or Factory Fabricated Station Unit):
   a. Installation data
      1) Manufacturer and model
      2) Size
      3) Arrangement, discharge and class
      4) Motor hp, voltage, phase, cycles, and full load amps
      5) Location and local identification data
   b. Design data
      1) Data listed in schedules on drawings and specifications.
   c. Fan recorded (test) data
      1) cfm
      2) static pressure
      3) rpm
      4) motor operating amps
      5) motor operating bhp

2. Duct Systems:
   a. Duct air quantities (maximum and minimum) - main, submains, branches, outdoor (outside) air, total air, and exhaust:
      1) duct size(s)
      2) number of pitot tube (pressure measurements)
      3) sum of velocity measurements (Note: Do not add pressure measurements)
      4) average velocity
      5) recorded (test) cfm
      6) design cfm
   b. Individual air terminals
      1) terminal identification supply or exhaust, location and number designation
      2) type size, manufacturer and catalog identification applicable factor for application, velocity, area, etc., and designated area
      3) design and recorded velocities - fpm (state "core," "inlet," etc., as applicable)
      4) design and recorded quantities - cfm (deflector vane or diffusion cone settings)
3.5 DUCTWORK AIR LEAKAGE TESTING

A. Test and balance agency shall perform active air flow testing of ductwork systems or sections of ductworks. Agency shall inspect and confirm that all ductwork is sealed per the specification requirements prior to performing any testing. Calculate maximum allowable air leakage by system based on total design air flow rate. Maximum allowable system leakage shall not exceed 5%. Test a random sample of 10% of the ductwork. If any ductwork within the sample fails to meet the criteria than an additional 10% (20% total) sample must be measured. If any ductwork within this second 10% sample fails than 100% of all ductwork must be tested and verified to have a leakage rate than does not exceed the maximum allowable limit.

B. Ductwork systems to be leakage tested shall include:
   1. Testing shall be performed at 1.5 times the peak design outlet static pressure from the air handling unit/fan, but not greater than the maximum SMACNA pressure rating of the ductwork construction classification. Testing is not required of flexible ductwork or ductwork downstream of VAV terminal units.
   2. Leakage through manufactured products, such as dampers, fire smoke dampers and terminal units may be excluded from the leakage calculations based on manufacturer stated values, at pressure, or these units may be temporarily sealed with painter’s tape during testing to seal any openings and must be removed after testing.
   3. Supply air ductwork from outlet of the air handling unit/fan to inlet side of terminal units or connection to flexible ductwork.
   4. All supply, return and exhaust air ductwork located outside the building envelope.
   5. Return and exhaust air ductwork located in unconditioned spaces from inlet of the air handling unit/fan to the ductwork terminations upstream of each return air grille.
   6. Laboratory and fume hood exhaust air ductwork from inlet of the air handling unit/fan to the connection at the remote exhaust air grille or fume hood connection.
   7. Kitchen exhaust air ductwork from inlet of the exhaust fan to the connection at the remote exhaust hood.

C. Ductwork installer shall prepare ductwork for pressure testing as deemed appropriate to maintain construction schedule. Ductwork may be tested as total systems or in sections. Sectional testing will require documentation to prove the totalized system leakage is within allowable range of entire system. Ductwork inlets and outlets may be temporarily sealed airtight with plastic, or other means, to facilitate testing pressures.

D. Testing may occur through ductwork devices such as balancing dampers, smoke fire dampers and coils. Manufacturer provided air leakage allowances for such devices may be excluded from duct leakage measurement but must be documented in final report.

E. Perform all testing utilizing a duct leakage testing system, Oriflow Duct Leakage Tester or equal, with calibrated fan, orifice, gauges, ductwork, pressure tips and tubing.

3.6 UNDERFLOOR PLENUM AIR LEAKAGE TESTING

A. Test and balance agency shall perform active air leakage testing of raised floor plenums. Agency shall inspect and confirm that all plenums are sealed per the specification requirements prior to testing. Agency shall coordinate with commissioning agent and all installing contractors and identify areas where floor plenum integrity has been compromised. Reports of inspections will be submitted to the general contractor.

B. Plenum Mock-Up & Testing: All subcontractors responsible for constructing or penetrating the underfloor plenum must participate in the construction of an on-site plenum mockup consisting of all planned plenum components, penetrations, seams and openings. The mock-up plenum is to be inspected and tested by the test and balance agency and an independent commissioning agent for
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air leakage to verify that it was constructed and sealed in accordance with specifications and drawings including meeting the air leakage requirements.

C. Air leakage requirement for mock-up and final plenums: total air leakage from each plenum should be no more than 5% of the design airflow when tested at a static pressure of 0.10” w.g. (25 Pascals). Areas with leakage exceeding 5% shall be inspected, repaired and retested until such time that plenum leakage is less than 5% of the design air flow for each floor area.

D. Perform all pressure testing using a calibrated blower door apparatus, such as a Minneapolis Blower Door model 3 as manufactured by the Energy Conservatory. The fan discharge plenum shall be sized to match a typical floor tile, such as 24” x 24”. A minimum of three measurements shall be obtained to assure the average pressure does not exceed the allowable leakage rate. Document results in TAB report.

3.7 WATER SYSTEM PROCEDURES

A. Preparation:
1. Open all valves to full open position. Close coil bypass stop valves. Set mixing valve to full coil flow.
2. Remove all strainers and clean same. Reinstall.
3. Examine water system and determine if water has been treated and cleaned.
4. Check pump rotation.
5. Check expansion tank to determine they are not air bound and the system is completely full of water.
6. Check all air vents at high points of water systems and determine that all are installed and operating freely.
7. Check operation of automatic bypass valve.
8. Check and set operating temperatures of all equipment at design requirements.
9. Complete air balance must have been accomplished before actual water balance begins.

B. Adjustment: All heating, cooling and condensing water systems shall be adjusted to provide required quantity to or through each component.

C. Metering: Water quantities and pressures shall be measured with calibrated meters.
1. Venturi tubes, orifices, or other metering fittings and pressure gauges shall be used to measure water flow rates and balance systems. Systems shall be adjusted to provide the approved pressure drops through the heat transfer equipment (coils except room units, converters, etc.) prior to the capacity testing.
2. Where flow metering fittings are not installed, in air/water type heat transfer equipment, flow balance shall be determined by measuring the air side energy differential across the heat transfer equipment. Measurement of water temperature differential shall be performed with the air system, adjusted as described herein, in operation.

D. Automatic Controls: Automatic control valves shall be positioned for full flow through the heat transfer equipment of the system during tests.

E. Flow: Flow through bypass circuits at three-way valves shall be adjusted to equal that through the supply circuit, when the valve is in the bypass position.

F. Distribution: Adjustment of distribution shall be effected by means of balancing devices (cocks, valves, and fittings) and automatic flow control valves as provided; service valves shall not be used.
1. Where automatic flow control valves are utilized in lieu of Venturi tubes, only pressure differential need be recorded, provided that the pressure is at least the minimum applicable to the tag rating.
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G. Special Procedures: Where available pump capacity (as designed) is less than total flow requirements of individual heat transfer units of system served, full flow may be simulated by the temporary restriction of flow to portions of the system; specific procedures shall be delineated in the agenda.

H. Water System Test and Balance Procedure: Perform the following tests, and balance each system in accordance with the following requirements:
1. Set chilled, heating and condenser water pumps to proper gallons per minute delivery.
2. Adjust chilled water flow through chiller(s).
3. Adjust heating water flow through boiler(s).
4. Adjust condenser water flow through cooling tower(s).
5. Test and record entering and leaving water temperatures through chillers, boilers and cooling towers.
6. Test and record water temperatures at inlet and outlet side of each terminal unit. Note rise or drop of temperatures from source.
7. Proceed to balance each terminal unit.
8. Upon completion of flow readings and adjustments at coils, mark all settings and record data.
9. After adjustments to coils are made, recheck settings at the pumps, chiller, boilers, and cooling towers and readjust if required.
10. Record and check the following items at each coil.
   a. Inlet water temperatures.
   b. Leaving water temperatures.
   c. Water pressure drop of each coil.
11. Pump operating suction and discharge pressures and final total dynamic head.
12. List all mechanical specifications of pumps.
13. Rated and actual running amperage of pump motor.

3.8 WATER SYSTEM DATA

A. Report: The certified report for each water system shall include the data listed below.
1. Pumps:
   a. Installation data
      1) manufacturer and model
      2) size
      3) type drive
      4) motor hp, voltage, phase, and full load amps
   b. Design data
      1) gpm
      2) head
      3) rpm and amps
   c. Recorded data
      1) discharge pressures (full-flow and no-flow)
      2) suction pressures (full-flow and no-flow) operating head
      3) operating gpm (from pump curves if metering is not provided) no-load
      4) amps
      5) full-flow amps
      6) no-flow amps
2. Air Heating and Cooling Equipment:
   a. Design data
      1) load in Btu or MBh
      2) gpm
      3) entering and leaving water temperature
TESTING, ADJUSTING AND BALANCING

4) entering and leaving air conditions (DB and WB)
5) cfm
6) water pressure drop
7) entering steam pressure

b. Recorded data
   1) type of equipment and identification (location or number designation)
   2) entering and leaving air conditions (DB and WB)
   3) entering and leaving water temperatures
   4) gpm (if metered)
   5) temperature rise or drop
   6) entering steam pressure

3. Water Chilling Units:
   a. Installation data
      1) manufacturer and model
      2) motor hp, voltage, cycles, phase, and full load amps
      3) part load amperes
      4) gpm - chiller and condenser
      5) water pressure drop - chiller and condenser
      6) entering and leaving water temperature - chiller and condenser
   b. Recorded data (chiller and condenser)
      1) gpm
      2) water pressure drop
      3) entering and leaving water temperature
      4) amperes

4. Heat Exchangers:
   a. Installation Data
      1) manufacturer, model, and type
      2) flow rate
      3) inlet (entering) and outlet (leaving) temperatures
      4) inlet (entering) and outlet (leaving) pressures
   b. Recorded Data
      1) flow rate
      2) entering and leaving water temperatures
      3) entering and leaving pressures

3.9 HEAT EXCHANGER CAPACITY VERIFICATION

A. Air coil capacities shall be verified from air side measurement data. Capacities of coils shall be the difference of the energy carried by the air between the up stream and down stream of the coils.

B. The measured air flow rate for the fan may be used for air coil capacity calculations providing no ducted bypassing of coil is occurring.

C. Water/water heat exchanger equipment capacity shall be verified by measuring the flow rate and temperature differential of the water.

D. Capacity verification shall be performed after air and water systems have been balanced.

E. False load shall be applied if the upstream air or water does not meet the specified conditions at the time of test.
3.10 SOUND TEST PROCEDURES

A. Scope: Tests of sound levels shall be made at each selection point included in the agenda.

B. Timing: Sound level measurements shall be taken at times when the building is unoccupied, or when activity in surrounding areas and background noise level in areas tested are at a minimum and relatively free from sudden changes in noise levels.
1. Measurements shall be taken with all equipment turned off, except that being tested.
2. The required sound levels shall be measured at any point within a room not less than 6 feet from an air terminal or room unit, and not closer than 3 feet from any floor, wall, or ceiling surface.

C. Meters: Sound levels shall be measured with a sound meter complying with ANSI S1.4. The "A" scale shall be used to measure over all sound levels. To determine the specified octave band levels, the above sound level meter, set on "C" scale, shall be supplemented by an octave band analyzer complying with ANSI S1.11.

D. Equipment Components: The "Equipment Component" of room sound equals LPt-C. The "Equipment Component" of room sound (noise) levels shall be determined for each of eight octave bands as follows:
1. Measure room sound pressure level "LPb" with equipment to be tested shut off.
2. Measure room sound pressure level "LPt" with equipment to be tested turned on.
3. Calculate LPt-LPb; if this value is less than 1, applicable test must be rerun with lower background level (LPb) unless LPt is within sound pressure level specified for equipment.
4. Determine "c" from the table below.

<table>
<thead>
<tr>
<th>LPT-LPb (db)</th>
<th>c (db)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4 to 4-½</td>
<td>2</td>
</tr>
<tr>
<td>5 to 5-½</td>
<td>1 - ½</td>
</tr>
<tr>
<td>6 to 7-½</td>
<td>1</td>
</tr>
<tr>
<td>8 to 12</td>
<td>½</td>
</tr>
<tr>
<td>over 12</td>
<td>0</td>
</tr>
</tbody>
</table>

3.11 SOUND LEVEL DATA

A. Report: certified report shall record data on sound levels, taken at each selected location, as follows:
1. Source of sound and location.
2. Diagram or description of relationship of sound source to measuring instrument.
3. "A" scale readings equipment being tested turned off (ambient) equipment being tested turned on (operating conditions).
4. Readings at each specified octave band frequency equipment being tested turned off (ambient) equipment being tested turned on (operating conditions).
5. "Equipment Components" of sound (noise) levels with applicable calculations per "Sound Test Procedures".
6. Graph showing relationship between pressure levels specified and recorded readings

B. Retest: Subsequent to any correctional construction work, such as acoustic corrections, measurement shall be made to verify that associated air and water quantities, as previously measured, have not been disrupted.
1. Certified report shall record all sound data, and their locations, after final adjustments of air and water systems involves.
3.12 CERTIFIED REPORTS

A. Submittals: Six (6) copies of the reports described herein, covering air and water system performance, air motion (fpm), and sound pressure levels, shall be submitted prior to final tests and inspection.

B. Instrument Records: Types, serial numbers, and dates of calibration of all instruments shall be included.

C. Reports: Reports shall conspicuously identify items not conforming to contract requirements, or obvious malfunction and design deficiencies.

D. Certification: Certification shall include checking of adherence to agenda, of calculations, of procedures, and evaluation of final summaries.

3.13 FINAL COMMISSIONING TESTS, INSPECTIONS AND ACCEPTANCE

A. Scope: Test shall be made to demonstrate that capacities and performance of air and water systems comply with contract requirements.

1. At the time of final inspection, the Contractor shall recheck, random selection of data (water and air quantities, air motion, and sound levels) recorded in the certified report. In addition, all courtrooms, auditoriums, and conference rooms shall be rechecked.

2. Points and areas for recheck shall be selected by the commissioning team.

3. Measurement and test procedures shall be the same as approved for work forming basis of certified report.

4. Selections for recheck (specific plus random), in general, will not exceed 25 percent of the total number tabulated in the report, except that special air systems may require a complete recheck for safety reasons.

B. Retests: If random tests elicit a measured flow deviation of 10 percent or more from, or a sound level of 2 db or more greater than, that recorded in the certified report listings, as 10 percent or more of the rechecked selections, the report shall be automatically rejected. In the event the report is rejected, all systems shall be readjusted and tested, new data recorded, new certified reports submitted, and new inspection tests made, all at no additional cost. Retainage time shall be based on the date of the final acceptance of the certified report.

C. Marking of Settings: Following final acceptance of certified reports, the settings of all valves, splitters, dampers, and other adjustment devices shall be permanently marked by the Contractor so that adjustment can be restored if disturbed at any time. Devices shall not be marked until after final acceptance.

END OF SECTION
PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS
A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, and Section 230500 - Basic Materials and Methods, and other Sections in Division 23 specified herein.

1.2 SCOPE
A. All work to be furnished and installed under this Section shall include, but not necessarily be limited to, providing insulation for the following:
1. Ductwork
   a. All supply air ductwork, unless otherwise shown on drawings.
   b. All return air ductwork, unless otherwise shown on drawings.
   c. Acoustical duct lining, in vertical/horizontal supply and return ducts within twenty feet (20’) of air handling equipment and where otherwise shown on drawings.
   d. Outside air ductwork in return plenums, mechanical rooms and in freezing climates.
   e. Exhaust air ductwork in cold air plenums.
   f. Vapor/moisture ductwork.
   g. Insulation to protect fire rated exhaust systems.
2. Piping:
   a. Heating hot water supply and return piping.
   b. Chilled water supply and return piping.
   c. Condenser water supply and return piping.
   d. Steam and condensate return piping.
   e. Heat recovery piping.
   f. Process piping.
   g. Valves, pumps, air separators, strainers and fittings in insulated piping systems.
   h. Refrigerant hot gas and suction piping.
3. Hot and cold equipment.
   a. Generator exhaust systems.
4. Plenums and equipment rooms, as noted.
B. Types of mechanical insulation specified in this Section include the following:
1. Fiberglass pipe insulation.
2. Cellular glass pipe insulation.
3. Calcium silicate pipe insulation.
4. Flexible elastomeric closed cell insulation.
5. Fiberglass duct insulation.
6. Natural fiber duct liner.
7. Polymide Foam Acoustic duct liner.
8. Cellular glass duct insulation.
10. Calcium silicate duct insulation.
11. Fiberglass equipment insulation.
12. Calcium silicate equipment insulation.
13. Cellular glass equipment insulation.
14. Flexible unicellular equipment insulation.
15. Insulation jackets.
16. Insulation accessories.
1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Section 220501: Plumbing.
B. Section 230500: Basic Materials and Methods.
C. Section 232113: HVAC Piping, Valves and Specialties.

1.4 DEFINITIONS

A. Ambient: The air temperature to be maintained in a conditioned room. Typically between $70\,^\circ F$ and $78\,^\circ F$.
B. Insert: Spacer placed between the pipe support system and the piping to allow for the space required for insulation.
C. Insulation Group (IG): Definition of Insulation Materials and Operating Temperatures.
D. Insulation Shield: Buffer material placed between the pipe support system and the insulation to prevent the insulation material from crushing.
E. Jacket: Protective covering over the pipe insulation; may be factory applied such as “all service jacket” or field applied to provide additional protection; of such materials as canvas, PVC, aluminum or stainless steel.
F. Piping Insulation: Thermal insulation applied to prevent heat transmission to or from a piping system.
G. Vapor Barrier Jacket: Insulation jacket material that impedes the transmission of water vapor.
H. Freezing Climate: Where outdoor design temperature is less than $33\,^\circ F$, as stated in ASHRAE fundamentals under 99% column for winter design conditions.

1.5 QUALITY ASSURANCE

A. Codes and Standards: Provide products conforming to the requirements of the following:
   1. American Society for Testing and Materials (ASTM): Manufacture and test insulation in accordance with the ASTM Standards, including:
      b. C165 - Recommended Practice for Measuring Compressive Properties of Thermal Insulation.
      c. C167 - Test Methods for Thickness and Density of Blanket or Batt Thermal Insulations.
      g. C196 - Specification for Expanded or Exfoliated Vermiculite Thermal Insulating Cement.
      i. C303 - Test Method for Density of Preformed Block-Type Thermal Insulation.
      j. C305 - Test for Thermal Conductivity of Pipe Insulation.
      k. C356 - Test for Linear Shrinkage of Preformed High-Temperature Thermal Insulation.
      l. C411 - Test for Hot-Surface Performance of High Temperature Thermal Insulation.
NOTICE OF ALTERNATE BILLING CYCLE: The Contract will allow the Owner to require the submission of billings or estimates in billing cycles other than 30-day cycles. Billing or statements shall be submitted monthly ending on the last day of the month.

NOTICE OF EXTENDED CERTIFICATION PROVISION: The Contract will allow the Owner to certify billings and estimate within 20 days after the billings and estimates are received from the original contractor.

NOTICE OF EXTENDED PAYMENT PROVISION: The Contract will allow the Owner to make payment within 30 days after the date a billing or estimate is received.
NOTICE OF ALTERNATE BILLING CYCLE: The Contract will allow the Owner to require the submission of billings or estimates in billing cycles other than 30-day cycles. Billing or statements shall be submitted monthly ending on the last day of the month.

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5. Installation: See Part 3 below.

B. Rigid Fiberglass Board: Knauf ECOSE insulation board, Johns Manville Linacoustic R-300, Type II duct board:
   1. Application: Lining insulation for HVAC plenums and ductwork.
   2. 'K' Value: ASTM C1071, 0.23 Btu•in./(hr•ft²•ºF) at 75°F.
   3. Density: 3.0 lb/cu ft.
   4. Vapor Barrier Jacket: FSK (Foil-Scrim-Kraft) aluminum foil faced reinforced with fiberglass yarn and laminated to fire-resistant kraft paper.
   5. Installation: See Part 3 below.

C. Fiberglass Acoustic Duct Liner: Johns Manville Duct Liner PM with Anti-Microbial Treatment:
   1. Application: Duct lining for acoustic or thermal purposes.
   2. 'K' Value: ASTM 1071, 0.23 Btu•in./(hr•ft²•ºF) at 75°F.
   3. Noise Reduction Coefficient: 0.65 or higher based on "Type A mounting."
   4. Maximum Velocity on Mat or Coated Air Side: 5,000 ft/min.
   5. Adhesive: UL listed waterproof type compliant with ASTM C916.
   6. Fasteners: Duct liner galvanized steel pins, welded or mechanically fastened.

D. Natural Fiber (Cotton) Acoustic Duct Liner: Reflectix #HVNF, Flexible Blanket with Anti-Microbial Treatment:
   1. 'K' Value: ASTM C518, 0.25 Btu•in./(hr•ft²•ºF) at 75°F.
   2. Noise Reduction Coefficient: 0.75 or higher based on "Type A mounting."
   3. Maximum Velocity on Mat or Coated Air Side: 5,000 ft/min.
   5. Fasteners: Duct liner galvanized steel pins, welded or mechanically fastened.

E. Elastomeric Foam Duct Liner: Armacell Industries model AP Armaflex and AP Coilflex or equal, Flexible insulation:
   1. Greenguard certified, low VOC.
   2. Elastomeric foam insulation with acrylic polymer airstream coating.
   3. 'K' Value: ASTM C518, 0.25 Btu•in./(hr•ft²•ºF) at 75°F.
   4. R' value per inch thickness: ASTM C518, 4.0 (hr•ft²•ºF) / Btu at 75°F.
   6. Water vapor sorbtion: ASTM C 1104, less than 2% by weight.
   8. Noise Reduction Coefficient: ASTM C 423, 0.49 or higher based on "Type A mounting."
   9. Maximum Velocity on Mat or Coated Air Side: 5,000 ft/min.
   10. Maximum operating temperature: 250 degrees F.
   11. Flame spread index: ASTM E84, less than 25
   12. Smoke developed index: ASTM E84, less than 50
   14. Fasteners: Duct liner galvanized steel pins, welded or mechanically fastened.

F. Polymide Foam Acoustic Duct Liner: Evonic Industries model SOLCOUSTIC, or equal, Flexible Blanket:
   1. Greenguard certified, low VOC.
   2. Polymide foam insulation with acrylic polymer airstream coating.
   3. 'K' Value: ASTM C518, 0.30 Btu•in./(hr•ft²•ºF) at 75°F.
   4. R' value per inch thickness: ASTM C518, 3.3 (hr•ft²•ºF) / Btu at 75°F.
   5. Density: ASTM D 3574, 0.80 lb/ft3.
   6. Water vapor sorbtion: ASTM C 1104, less than 2% by weight.
   8. Noise Reduction Coefficient: ASTM C 423, 0.70 or higher based on "Type A mounting."
   9. Maximum Velocity on Mat or Coated Air Side: 5,000 ft/min.
10. Maximum operating temperature: 250 degrees F.
11. Flame spread index: ASTM E84, less than 25
12. Smoke developed index: ASTM E84, less than 50
14. Fasteners: Duct liner galvanized steel pins, welded or mechanically fastened.

G. Round Duct Liner: Johns Manville with Anti-Microbial Treatment.
   1. Application: Round duct lining for acoustic or thermal purposes.
   2. ‘K’ Value: ASTM C518, 0.23 Btu in./(hr*ft²*ºF) at 75°F.
   3. Noise Reduction Coefficient: 0.70 as per ASTM C427. (Type A mounting.)
   4. Maximum Velocity: 4,000 ft/min.

H. Hydrous Calcium Silicate: Schuller Thermo-12/Gold ASTM C533; Rigid Molded Block Insulation; Asbestos-Free Coded Throughout Material Thickness and Maintained Throughout Temperature Range:
   1. ‘K’ Value: 0.40 Btu in./(hr*ft²*ºF) at 300°F.
   2. Maximum Service Temperature: 1,200°F.
   3. Compressive Strength (block): Minimum of 200 psi to produce 5% compression at 1½” thickness.
   4. Tie Bands: Secure blocks in places with staggered joints using ¾” or ½” stainless steel bands on 12” centers.

I. Field Applied Jackets (For Exterior Applications):
   1. Longitudinal seams shall not be located on top of ducts when exposed to outdoor environment.
   2. Stainless Steel Jacket: Type 304 stainless steel, 0.010” minimum (smooth/corrugated) finish.
   3. Aluminum Jacket: 0.016” aluminum with factory applied moisture barrier positioned such that the longitudinal overlap provides a watershed.
   4. Circumferential joints shall be wide enough to provide weather-proofing jacket.
   5. Secure jacket with ¾” or ½” stainless steel bands on 12” centers.

J. Field Applied Jackets (For Interior Applications):
   1. All longitudinal seams shall be located on bottom of ductwork

2.3 PIPE INSULATIONS

A. Glass Fiber: Molded fibrous glass pipe insulation shall comply with the requirements of ASTM C547 and meet ASTM C585 for sizes required in the particular system. For all fluid distribution temperatures below 45°F the system shall be of a wicking type.
   1. Non-Wicking:
      a. Manufacturers:
         1) Johns Manville Micro-Lok plain with PVC cover Meeting ASTM C547; or FSK faced Micro-Flex (pipe sizes larger than 18”)
         2) Knauf
         3) einsulation
      b. Applications: Insulation of piping up to 18” in diameter and 3” thick insulation.
      c. ‘K’ Value: 0.23 at 75°F.
      d. Maximum Service Temperature: 850°F.
HVAC INSULATION

2. Wicking: Owens Corning VaporWick Meeting ASTM C547; Rigid Molded Noncombustible:
   a. 'K' Value: 0.23 at 75°F.
   b. Maximum Service Temperature: 850°F.
   c. Jacket: Polymer facing with factory-applied adhesive closure to provide positive mechanical and vapor sealing of longitudinal seams.

B. Rigid polyisocyanurate foam: HiTHERM HT-300.
   1. 'K' Value: 0.165 at 75°F (24°C)
   2. Maximum Continuous Service Temperature: 300°F.
   3. Vapor Retarder Jacket: Saran 540/SSL or Mylar laminate.

C. Hydrous Calcium Silicate: Johns Manville Thermo-12/Gold, ASTM C533; Rigid Molded Pipe:
   1. 'K' Value: 0.40 at 300°F
   2. Maximum Service Temperature: 1,200°F.
   3. Compressive Strength (block): Minimum of 200 psi to produce 5% compression at 1½" thickness.
   4. Tie Wire: 16 gauge stainless steel with twisted ends on maximum 12" centers.

D. Cellular Glass: Pittsburgh-Corning Foamglas Meeting ASTM C522: Cellular Glass Thermal Insulation:
   1. 'K' Value: 0.35 at 75°F.
   2. Density: 8.0 lbs./cu. ft.
   3. Maximum Service Temperature: 900°F.

   1. 'K' Value: 0.27 at 75°F.
   2. Density: 3.0 to 6.0 lbs./cu.ft.
   3. Maximum Service Temperature: 260°F.
   4. Seal all seams and joints with contact adhesive.

F. Field Applied Jackets (For Interior Applications):
   1. All longitudinal seams shall be located on bottom of pipes.
   4. Aluminum Jacket: 0.016" thick sheet, smooth finish, with longitudinal slip joints and 2" laps, die shaped fitting covers with factory attached protective liner.
   5. Secure aluminum jackets with 3/8" or ½" stainless steel bands on 12" centers.

G. Field Applied Jackets (For Exterior Applications):
   1. All longitudinal seams, on horizontal pipe runs, shall be installed on the bottom of pipes.
   2. Aluminum Jacket: 0.016" (minimum) thick sheet, [smooth/embossed] finish, with longitudinal slip joints and 2" laps, die shaped fitting covers with factory attached protective liner.
   3. Stainless Steel Jacket: Type 304 stainless steel, 0.010" minimum (smooth/corrugated) finish.
   4. Secure stainless steel or aluminum jackets with ¾" or ½" stainless steel bands on 12" centers.
HVAC INSULATION

5. Manufacturers: Pabco, Childers, RPR, or approved equal.

H. Removable Covers:
1. Provide removable covers on pumps, valves, air separators, vents, fittings, flanges, strainers, traps, etc., where periodic maintenance or removal of insulation may be required.
2. Use of premolded fittings with PVC covers is acceptable.
3. Use of lace-on type insulating blankets is acceptable.

2.4 EQUIPMENT INSULATIONS

A. Flexible Fiberglass Blanket: Johns Manville Microlite Type 75 Flexible Blanket:
1. 'K' Value: ASTM C518, 0.27 Btu•in./(hr•ft²•ºF) at 75°F installed full thickness.
2. Maximum Service Temperature: 250°F.
3. Density: 0.75 lb/cu ft.
4. Vapor Barrier Jacket: FSK (Foil-Scrim-Kraft) aluminum foil faced reinforced with fiberglass yarn and laminated to fire-resistant kraft, secured with UL listed pressure sensitive tape and/or outward clinched expanded staples and vapor barrier mastic as needed.

B. Rigid Fiberglass Board: Johns Manville Mat-Faced Micro-Aire Rigid Board
1. 'K' Value: ASTM C518, 0.23 Btu•in./(hr•ft²•ºF) at 75°F.
2. Maximum Service Temperature: 250°F.
3. Density: 3.0 lb/cu ft.
4. Vapor Barrier Jacket: FSK (Foil-Scrim-Kraft) aluminum foil faced reinforced with fiberglass yarn and laminated to fire-resistant kraft, secured with UL listed pressure sensitive tape and/or outward clinched expanded staples and vapor barrier mastic as needed.
5. Facing: 1" galvanized hexagonal wire mesh stitched on one face of insulation. (Optional.)

C. Rigid Fiberglass Board for High Temperature: Johns Manville 1000 Spin-Glas Meeting ASTM C612; Rigid, Noncombustible:
1. 'K' Value: ASTM C518, 0.23 Btu•in./(hr•ft²•ºF) at 75°F.
2. Maximum Service Temperature: 850°F.
3. Density: 3.0 lb/cu ft.
4. Facing: 1" galvanized hexagonal wire mesh stitched on one face of insulation. (Optional.)

D. Cellular Glass: Pittsburgh-Corning Foamglas Meeting ASTM C552; Cellular Glass Thermal Insulation:
1. 'K' Value: 0.35 at 75°F.
2. Density: 8.0 lb/cu. ft.
3. Maximum Service Temperature: 900°F.

E. Hydrous Calcium Silicate: Johns Manville Thermo-12/Gold Meeting ASTM C533; Rigid Molded Block; Asbestos-Free Coded Throughout Material Thickness and Maintained Throughout Temperature Range:
1. 'K' Value: 0.40 at 300°F.
2. Maximum Service Temperature: 1,200°F.
3. Compressive Strength (block): Minimum of 200 psi to produce 5% compression, based on 1½" thickness.
4. Securement: Insulation shall be securely banded in place, tightly butted, joints staggered and secured with 16 gauge galvanized or stainless steel wire or ½" x .015" galvanized steel bands on 12” maximum centers for large areas.
PART 3 - EXECUTION

3.1 EXAMINATION AND PREPARATION

A. Verify that piping and ductwork has been tested for leakage in accordance with specifications before applying insulation materials. All piping and ductwork shall be inspected by Owner’s Representative prior to installation of insulation. Any insulation applied prior to inspection shall be removed and new insulation applied at no additional cost to Owner. Notify Owner’s Representative five (5) working days prior to insulation installation. Verify that all surfaces are clean, dry and free of foreign material.

3.2 INSTALLATION

A. General:
1. Install materials in accordance with manufacturer's recommendations, building codes and industry standards.
2. Remove and replace any insulation that has become wet or damaged during the construction process.
3. Continue insulation and vapor barrier at penetrations and duct supports, except where prohibited by code. Instances where this is required include:
   a. Ductwork support angle or struts. To prevent crushing of low density insulation, provide separator or high density insulation at point of support. Vapor barrier to continue unbroken at point of support.

B. Ductwork – Insulation on the Duct Exterior:
1. Provide insulated ductwork conveying air below ambient temperature (below room temperature) with vapor retardant jacket. Seal all vapor retardant jacket seams and penetrations with UL listed tapes or vapor retardant adhesive.
2. Provide insulated ductwork conveying air above ambient temperature (above room temperature) with or without vapor retardant jacket. Where service access is required, bevel and seal ends of insulation.
3. All exposed exterior metallic ductwork exposed or covered with cladding is to be built with a crown to shed moisture.
4. Continue insulation through walls, sleeves, hangers, and other duct penetrations except where prohibited by code.
5. The insulation shall be firmly wrapped around the ducts with all joints lapped a minimum of 2". The vapor barrier shall be sealed with FSK or metallic pressure sensitive tape. Installed thickness shall not exceed 25% compression. Secure insulation with 16 gage soft annealed black or galvanized wire spaced not more than 12" on centers for straight runs of duct and 6" on centers for elbows and fittings.
6. The underside of duct work 24" or greater in width shall be secured with mechanical fasteners and speed clips spaced approximately 18" on center. The protruding ends of the fasteners shall be cut off flush after the speed clips are installed, and then, when required, sealed with the same tape as specified above.
7. For ductwork exposed in mechanical equipment rooms below 7' or in finished spaces, finish with Johns Manville Zeston 2000 PVC jacket or aluminum or stainless steel jacket.
8. For interior vapor/moisture duct applications, install fiberglass insulation unless specifically indicated otherwise on drawings. Install to meet manufacturer’s requirements and as required by local code authorities.
9. For exterior applications, provide insulation with a weather protection jacket.
10. For exterior vapor duct applications, install fiberglass insulation with weatherproof jacket.

C. Grease Ducts:
1. For grease ducts inside the conditioned building envelope but not in rated enclosures, install two-hour fire rated blanket wrap or duct board system to meet manufacturer’s requirements and as required by NFPA and local code authorities.
2. For grease duct outside the conditioned building envelope, install calcium silicate insulation with weatherproofing jacket. Install to meet manufacturer’s requirements and as required by local code authorities.

D. Duct Liner:
1. Adhere insulation to sheet metal with a UL listed adhesive. Adhesive shall be applied to the sheet metal with a minimum coverage of 90%.
2. Secure insulation with mechanical liner fasteners as indicated by SMACNA or manufacturer. Pin length should be as recommended by the liner manufacturer.
3. All exposed edges of the liner must be factory or field coated. Unless factory coated, all transverse edges and longitudinal joints of the duct liner shall be coated. For systems operating at 4,000 fpm or higher, a metal nosing must be installed in all liner leading edges.
4. Repair liner surface penetrations with UL listed adhesive.
5. Duct dimensions indicated on plans are net inside dimensions required for airflow. Increase duct size to allow for insulation thickness.

E. Piping Insulation:
1. Locate insulation and cover seams in least visible locations unless otherwise specified.
2. Neatly finish insulation at supports, protrusions, and interruptions.
3. Provide insulated dual temperature pipes or cold pipes conveying fluids below ambient temperature with vapor retardant jackets with self sealing laps. Insulate complete system.
4. For insulated pipes conveying fluids above ambient temperature, secure jackets with self sealing lap or outward clinched, expanded staples. Seal ends of insulation at equipment, flanges, and unions.
5. Provide insert between support shield and piping on piping 1½” diameter or larger. Fabricate of Johns Manville Thermo-12, or other heavy density insulating material suitable for temperature. Insulation inserts shall not be less than the following lengths:
   a. 1½” to 2½” pipe size 10” long
   b. 3” to 6” pipe size 12” long
   c. 8” to 10” pipe size 16” long
   d. 12” and over 22” long
6. Use of metal saddles is acceptable as specified in Section 230500. Fill interior voids with segments of insulation matching adjoining pipe insulation.
7. Use of pipe hangers designed as an insulation coupling is acceptable in lieu of saddles and other devices. Klo-Shure coupling or equal.
8. For pipe exposed in mechanical equipment rooms or in finished spaces below 7 feet above finished floor, finish with Johns Manville Zeston 2000 PVC jacket and fitting covers, or aluminum or stainless steel jacket.
9. Where pumps, valves, strainers, etc., with insulation require periodic opening for maintenance, repair, or cleaning, install insulation in such a manner that it can be easily removed and replaced without damage. Use of premolded covers or lace-on type insulation blankets is required.
10. For exterior applications:
   a. Provide weather protection jacket. Insulated pipe lengths, pumps, fittings, joints, and valves shall be covered with aluminum jacket or stainless steel jacket. Jacket seams shall be located on bottom side of horizontal piping. All lateral joints shall be caulked with a minimum 20-year silicone sealant (clear). All longitudinal joints, except those at the bottom of a horizontal pipe run, shall be caulked with a minimum 20-year silicone sealant (clear).
   b. Apply weather-resistant protective finish such as WB Armaflex to flexible elastomeric insulation. Insulation seams shall be located on the bottom side of horizontal piping. All lateral and longitudinal joints to be sealed with low V.O.C., UV inhibitive adhesive, such as Armaflex 520 BLV adhesive.

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11. For underground installations, install per manufacturer’s written instructions and recommendations.
12. When maintenance or service access for equipment will result in foot traffic over floor mounted insulated piping the contractor is to fabricate a permanent removable walkway to prevent damage to the piping and insulation.

F. Equipment Insulation:
1. See Piping Insulation above for additional requirements.
2. Apply insulation as close as possible to equipment by grooving, scoring, and beveling insulation, if necessary. Secure insulation to equipment with studs, pins, clips, adhesive, wires, or bands, per manufacturer’s recommendations.
3. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retardant cement.
4. Provide insulated dual temperature equipment or cold equipment containing fluids below ambient temperature with vapor retardant jackets.
5. For insulated equipment containing fluids above ambient temperature, provide jacket with or without vapor barrier.
6. Cover insulation with metal mesh and finish with heavy coat of insulating cement, mastic, or aluminum jacket as indicated in the drawings.
7. For equipment in mechanical equipment rooms or in finished spaces, finish with Johns Manville Zeston 2000 jacketing and fitting covers or aluminum or stainless steel jacketing.
8. Do not insulate over nameplate or ASME stamps. Bevel and seal insulation around such.
9. When equipment with insulation requires periodic opening for maintenance, repair, or cleaning, install insulation in such a manner that it can be easily removed and replaced without damage. Use of lace-on type insulation blankets is acceptable.

3.3 DUCTWORK INSULATION SCHEDULE

A. All insulation thicknesses shall meet or exceed state energy code and mechanical code requirements as noted below. Minimum thermal resistance in range of 4.2 to 4.6 per inch of thickness. Insulation thicknesses are based on fiberglass insulation and may be adjusted for equivalent insulation values for materials with superior “K” factors.

B. All air distribution system ducts and plenums, but not limited to, building cavities, mechanical closets, air handler boxes, and support platforms uses as ducts or plenums, shall be installed, sealed, and insulated to meet the requirements of the code. Portions of supply-air and return-air ducts conveying heated or cooled air located in one or more of the following spaces shall be insulated to a minimum level of R-8.
1. In a space between the roof and an insulated ceiling.
2. In a space directly under a roof with fixed vents or opening to the outside or unconditioned spaces
3. In an unconditioned crawlspace.
4. In other unconditioned spaces.

C. Flexible Fiberglass

<table>
<thead>
<tr>
<th></th>
<th>THICKNESS (inches)</th>
<th>FINISH</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply ducts within building envelope</td>
<td>1-1/2</td>
<td>FSK</td>
<td></td>
</tr>
<tr>
<td>Supply or return duct installed as exposed ductwork in the occupied space.</td>
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<td></td>
<td>Except where noted on drawings for acoustical reasons</td>
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<tr>
<td>Return ducts within building envelope</td>
<td>1-1/2</td>
<td>FSK</td>
<td></td>
</tr>
<tr>
<td>Exterior/Outside supply and exhaust ducts</td>
<td>2-1/2</td>
<td>FSK</td>
<td>* or a thickness resulting in</td>
</tr>
</tbody>
</table>

SERA Architects, Inc.
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**HVAC INSULATION**

<table>
<thead>
<tr>
<th>THICKNESS (inches)</th>
<th>FINISH</th>
<th>REMARKS</th>
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</thead>
<tbody>
<tr>
<td>return ductwork sandwiched in double wall sheet metal</td>
<td></td>
<td>compressed R value=8</td>
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<tr>
<td>Supply and return ductwork located as described in 3.3.B above.</td>
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</tr>
<tr>
<td>Exhaust ducts within 10 ft. of exterior openings</td>
<td>2</td>
<td>FSK</td>
</tr>
<tr>
<td>Exhaust ducts and ventilation equipment casing exposed to outdoor air</td>
<td>2</td>
<td>FSK</td>
</tr>
</tbody>
</table>

D. Thicknesses in the above table shall have insulation values as follows: 1 1/2” = R-6, 2” = R-8.0, 3” = R-12. Greater thicknesses are permitted to achieve identical values if space constraints allow.

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**E. Rigid Fiberglass**

<table>
<thead>
<tr>
<th>THICKNESS (inches)</th>
<th>FINISH</th>
<th>REMARKS</th>
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</thead>
<tbody>
<tr>
<td>Outside air intake ducts</td>
<td>1-1/2</td>
<td>FSK</td>
</tr>
<tr>
<td>Interior Plenums</td>
<td>1-1/2</td>
<td>FSK</td>
</tr>
<tr>
<td>Exterior Plenums</td>
<td>2</td>
<td>FSK</td>
</tr>
<tr>
<td>Supply, return and relief ducts in mechanical rooms and parking garages</td>
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<td>FSK</td>
</tr>
<tr>
<td>Vapor/moisture ducts installed exterior to the building envelope.</td>
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<td>FSK</td>
</tr>
<tr>
<td>Exterior ductwork sandwiched in double wall sheet metal</td>
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<td>FSK</td>
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</table>

Provide jacketing on exterior ducts

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**F. Duct Liner:**

<table>
<thead>
<tr>
<th>THICKNESS (inches)</th>
<th>FINISH</th>
<th>REMARKS</th>
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<tr>
<td>Where indicated</td>
<td>1” unless otherwise noted on plans</td>
<td>Linacoustic</td>
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<tr>
<td>Exterior ductwork in sandwiched in double wall sheet metal</td>
<td>2</td>
<td>Linacoustic</td>
</tr>
<tr>
<td>Within 20’ of Air Handling Unit in supply and return ducts</td>
<td>1</td>
<td>Refectix Natural Fiber</td>
</tr>
<tr>
<td>Within 20’ of Air Handling Unit in supply and return ducts</td>
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<td>Solcoustic</td>
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**G. Duct Liner (round):**

<table>
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<th>THICKNESS (inches)</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Where indicated</td>
<td>1</td>
<td>Spiracoustic</td>
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</tbody>
</table>
3.4 PIPING INSULATION SCHEDULE

A. All insulation thicknesses shall meet or exceed state energy code requirements as noted below. Increase thickness 1/2” if exposed to exterior ambient air. Minimum thermal resistance shall comply with building code minimum ranges and may exceed those minimum levels. Insulation thicknesses may be adjusted for equivalent insulation values for materials with superior “K” factors.

B. Oregon

### Insulation Based on Oregon OEESC Energy Code for Minimum Pipe Insulation Thicknesses or Greater

<table>
<thead>
<tr>
<th>FLUID TEMPERATURE RANGE (°F)</th>
<th>CONDUCTIVITY RANGE (in Btu-inch per hour per square foot °F)</th>
<th>INSULATION MEAN RATING TEMPERATURE (°F)</th>
<th>NOMINAL PIPE DIAMETER (in inches)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Runout s up to 1 2/3 less 1.25 2-4 5-6 8 and larger</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>INSULATION THICKNESS REQUIRED (in inches)</td>
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<tr>
<td>Space heating systems (steam, steam condensate and hot water)</td>
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<tr>
<td>Above 350</td>
<td>0.32-0.34</td>
<td>250</td>
<td>1.5 1.5 1.5 3.0 3.0 3.0</td>
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<td>251-350</td>
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<td>200</td>
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<td>150</td>
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<td>141-200</td>
<td>0.25-0.29</td>
<td>125</td>
<td>1.5 1.5 1.5 2.0 2.0 2.0</td>
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<td>105-140</td>
<td>0.24-0.28</td>
<td>100</td>
<td>1.0 1.5 1.5 2.0 2.0 2.0</td>
</tr>
<tr>
<td>Service water-heating systems (recirculating sections, all piping in electric trace tape systems, and the first 8 feet of piping from the storage tank for nonrecirculating systems)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Above 105</td>
<td>0.24-0.28</td>
<td>100</td>
<td>1.0 1.5 1.5 2.0 2.0 2.0</td>
</tr>
<tr>
<td>Space cooling systems (chilled water, refrigerant and brine)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40-55</td>
<td>0.23-0.27</td>
<td>75</td>
<td>1.0 1.5 1.5 1.5 1.5 1.5</td>
</tr>
<tr>
<td>Below 40</td>
<td>0.23-0.27</td>
<td>75</td>
<td>1.0 1.5 1.5 1.5 1.5 1.5</td>
</tr>
</tbody>
</table>

C. Elastometric Foam (Closed Cell):

<table>
<thead>
<tr>
<th>PIPE SIZE (inches)</th>
<th>THICKNESS (inches)</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condensate drain pipes</td>
<td>All Sizes</td>
<td>1/2</td>
</tr>
<tr>
<td>Refrigerant suction and hot-gas piping</td>
<td>All Sizes</td>
<td>3/4</td>
</tr>
<tr>
<td>Refrigerant liquid piping</td>
<td>All Sizes</td>
<td>3/4</td>
</tr>
</tbody>
</table>

D. Cellular Glass:

<table>
<thead>
<tr>
<th>PIPE SIZE (inches)</th>
<th>THICKNESS (inches)</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chilled water supply and return systems and fittings. (40°F and above)</td>
<td>Up to 2 2 ½ and over</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

3.5 EQUIPMENT INSULATION SCHEDULE

A. Flexible Fiberglass Blanket

<table>
<thead>
<tr>
<th>THICKNESS (inches)</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat exchangers/converters</td>
<td>1 ½</td>
</tr>
</tbody>
</table>
### HVAC INSULATION

<table>
<thead>
<tr>
<th>Description</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expansion/Compression tanks</td>
<td>1 ½</td>
</tr>
<tr>
<td>Air separators</td>
<td>1 ½</td>
</tr>
<tr>
<td>Chilled water pump bodies</td>
<td>1 ½</td>
</tr>
<tr>
<td>Condensate pump receivers</td>
<td>1</td>
</tr>
</tbody>
</table>

**B. Rigid Fiberglass Board:**

<table>
<thead>
<tr>
<th>Thickness (inches)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating hot water pumps</td>
<td>2</td>
</tr>
</tbody>
</table>

**C. Flexible Elastomeric Foam (Closed Cell):**

<table>
<thead>
<tr>
<th>Thickness (inches)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold water storage tank</td>
<td>1 ½</td>
</tr>
<tr>
<td>Chilled water pump bodies</td>
<td>1 ½</td>
</tr>
</tbody>
</table>

**D. Calcium Silicate:**

<table>
<thead>
<tr>
<th>Thickness (inches)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine exhaust mufflers and piping</td>
<td>4</td>
</tr>
<tr>
<td>Steam Condensate Receivers</td>
<td>2</td>
</tr>
</tbody>
</table>

END OF SECTION
PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS
A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 230500 - Basic Materials and Methods, and other Sections in Division 23 specified herein.

1.2 SCOPE
A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include but not necessarily be limited to the following:
1. Submit shop drawings of the entire control system components fully coordinated with major equipment suppliers' requirements. Provide proposed programming logic sequences of control functions on each system.
2. Installation of control components other than valves, dampers and sensing wells as required for a complete and workable system.
3. This Contractor shall furnish, install and coordinate the interlock and control wiring as specified and/or required for a complete and workable control system.
4. Controls dampers are specified and furnished in Section 233113 of these specifications. Provide damper actuators, wiring and conduit as required to operate all dampers as shown.
5. Upon completion of the installation, data entry and programming, provide complete validation and adjustment of specified control system through period of testing and Owner’s acceptance. The control contractor shall perform a point-to-point check out of all newly installed points to verify point existence, proper end to end connection and correct SI units with the Owners Representative.
6. The entire program and sequence of operation with the final points list shall be verified by the Control Contractor, the Owners Representative, and signed by both parties. A copy of the final program, sequence of operation, and points list shall be submitted to the Engineer for approval and inclusion with the operation and maintenance manuals.
7. Owner training on operation of the control system.
8. One-year warranty on workmanship and materials.
9. Interlocking of electrical systems and motors as shown on Drawings, except where specifically shown on electrical drawings.

1.3 RELATED WORK SPECIFIED ELSEWHERE
A. Sources of 120-volt electrical power as indicated on the Electrical drawings and specifications for control system components furnished by this section. The controls contractor shall be responsible for all additional electrical distribution from these connection points to the control panels and other controls devices.
B. Provide certificates of calibration for all sensors required for DDC control and DDC monitoring including temperature and pressure.

1.4 QUALITY ASSURANCE
A. Manufacturers are subject to compliance with requirements contained herein and on the Drawings. Control systems shall be provided by one of the following manufacturers, no other manufacturers will be considered for this work:
1. Siemens (Apogee)
B. Electrical Standards: Provide electrical products that have been tested, listed, and labeled by Underwriter Laboratories (UL) and comply with NEMA standards.
1.5 SUBMITTALS

A. Prior to construction submit for approval the following materials:
   1. Wiring diagrams.
   2. Sequence of operation, control logic and control points list.
   3. Controls service contract.
   4. Operations and maintenance manuals.
   5. Temperature sensors, with bypass buttons where shown.
   6. Pressure sensors.
   7. Duct smoke detectors.
   8. Actuators.
   9. Control valves (Note that service valves are specified in Section 230500 of these documents)
   10. Dampers (Note that dampers are specified in Section 233113 of these documents)
   11. Miscellaneous Devices.
   13. Control panels and controllers.
   14. Other components such as relays, solenoid valves, restrictors, etc., complete material submittal.
   15. Parts list for each system control.

1.6 LAYOUT DRAWINGS

A. Prior to the start of installation, submit to the Owner’s Representative for approval layout drawings coordinated with all building systems, and lists of materials, fixtures, and equipment to be incorporated in the work. The layout drawings shall consist of plans and diagrams to show clearly the locations and size of major items of equipment and controls. The general arrangement of the systems to be installed, coordination with other work, and all requirements for installation shall be met.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the site in containers with manufacturer’s stamp or label affixed.
B. Store and protect products against dirt, water, chemical, and mechanical damage. Do not install damaged components; remove from project site.

PART 2 - PRODUCTS

2.1 GENERAL

A. All components used shall be serviceable, repairable, and replaceable by qualified temperature control technicians using non-proprietary parts, tools, and instruments.

2.2 IDENTIFICATION

A. All control devices shall have identification means attached to the front or most visible surface. Room thermostat having no special purpose other than to control local temperature shall not be identified.

B. Small Devices: Milled laminate plates secured with epoxy cement.

2.3 FIELD DEVICES

A. Provide instrumentation as required for monitoring, control or optimization functions. All devices and equipment shall be approved for installation in the City of Portland.
# INSTRUMENTATION AND CONTROL

**B. Room Temperature Sensors**

1. **Blank face standard room sensor except where plans or specifications call for override buttons, setpoint adjustment, or displays.**

<table>
<thead>
<tr>
<th>Temperature monitoring range</th>
<th>+20/120°F (-13° to 49°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output signal</td>
<td>Changing resistance</td>
</tr>
<tr>
<td>Accuracy at Calibration point</td>
<td>±0.5°F (+/- 0.3°C)</td>
</tr>
<tr>
<td>Set Point and Display Range</td>
<td>55° to 95° F (13° to 35°C)</td>
</tr>
</tbody>
</table>

2. **Liquid immersion temperature:**

<table>
<thead>
<tr>
<th>Temperature monitoring range</th>
<th>+30/250°F (-1°/121°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output signal</td>
<td>Changing resistance</td>
</tr>
<tr>
<td>Accuracy at Calibration point</td>
<td>±0.5°F (+/-0.3°C)</td>
</tr>
</tbody>
</table>

3. **Duct (single point) temperature:**

<table>
<thead>
<tr>
<th>Temperature monitoring range</th>
<th>+20/120°F (-7°/49°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output signal</td>
<td>Changing resistance</td>
</tr>
<tr>
<td>Accuracy at Calibration point</td>
<td>±0.5°F (+/-0.3°C)</td>
</tr>
</tbody>
</table>

4. **Duct Average temperature:**

<table>
<thead>
<tr>
<th>Temperature monitoring range</th>
<th>+20° +120°F (-7°/+49°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output signal</td>
<td>4 – 20 mA DC</td>
</tr>
<tr>
<td>Accuracy at Calibration point</td>
<td>±0.5°F (+0.3°C)</td>
</tr>
<tr>
<td>Sensor Probe Length</td>
<td>25’ L (7.3m)</td>
</tr>
</tbody>
</table>

5. **Outside air temperature:**

<table>
<thead>
<tr>
<th>Temperature monitoring range</th>
<th>-58° +122°F (-50°C to +50°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output signal</td>
<td>4 – 20 mA DC</td>
</tr>
<tr>
<td>Accuracy at Calibration point</td>
<td>±0.5°F (+/-0.3°C)</td>
</tr>
</tbody>
</table>

6. **Liquid Differential Pressure Transmitter**

<table>
<thead>
<tr>
<th>Ranges</th>
<th>0-5/30 inches H2O</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0-25/150 inches H2O</td>
</tr>
<tr>
<td></td>
<td>0-127/750 inches H2O</td>
</tr>
<tr>
<td>Output</td>
<td>4 – 20 mA DC</td>
</tr>
<tr>
<td>Calibration Adjustments</td>
<td>Zero and span</td>
</tr>
<tr>
<td>Accuracy</td>
<td>±0.2% of span</td>
</tr>
<tr>
<td>Linearity</td>
<td>±0.1% of span</td>
</tr>
<tr>
<td>Hysteresis</td>
<td>±0.05% of span</td>
</tr>
</tbody>
</table>

7. **Differential pressure:**

a. **Unit for fluid flow proof shall be Penn P74.**

<table>
<thead>
<tr>
<th>Range</th>
<th>8 to 70 psi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Differential</td>
<td>3 psi</td>
</tr>
<tr>
<td>Maximum differential pressure</td>
<td>200 psi</td>
</tr>
<tr>
<td>Maximum pressure</td>
<td>325 psi</td>
</tr>
</tbody>
</table>

b. **Unit for air flow shall be Siemens Building Technologies SW141.**

<table>
<thead>
<tr>
<th>Set point ranges:</th>
<th>0.5” WG to 1.0” WG (124.4 to 248.8 Pa)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.0” WG to 12.0” WG (248.8 to 497.6 Pa)</td>
</tr>
</tbody>
</table>
### INSTRUMENTATION AND CONTROL

8. **Static pressure sensor:**

| Range | 0 to .5" WG (0 to 124.4 Pa)  
|       | 0 to 1" WG (0 to 248.8 Pa)  
|       | 0 to 2" WG (0 to 497.7 Pa)  
|       | 0 to 5" WG (0 to 1.2 kPa)   
|       | 0 to 10" WG (0 to 2.5 kPa)  |
| Output signal | 4 – 20 mA VDC |
| Combined static error | 0.5% full range |
| Operating Temperature | -40° to 175°F (-40°C to 70.5°C) |

9. **Air Pressure Sensor:**

| Range | 0 to 0.1 in. water (0 to 24.9 Pa)  
|       | 0 to 0.25 in. water (0 to 63.2 Pa)  
|       | 0 to 0.5 in. water (0 to 124.5 Pa)  
|       | 0 to 1.0 in. water (0 to 249 Pa)   
|       | 0 to 2.0 in. water (90 to 498 Pa)  
|       | 0 to 5.0 in. water (0 to 1.25 kPa) 
|       | 0 to 10.0 in. water (0 to 2.49 kPa)|
| Output signal | 4 – 20 mA |
| Accuracy | +1.0% of full scale |

10. **Humidity Sensors:**

| Range | 0 to 100% RH |
| Sensing Element | Bulk Polymer |
| Output Signal | 4 – 20 mA DC |
| Accuracy | At 77°F (25°C) ± 2% RH |

11. **Insertion Flow Meters (Equal to Onicon Series F-1200)**

| Sensing Method | Impedance Sensing |
| Accuracy | + 2% of Actual Reading |
| Maximum Operating Pressure | 400 PSI |
| Output Signal | 4 – 20 mA |
| Bi-directional | Where required |

12. **Pressure to Current Transducer**

| Range | 3 to 15 psig (21 to 103 kPa) or 3 to 30 psig (21 to 207 kPa) |
| Output signal | 4 – 20 mA |
| Accuracy | + 1% of full scale (+ 0.3 psig) |

13. **Control Valves (all control valves shall have electric actuators).**

| Electric Control |  |
| Rangeability | 40:1 |
| Flow Characteristics | Modified. Equal percentage |
| Control Action | Normal open or closed as selected |
| Medium | Steam, water, glycol |
| Body Type | Screwed ends 2” and smaller, flanged  
|           | Valves 2 ½ and larger |
| Body Material | Bronze for cast bodies  
|               | Brass acceptable for forged valves |
INSTRUMENTATION AND CONTROL

| Body Trim              | Bronze for cast bodies                  |
|                       | Brass acceptable for forged valves      |
| Stem                  | Stainless steel for globe valve         |
|                       | Brass acceptable for ball valves        |
| Actuator              | 0-10 VDC, 4-20 MA or 2 position        |
|                       | 24 VAC/120VAC                           |

a. All automatic temperature control valves in water lines shall be provided with characterized throttling plugs or ball and shall be sized for minimum 25% of the system pressure drop or 5 psi, whichever is less.
b. Positive positioning relays shall be provided on pneumatic control when required to provide sufficient power for sequencing.
c. Two position valves shall be line size.
d. Control valves shall be two-way or three-way pattern as shown, constructed for tight shut-off and shall operate satisfactorily against system pressures and differentials. Valves shall be constructed to satisfactorily operate and close against a maximum pump head pressure plus 50%. Valves with sizes up to and including 2" shall be "screwed"; 2-½" and larger valves shall be "flanged" configuration. Control valves shall be sized for maximum pressure drop of 5.0 psig at rated flow (except as noted).
e. Valve design shall produce a true equal percentage flow characteristic. Globe valve or characterized ball valves are acceptable in the ½" to 2" range size.
f. See Section 232113 for additional valve specifications including acceptable manufacturers or packagers of valve/actuator assemblies.
g. Valve actuators shall be rated for at least 125% of the motive power necessary to operate the valves over their full range of operation against the total and differential pressures shown, including torque required to seat or unseat resilient seated butterfly valves.

14. Actuators
a. Actuators shall be Underwriters Laboratories Listed under Standard 873 or Canadian Standards association Class 4813 02 and have NEMA type 2 housings -- water and moisture resistant. Spring return actuators mounted near outdoor air streams shall have a semi-permeable membrane to remove moisture from inside actuator.
b. Actuators shall be applied according to the manufacturer’s application instructions. See execution for additional requirements.
c. Each actuator shall be factory tested before shipment at 110% of guaranteed minimum torque.
d. Damper actuators shall be rated and tested for at least 125% of the maximum motive power necessary to operate against the pressure shown.
e. Overload Protection: Actuators shall provide protection against actuator burnout using an internal current limited circuit or digital motor rotation sensing circuit. Circuit shall insure that actuators cannot burn out due to stalled damper or mechanical and electrical paralleling. End switches to deactivate the actuator at the end of rotation or use of magnetic clutches are not acceptable.
f. Actuators shall be properly sized to provide sufficient torque to position the damper or valve throughout its operating range.
g. For power failure and safety applications a mechanical spring return mechanism shall be used. Capacitors or other non-mechanical forms of fail-safe are not acceptable except a “central emergency backup power source”.
h. Actuators shall be direct coupled (over the shaft) enabling them to be mounted directly to the damper shaft without the need for connecting linkage. The clamp holding the damper shaft shall use a V-bolt and toothed V-clamp causing a cold-
weld effect for positive gripping. Single bolt or setscrew type fasteners are not acceptable.

i. Actuators shall be capable of being mechanically and electrically paralleled to increase torque where required.

j. Spring return actuators should be capable of mounting directly onto a jackshaft up to 1.05” diameter.

k. Provide spring return actuators for AHU economizer dampers.

l. Provide spring return and end switches on all 100% OSA dampers.

C. Ventilation Damper actuators
   1. When the actuator is at either the full open or full closed position, continual pulsing of actuator against end stops (end stop dithering) shall not occur. Actuator shall be constructed to de-energize or stall against the end stop.

2.4 MISCELLANEOUS DEVICES

A. Thermostats
   1. Room thermostats shall be of the gradual acting type with adjustable sensitivity.
   2. They shall have a bi-metal sensing element capable of responding to a temperature change of one-tenth of one degree. (Provide all thermostats with limit stops to limit adjustments as required.)
   3. Thermostats shall be arranged for either horizontal or vertical mounting.
   4. In the vertical position thermostat shall fit on a mullion of movable partitions without overlap.
   5. Mount the thermostat covers with tamper-proof socket head screws.

B. Freezestats:
   1. Install freezestats as indicated on the plans and provide protection for every square foot of coil surface area with one linear foot of element per square foot of coil.
      a. Upon detection of low temperature, the freezestats shall stop the associated supply fans and return the automatic dampers to their normal position. Provide manual reset.

C. Firestats:
   1. Provide manual reset, fixed temperature line voltage type with a bi-metal actuated switch.
   2. Switch shall have adequate rating for required load.

D. Current Sensing Relay:
   1. Provide solid-state, adjustable, current operated relay. Provide a relay which changes switch contact state in response to an adjustable set point value of current in the monitored A/C circuit.
   2. Adjust the relay switch point so that the relay responds to motor operation under load as an “on” state and so that the relay responds to an unloaded running motor as an “off” state. A motor with a broken belt is considered an unloaded motor.
   3. Provide for status device for all fans and pumps.

E. Carbon Dioxide Sensors
   2. Sensor: Non-dispersive infrared sensing technology. Sensor chamber shall be manufacturer with a non-corrosive material (i.e. gold plating) that does not affect sampling.
   3. Detection range: 0 to 3000 ppm. +/- 5% and +/- 50 ppm. Annual drift 20 ppm nominal
   4. Analog Output: 4-20 mA, 0-10 Vdc.

F. Airflow Measuring Arrays
   1. Fan flow measurement: Supply and return fan inlets shall be provided with airflow measuring devices. This device shall not obstruct the inlet cone to the fan, nor add any
INSTRUMENTATION AND CONTROL

pressure losses or sound level increases to the fan performance. The unit shall be AMCA lab tested for accuracy of 3%±.

2. Outside Air Measurement: Provide a minimum outside airflow measuring station in a straight duct section upstream from the minimum outside air dampers and interfacing control for providing an electronic signal for use by the control contractor in controlling a minimum outside airflow. On outdoor mounted units, outside airflow measurement station is to be factory mounted on the intake side of the outside air intake.

3. Sensor Performance:
   a. Fan Installation:
      1) Installed airflow accuracy: +/- 3% to 10% of reading with +/- 0.25% repeatability.
      2) Sensor probe performance: +/- 2% of reading, 0-5000 fpm, 0.15°F temperature accuracy +/-.
   b. Outside Air/duct Installation:
      1) Installed airflow accuracy: +/- 2% of reading with +/- 0.25% repeatability.
      2) Sensor probe performance: +/- 2% of reading, 0-5000 fpm, 0.15°F temperature accuracy +/-.

4. Transmitter:
   a. Flow measuring array to include a transmitter for flow and temperature analog output signal for the building energy management system in either 4-20 mA or 0-10VDC. Coordinate signal output with controls installer.
   b. Transmitter to include an analog airflow gauge to provide direct analog readout in cfm. Mount on the outside of the air handler if air handler is located in a mechanical room. Mount in a NEMA 3R control cabinet if located outside.
   c. Device to provide switch selectable Modbus or Johnson N2 outputs.

5. Airflow measuring station to be by Ebtron, KURZ, Fluid Components and Sierra Instruments or equal.

2.5 PRESSURE INDEPENDENT TEMPERATURE CONTROL VALVES (COIL CONTROL VALVES)

A. Modulating control valves shall be pressure independent characterized two-way actuated flow control valves. The flow rate through the valve shall not vary more than + or - 5% due to system pressure fluctuations across the valve in the selected operating range.

B. The range-ability of the valve shall be 90:1 (minimum).

C. The valve bodies shall be of cast brass and rated for 200 PSI working pressure (minimum). All internal parts shall be stainless steel, teflon, brass, or bronze. The valves shall be serviceable without removing them from the piping system. Valve flow characteristics shall be able to be changed without removing the valve from the piping system.

D. Balancing valves shall not be required where these control valves are installed. Flow performance curves shall be provided with each valve

E. The actuator shall modulate the control valve from 0 to 100% design flow. The actuator shall be directly coupled to the valve at the factory.

F. Pressure/temperature ports (Pete's Plugs) shall be installed at the factory in each valve larger than 1”. Two ports shall be used to measure inlet and outlet pressure to the valve.

G. Manufacturer: Belimo PICCV or approved equal by Flow Control Industries, Inc. or Griswold. Valves shall be provided by controls provider and installed by piping installer.

SERA Architects, Inc.

NOTICE OF ALTERNATE BILLING CYCLE: The Contract will allow the Owner to require the submission of billings or estimates in billing cycles other than 30-day cycles. Billing or statements shall be submitted monthly ending on the last day of the month.

NOTICE OF EXTENDED CERTIFICATION PROVISION: The Contract will allow the Owner to certify billings and estimate within 20 days after the billings and estimates are received from the original contractor.

NOTICE OF EXTENDED PAYMENT PROVISION: The Contract will allow the Owner to make payment within 30 days after the date a billing or estimate is received.
2.6 WIRE AND CABLE, TRANSFORMERS AND TERMINAL BLOCKS

A. Wire and Cable General: Wire and cable jacket material shall be flame retardant PVC, or fluoropolymer as required for the application per NFPA 70. Multiconductor cable shall have an outer jacket. Wire and cable not indicated as GFE shall be provided.

B. Control Wiring
1. Digital Functions: Control wiring for digital functions shall be 18 AWG minimum with 600-volt insulation.
2. Analog Functions: Control wiring for analog functions shall be 18 AWG minimum with 600-volt insulation, twisted and each pair shielded, 2, 3, or 4 wire to match analog function hardware.

C. Sensor Wiring: Sensor wiring shall be 20 AWG minimum twisted and shielded, 2, 3, or 4 wire to match analog function hardware.

D. Terminal Blocks: Terminal blocks shall be insulated, modular, feed-through, clamp style with recessed captive screw-type clamping mechanism, suitable for rail mounting, and shall have end plates and partition plates for separation or shall have enclosed sides.

E. Transformer: Step-down transformer shall be utilized where control equipment operates at lower than line circuit voltage. Transformer, other than transformers in bridge circuits, shall have primaries wound for the voltage available and secondaries wound for the correct control circuit voltage. Transformer shall be sized so that the connected load is 80% of the rated capacity or less. Transformer shall conform to UL 508 and NEMA ST1.

F. Nonconducting Wiring Duct: UL listed nonconducting wiring duct in control panels shall have slotted sides, snap-on duct covers, fittings for connecting ducts, mounting clips for securing ducts, and wire-retaining clips. Wire shall be sequentially labeled on both ends for identification with point address.

2.7 DDC CONTROLS

A. General: This specification defines the minimum equipment and performance requirements for a Direct Digital Control (DDC) building control system.

B. Scope of Work: The Control Contractor shall furnish and install all equipment, accessories, wiring and instrument piping required for a complete and functioning system.
1. All materials and equipment used shall be standard components, regularly manufactured for this and/or other systems and shall not be custom designed especially for this project. All components shall have been thoroughly tested and proven in actual use.
2. The building control system shall possess a fully modular architecture, permitting expansion through the addition of more stand-alone control units, temperature sensors, pressure sensors, actuators, and/or operator terminals.
3. Supervision and checkout of the system shall be by local branch engineers and technicians directly employed by the Control Contractor.

C. Warranty: The building control system, including all hardware and software components shall be warranted for a period of one year following the date of beneficial use. Any manufacturing defects arising during this period shall be corrected without cost to the owner.

D. Building Control System: The building control system specified herein shall be a Direct Digital Control system which can, without additional equipment, perform all of the automatic temperature control and energy management functions as required on the accompanying plans. Direct Digital Control shall be defined as a control technique through which the process variable is continuously monitored by a digital computer which accomplished loop control by calculating a control solution for output to a control device.
E. The system, as specified, shall independently control the building's HVAC equipment to maintain a controlled environment in an energy efficient manner. The building operator shall communicate with the system and control the sequence of operation to maintain 78 degrees Fahrenheit during the summer (user defined period) and 70 degrees Fahrenheit during the winter (user defined period).

2.8 GENERAL PRODUCT DESCRIPTION

A. The Facility Management System shall be capable of integrating multiple building functions including equipment supervision and control, alarm management, energy management, and historical data collection and archiving.

B. The facility management system shall consist of the following:
   1. Standalone DDC panels
   2. Standalone application specific controllers (ASCs)
   3. Portable Operator's Terminals

C. The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, standalone DDC panels, and operator devices.

D. System architectural design eliminate dependence upon any single device for alarm reporting and control execution. Each DDC panel shall operate independently by performing its own specified control, alarm management, operator I/O, and historical data collection. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

E. Standalone DDC panels shall be able to access any data from, or send control commands and alarm reports directly to any other DDC panel or combination of panels on the network without dependence upon a central processing device. Standalone DDC panels shall also be able to send alarm reports to multiple operator workstations without dependence upon a central processing device.

2.9 COMMUNICATIONS

A. Inherent in the system's design shall be the ability to expand or modify via an auto-dial telephone line modem connections.

B. Dial-Up Communications: Auto-dial/auto-answer communications shall be provided to allow standalone DDC panels to communicate with remote operator stations on an intermittent basis via telephone lines.
   1. Dial-Up Standalone DDC Panels: Auto-Dial panels shall automatically place calls to workstations to report critical alarms, or to upload trend and historical information for archiving.
      a. Standalone DDC Panels shall analyze and prioritize all alarms to minimize the initiation of calls. Non-critical alarms shall be buffered in memory and reported as a group of alarms, or until an operator manually requests an upload of all alarms.
      b. The auto-dial program shall include provisions for handling busy signals, "no-answers", and incomplete data transfers. Default devices shall be called when communications cannot be established with primary devices.

C. Modem characteristics: dial-up communications shall make use of 52k baud modems and voice grade telephone lines. Each standalone DDC panel may have its own modem, or a group of standalone DDC panels may share a modem.
2.10 STAND-ALONE DDC PANELS

A. General: Standalone DDC panels shall be microprocessor based, multi-tasking, multi-user, real-time digital control processors. Each standalone DDC panel shall consist of modular hardware with plug-in enclosed processors, communication controllers, power supplies, and input/output modules. A sufficient number of controllers shall be supplied to fully meet the requirements of this specification and the attached point list.

B. Memory: Each DDC panel shall have sufficient memory to support its own operating system and databases including:
   1. Control processes
   2. Energy Management Applications
   3. Alarm Management
   4. Historical/Trend Data for all points
   5. Maintenance Support Applications
   6. Custom Processes
   7. Operator I/O
   8. Dial-Up Communications
   9. Manual Override Monitoring

C. Point types: Each DDC panel shall support the following types of point inputs and outputs:
   1. Digital Inputs for status/alarm contacts
   2. Digital Outputs for on/off equipment control
   3. Analog Inputs for temperature, pressure, humidity, flow, and position measurements
   4. Analog Outputs for valve and position control, and capacity control of primary equipment
   5. Pulse Inputs for pulsed contact monitoring

D. Expandability: The system shall be modular in nature, and shall permit easy expansion through the addition of software applications, workstation hardware, field controllers, sensors, and actuators.

E. The system architecture shall support 10% expansion capacity of all types of DDC panels, and all point types included in the initial installation.

F. Serial Communication Ports: Standalone DDC panels shall provide at least two RS-232C serial data communication ports for simultaneous operation of multiple operator I/O devices such as industry standard printers, laptop workstations, PC workstations, and panel mounted or portable DDC panel Operator’s Terminals. Standalone DDC panels shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers, or network terminals.

G. Hardware Override Switches: As indicated in the point schedule, the operator shall have the ability to manually override automatic or centrally executed commands at the DDC panel via local, point discrete, onboard hand/off/auto operator override switches for binary control points and gradual switches for analog control type points. These override switches shall be operable whether the panel is powered or not.

H. Hardware Override Monitoring: DDC panels shall monitor the status of position of all overrides, and include this information in logs and summaries to inform the operator that automatic control has been inhibited. DDC panels shall also collect override activity information for daily and monthly reports.

I. Local Status Indicator Lamps: The DDC panel shall provide local status indication for each binary input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device.
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J. Integrated On-Line Diagnostics: Each DDC panel shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all subsidiary equipment. The DDC panel shall provide both local and remote annunciation of any detected component failures, or repeated failure to establish communication. Indication of the diagnostic results shall be provided at each DDC panel, and shall not require the connection of an operator I/O device.

K. Surge and Transient Protection: Isolation shall be provided at all network terminations, as well as all field point terminations to suppress induced voltage transients consistent with IEEE Standard 587-1980. Isolation levels shall be sufficiently high as to allow all signal wiring to be run in the same conduit as high voltage wiring where acceptable by electrical code.

L. Powerfail Restart: In the event of the loss of normal power, there shall be an orderly shut down of all standalone DDC panels to prevent the loss of database or operating system software. Non-Volatile memory shall be incorporated for all critical controller configuration data, and battery back-up shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours.
   1. Upon restoration of normal power, the DDC panel shall automatically resume full operation without manual intervention.
   2. Should DDC panel memory be lost for any reason, the user shall have the capability of reloading the DDC panel via the local area network, via the local RS-232C port, or via telephone line dial-in.

2.11 SYSTEM SOFTWARE FEATURES

A. General
   1. All necessary software to form a complete operating system as described in this specification shall be provided.
   2. The software programs specified in this section shall be provided as an integral part of the DDC panel and shall not be dependent upon any higher level computer for execution.

B. Control Software Description:
   1. Pre-Tested Control Algorithms: The DDC panels shall have the ability to perform the following pre-tested control algorithms:
      a. Two Position Control
      b. Proportional Control
      c. Proportional plus Integral Control
      d. Proportional, Integral, plus Derivative Control
      e. Automatic Control Loop Tuning
   2. Equipment Cycling Protection: Control software shall include a provision for limiting the number of times each piece of equipment may be cycled within any one-hour period.
   3. Heavy Equipment Delays: The system shall provide protection against excessive demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.
   4. Powerfail Motor Restart: Upon the resumption of normal power, the DDC panel shall analyze the status of all controlled equipment, compare it with normal occupancy scheduling, and turn equipment on or off as necessary to resume normal operation.

C. Energy Management Applications: DDC Panels shall have the ability to perform any or all of the following energy management routines:
   - Time of Day Scheduling
   - Calendar Based Scheduling
   - Holiday Scheduling
   - Temporary Schedule Overrides
   - Optimal Start
   - Optimal Stop
   - Night Setback Control
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- Enthalpy Switchover (Economizer)
- Peak Demand Limiting
- Temperature Compensated Load Rolling
- Fan Speed/CFM Control
- Outside Air Intake CFM Monitoring
- Heating/Cooling Interlock
- Cold Deck Reset
- Hot Deck Reset
- Hot Water Reset
- Compressor Sequencing

All programs shall be executed automatically without the need for operator intervention, and shall be flexible enough to allow user customization. Programs shall be applied to building equipment as described in the Execution portion of this specification.

D. Custom Process Programming Capability: DDC panels shall be able to execute custom, job-specific processes defined by the user, to automatically perform calculations and special control routines.

1. Process Inputs and Variables: It shall be possible to use any of the following in a custom process:
   a. Any system-measured point data or status
   b. Any calculated data
   c. Any results from other processes
   d. User-Defined Constants
   e. Arithmetic functions (+,-,*,/, square root, exp, etc.)
   f. Boolean logic operators (and, or, exclusive or, etc.)
   g. On-delay/Off-delay/One-shot timers

2. Process Triggers: Custom processes may be triggered based on any combination of the following:
   a. Time interval
   b. Time of day
   c. Date
   d. Other processes
   e. Time programming
   f. Events (e.g., point alarms)

3. Dynamic Data Access: A single process shall be able to incorporate measured or calculated data from any and all other DDC panels on the local area network.
   a. In addition, a single process shall be able to issue commands to points in any and all other DDC panels on the local area network.

4. Advisory/Message Generation: Processes shall be able to generate operator messages and advisories to operator I/O devices. A process shall be able to directly send a message to a specified device, buffer the information in a follow-up file, or cause the execution to a dial-up connection to a remote device such as a printer or pager.

5. Custom Process Documentation: The custom control programming feature shall be self-documenting. All interrelationships defined by this feature shall be documented via graphic flowcharts and English language descriptors.

E. Alarm Management: Alarm management shall be provided to monitor, buffer, and direct alarm reports to operator devices and memory files. Each DDC panel shall perform distributed, independent alarm analysis and filtering to minimize network traffic, and prevent alarms from being lost. At no time shall the DDC panel's ability to report alarms be affected by either operator activity at a PC Workstation or local I/O device.

1. Point Change Report Description: All alarm or point change reports shall include the point's English language description, and the time and date of occurrence.
2. Prioritization: The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of three priority levels shall be provided. Each DDC panel shall automatically inhibit the reporting of selected alarms during system shutdown and start-up. Users shall have the ability to manually inhibit alarm reporting for each point. The user shall also be able to define under which conditions point changes need to be acknowledged by an operator, and/or sent to follow-up files for retrieval and analysis at a later date.

3. Report Routing: Alarm reports, messages, and files will be directed to a user-defined list of operator devices, or PCs used for archiving alarm information. Alarms shall also be automatically directed to a default device in the event a primary device is found to be offline.

4. Alarm Messages: In addition to the point's descriptor and the time and date, the user shall be able to print, display or store a 65-character alarm message to more fully describe the alarm condition or direct operator response. Each standalone DDC panel shall be capable of storing a library of at least 250 Alarm Messages. Each message may be assignable to any number of points in the panel.

5. Auto-Dial Alarm Management: In Dial-up applications, only critical alarms shall initiate a call to a remote operator device. In all other cases, call activity shall be minimized by time-stamping and saving reports until an operator scheduled time, a manual request, or until the buffer space is full. The alarm buffer must store a minimum of 50 alarms.

F. Historical Data and Trend Analysis: A variety of Historical data collection utilities shall be provided to automatically sample, store, and display system date in all of the following ways.

1. Continuous Point Histories: Standalone DDC panels shall store Point History Files for all analog and binary inputs and outputs. The Point History routine shall continuously and automatically sample the value of all analog inputs at half hour intervals. Samples for all points shall be stored for the past 24 hours to allow the user to immediately analyze equipment performance and all problem-related events for the past day. Point History Files for binary input or output points and analog output points shall include a continuous record of the last ten status changes or commands for each point.

2. Control Loop Performance Trends: Standalone DDC panels shall also provide high resolution sampling capability with an operator-adjustable resolution of 10-300 seconds in one-second increments for verification of control loop performance.

3. Extended Sample Period Trends: Measured and calculated analog and binary data shall also be assignable to user-definable trends for the purpose of collecting operator-specified performance data over extended periods of time. Sample intervals of 1 minute of 2 hours, in one-minute intervals, shall be provided. Each standalone DDC panel shall have a dedicated buffer for trend date, and shall be capable of storing a minimum of 5000 data samples.

4. Data Storage and Archiving: Trend data shall be stored at the Standalone DDC panels, and uploaded to hard disk storage when archival is desired. Uploads shall occur based upon either user-defined intervals, manual command, or when the trend buffers become full. All trend data shall be available in disk file form for use in 3rd Party personal computer applications.

G. Runtime Totalization: Standalone DDC panels shall automatically accumulate and store runtime hours for binary input and output points as specified in the Execution portion of this specification.

1. The Totalization routine shall have a sampling resolution of one minute or less.

2. The user shall have the ability to define a warning limit for Runtime Totalization. Unique, user-specified messages shall be generated when the limit is reached.
H. Analog/Pulse Totalization: Standalone DDC panels shall automatically sample, calculate and store consumption totals on a daily, weekly, or monthly basis for user-selected analog and binary pulse input-type points.
   1. Totalization shall provide calculation and storage of accumulations of up to 99,999.9 units (e.g. KWH, gallons, KBTU, tons, klbs (for steam), etc.).
   2. The Totalization routine shall have a sampling resolution of one minute or less.
   3. The user shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when the limit is reached.

I. Event Totalization: Standalone DDC panels shall have the ability to count events such as the number of times a pump or fan system is cycled on and off. Event totalization shall be performed on a daily, weekly, or monthly basis.
   1. The Event Totalization feature shall be able to store the records associated with a minimum of 9,999,999 events before reset.
   2. The user shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when the limit is reached.

2.12 APPLICATION SPECIFIC CONTROLLERS - HVAC APPLICATIONS

A. Each Standalone DDC Controller shall be able to extend its performance and capacity through the use of remote Application Specific Controllers (ASCs).

B. Each ASC shall operate as a standalone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each ASC shall be a microprocessor-based, multi-tasking, real-time digital control processor.

C. Each ASC shall have sufficient memory to support its own operating system and database including:
   1. Control Processes
   2. Energy Management Applications
   3. Operator I/O (Portable Service Terminal)

D. The operator interface to any ASC point data or programs shall be through any network-resident PC workstation, or any PC or portable operator's terminal connected to any DDC panel in the network.

E. Application Specific Controllers shall support the temporary use of a portable service terminal. The capabilities of the portable service terminal shall include but not be limited to the following:
   1. Display temperatures
   2. Display status
   3. Display setpoints
   4. Display control parameters
   5. Override binary output control
   6. Override analog setpoints
   7. Modification of gain and offset constants

F. Powerfail Protection: All system setpoints, proportional bands, control algorithms, and any other programmable parameters shall be stored such that a power failure of any duration does not necessitate reprogramming the controller.

G. Application Description:
   1. AHU Controllers:
      a. AHU Controllers shall support, but no be limited to, the following configurations of systems to address current requirements as described in the Execution portion of this specification.
      b. AHU Controllers shall support all the necessary point inputs and outputs to perform the specified control sequences in a totally standalone fashion.
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c. AHU controllers shall have a library of control routines and program logic to perform the sequence of operation as specified in the Execution portion of this specification.
d. Occupancy-Based Standby/Comfort Mode Control: Each AHU Controller shall have a provision for occupancy sensing overrides. Based upon the contact status of either a manual wall switch or an occupancy sensing device, the AHU Controller shall automatically select either Standby or Comfort mode to minimize the heating and cooling requirements while satisfying comfort conditions.
e. Continuous Zone Temperature Histories: Each AHU Controller shall automatically and continuously, maintain a history of the associated zone temperature to allow users to quickly analyze space comfort and equipment performance for the past 24 hours. A minimum of two samples per hour shall be stored.
f. Alarm Management: Each AHU Controller shall perform its own limit and status monitoring and analysis to maximize network performance by reducing unnecessary communications.

2.13 OPERATOR INTERFACE

A. Basic Interface Description:


2. The operator interface shall minimize the use of a typewriter style keyboard through the use of a mouse or similar pointing device, and “point and click” approach to menu selection. Users shall be able to start and stop equipment of change setpoints from graphical displays through the use of a mouse of similar pointing device.

3. Multiple, Concurrent Displays: The Operator Interface shall provide the ability to simultaneously view several different types of system displays in overlapping windows to speed building analysis. For example, the interface shall provide the ability to simultaneously display a graphic depicting an air handling unit, while displaying the trend graph of several associated space temperatures to allow the user to analyze system performance. If the interface is unable to display several different types of displays at the same time, the FMS contractor shall provide at least two operator stations.

4. Password Protection: Multiple-level password access protection shall be provided to allow the user/manager to limit workstation control, display and data base manipulation capabilities as he deems appropriate for each user, based upon an assigned password.

a. Passwords shall be exactly the same for all operator devices, including portable or panel-mounted network terminals. Any additions or changes made to password definition shall automatically cause passwords at all DDC panels on a network to be updated and downloaded to minimize the task of maintaining system security. Users shall not be required to update passwords for DDC panels individually.

b. A minimum of five levels of access shall be supported:

1) Level 1 = Date Access and Display
2) Level 2 = Level 1 + Operator Overrides
3) Level 3 = Level 2 + Database Modification
4) Level 4 = Level 3 + Database Generation
5) Level 5 = Level 4 + Password Add/Modification

c. A minimum of 50 passwords shall be supported at each DDC panel.

d. Operators will be able to perform only those commands available for their respective passwords. Menu selections displayed at any operator device, including portable or panel mounted devices, shall be limited to only those items defined for the access level of the password used to log-on.

e. User-definable, automatic log-off timers of from 1 to 60 minutes shall be provided to prevent operators from inadvertently leaving devices on-line.
5. Operator Commands: The operator interface shall allow the operator to perform commands including, but not limited to, the following:
   a. Start-up of shutdown selected equipment
   b. Adjust setpoints
   c. Add/Modify/Delete time programming
   d. Enable/Disable process execution
   e. Lock/Unlock alarm reporting for each point
   f. Enable/Disable Totalization for each point
   g. Enable/Disable Trending for each point
   h. Override PID Loop setpoints
   i. Enter temporary override schedules
   j. Define Holiday Schedules
   k. Change time/data
   l. Enter/Modify analog alarm limits
   m. Enter/Modify analog warning lights
   n. View limits
   o. Enable/Disable Demand Limiting for each meter
   p. Enable/Disable Duty Cycle for each load

6. Logs and Summaries: Reports shall be generated automatically or manually, and directed to either CRT displays, printers, or disk files. As a minimum, the system shall allow the user to easily obtain the following types of reports:
   a. A general listing of all points in the network
   b. List all points currently in alarm
   c. List of all off-line points
   d. List all points currently in override status
   e. List of all disabled points
   f. List all points currently locked out
   g. List of all items defined in a Follow-Up file
   h. List all Weekly Schedules
   i. List all Holiday Programming
   j. List of Limits and Deadbands
   k. Summaries shall be provided for specific points, for a logical point group, for a user-selected group of groups, or for the entire facility without restriction due to the hardware configuration of the facility management system. Under no conditions shall the operator need to specify the address of hardware controller to obtain system information.

B. System Configuration and Definition: All temperature and equipment control strategies and energy management routines shall be definable by the operator. System definition and modification procedures shall not interfere with normal system operation and control.
   1. The system shall be provided complete with all equipment and documentation necessary to allow an operator to independently perform the following functions:
      a. Add/Delete/Modify Standalone DDC Panels
      b. Add/Delete/Modify Operator Workstations
      c. Add/Delete/Modify Application Specific Controllers
      d. Add/Delete/Modify points of any type, and all associated point parameters, and tuning constants
      e. Add/Delete/Modify alarm reporting definition for each point
      f. Add/Delete/Modify control loops
      g. Add/Delete/Modify energy management applications
      h. Add/Delete/Modify time- and calendar-based programming
      i. Add/Delete/Modify Totalization for every point
      j. Add/Delete/Modify Historical Data Trending for every point
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k. Add/Delete/Modify custom control processes
l. Add/Delete/Modify any and all graphic displays, symbols, and cross-references to point data
m. Add/Delete/Modify dial-up telecommunication definition
n. Add/Delete/Modify all operator passwords
o. Add/Delete/Modify Alarm Messages

2. System Definition/Control Sequence Documentation: All portions of system definition shall be self-documenting to provide hardcopy printouts of all configuration and application data. Control process and DDC control loop documentation shall be provided in logical, graphical flow diagram format to allow control sequences to be easily interpreted and modified at any time in the future.

3. Database Save/Restore/Back-Up: Back-up copies of all standalone DDC panel databases shall be stored in at least one personal computer operator workstation. Continuous supervision of the integrity of all DDC panel data bases shall be provided. In the event that any DDC panel on the network experiences a loss of its data base for any reason, the system shall automatically download a new copy of the respective data base to restore proper operation. Data base back-up/Download shall occur over the local area network without operator intervention. Users shall also have the ability to manually execute downloads of any of all portions of a DDC panels data base.

C. Personal Computer Operator Workstations shall be provided for command entry, information management, network alarm management, and database management functions. All real-time control functions shall be resident in the Standalone DDC panels to facilitate greater fault tolerance and reliability.

1. Workstations shall be general purpose, commercially available by Compaq, NEC, HP, IBM or Dell, personal computers with sufficient memory and processor capacity to perform all functions described in this specification. Minimum system requirements are 2.3 GHZ, 8 GB RAM, read/write CD ROM drive, and mouse.

2. Sufficient bulk storage (750 GB minimum) shall be provided to accommodate all fully configured point data bases, all application databases, all graphics data bases, all user-defined reports, and all historical data archival as described in this specification.

3. The display provided for system operation shall have a diagonal screen measurement of no less than 21", and a minimum display resolution of no less than 1920 x 1080 pixels. Separate controls shall be provided for color, contrast, and brightness. The screen shall be non-reflective.

D. Standalone DDC panel Local or Portable Operator's Terminals: Each DDC panel shall be capable of supporting an operator's terminal for local command entry, instantaneous and historical data display, and program additions and modifications.

1. There shall be a provision for both permanently mounting the standalone DDC panel Operator Terminal, or using it as a portable handheld unit.

2. The DDC panel Operator Terminal shall simultaneously display a minimum of 6 points with full English identification to allow an operator to view single screen dynamic displays depicting entire mechanical systems.

3. The operator functions provided by the DDC panel Operator Terminal shall include, but not limited to, the following:
   a. Start and Stop Points
   b. Modify Setpoints
   c. Modify PID Loop Setpoints
   d. Override PID Control
   e. Change Time/Date
   f. Add/Modify Start/Stop Weekly Scheduling
   g. Add/Modify Setpoint Weekly Scheduling
   h. Enter Temporary Override Schedules
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i. Define Holiday Schedules
j. View Analog Limits
k. Enter/Modify Analog Warning Limits
l. Enter/Modify Analog Alarm Limits
m. Enter/Modify Analog Differentials
n. View Point History Files

4. The DDC panel Operator Terminal shall provide access to all real or calculated points in the controller to which it is connected, or any other controller in the network. This capability shall not be restricted to a subset of predefined "global points", but shall provide totally open exchange of data between the operator terminal and any DDC panel in the network.

5. Operator access at all DDC panel Operator Terminals shall be identical to each other, as well as identical to the PC or Laptop Operator Workstations. Any password changes shall automatically be downloaded to all controllers on the network.

6. The DDC panel operator terminal shall provide English language prompting to eliminate the need for the user to remember command formats or point names. Prompting shall be provided consistent with a user's password clearance and the types of points being displayed, to eliminated the possibility of operator error.

7. A multi-function touchpad shall be provided for point and command selection, as well as parameter entry. To minimize the possibility of operator error, the DDC panel Operator Terminal shall change and limit touch pad functions based upon an operator's password clearance, the function being performed, and types of points being displayed. Screen displays shall clearly indicate only valid touchpad functions.

8. Context-Sensitive Help: On-line, interactive user's "Help" manuals and tutorials shall be provided. Based upon operator request, the "help" function shall provide general system operating instructions, and specific descriptions of commands available in the currently displayed menus.

9. Identification for all real or calculated points shall be consistent for all network devices. The same English language names used at PC workstations shall be used to access points at the DDC panel Operator's Terminal to eliminate cross-reference or look-up tables.

10. In addition to instantaneous summaries, the DDC panel Operator's Terminal shall allow a user to view a Point History field for system points. Point History fields shall provide a record of value of analog points over the last 24 hours, at 30-minute intervals, or a record of the last ten status changes for binary type points.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Control component shall be installed in accordance with manufacturer's instructions. Control components shall be grouped wherever possible, and installed within local control panels. See plans for locations.

B. Controls Contractor shall supervise the installation of control valves, dampers, temperature sensors, pressure sensors, actuators and sensing wells.

C. Conduit and wiring for the temperature control system not specifically shown on the electrical prints shall be installed by electricians and mechanics employed by the Temperature Control Contractor. All wiring must be in accordance with local and national electrical codes. All electrical conduit wiring and wiring methods shall be in full compliance with requirements of the electrical section.

D. Provide and install duct smoke detectors as required. The Balancing Contractor shall direct the Controls Contractor on the proper location for installing the smoke detectors.
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E. Thermostats or sensors mounted on outside walls shall be mounted on 1/4" minimum thickness cork or rigid fiberglass.

F. Identify each item mounted on the face of a control panel with an engraved phenolic label (1/4" high engraved letters minimum). Identify each item of control equipment (except room sensors and thermostats).

G. All control adjustments shall be accessible without use of a ladder.

H. All thermostats or temperature sensors in the conditioned space shall have blank locking covers.

I. Airflow measuring arrays installed in fan inlet volutes must be designed to withstand velocities encountered in this location. Mounting system is to be warranted against failure and consequent fan damage.

3.2 ELECTRIC ACTUATOR APPLICATION AND INSTALLATION

A. A weather shield shall be used if located outside. Ambient temperature rating of 122°F shall not be exceeded through any combination of medium temperature or surrounding air. Appropriate air gaps, thermal isolation washers or spacers, standoff legs, or insulation shall be provided as necessary.

B. Water shall not be allowed to contact actuator or internal parts. Location of conduits in temperatures dropping below dew point shall be avoided to prevent water from condensing in conduit and running into actuator. Cords or conduit shall incorporate a drip leg if condensation is possible.

C. Application Requirements:
   1. Airtight dampers shall be fully closed and leakage minimized during mounting of actuators. Both drive signal and spring return shall fully close dampers.
   2. Where spring return actuators are required for freeze protection, the power circuit to the actuators shall be disconnected by hard wire interlock to the freeze-stat. Use of a signal input to the program to initiate spring return is not acceptable. Use of the control signal to drive the actuators closed in not acceptable.
   3. Face and bypass shall be proportional spring return closed to face position.
   4. Outside air dampers shall be proportional control (2-10vdc or 4-20ma), with mechanical spring to return damper to the normally closed position on power failure.
   5. Relief air dampers shall be proportional control (2-10vdc or 4-20ma), with mechanical spring to return damper to the normally closed position on power failure.
   6. Return air dampers shall be proportional control (2-10vdc or 4-20ma), with mechanical spring to return damper to the normally open position on power failure.
   7. Exhaust air dampers shall be On/Off control, spring return to normally closed position.
   8. Combustion air intake dampers shall be On/Off control, spring return to open position.
   9. Inlet vane actuators shall be floating or proportional control (2-10vdc or 4-20ma), non-spring.
   10. Provide sufficient torque as velocity, static, or side seals require per damper manufacturer’s recommendation. In all cases torque shall be a minimum 5-in-lb per sq ft for opposed blade dampers and 7-in-lb per sq ft for parallel blade dampers. No individual damper section may exceed 20 sq ft.

3.3 SYSTEM OPERATION

A. It shall be the Control Contractor’s responsibility to coordinate requirements with equipment suppliers, and furnish and install all control devices necessary to provide the control sequence specified, where not furnished by others. This is to include control transformers, room or insertion thermostats, and other devices without limitation.
3.4 OPERATOR INSTRUCTION

A. During system commissioning and at such time acceptable performance of the control hardware and software has been established, the Control Contractor shall provide on-site operator instruction to the Owner’s operating personnel. Operator instruction during normal working hours shall be performed by a competent representative familiar with the system hardware, software, and accessories.

B. At a time mutually agreed upon during system commissioning as stated above, the System Contractor shall give instruction to the Owner’s designated personnel on the operation of the Control systems and describe its intended use with respect to the programmed functions specified. Operator orientation of the control system shall include, but not limited to, the overall operation program, equipment functions (both individually and as part of the total integrated system), commands, systems generation, advisories, and appropriate operator intervention required in responding to the System’s operation.

C. The training shall be in three sessions as follows:
   1. Twenty-Four Hour Initial Training - three day training after system is started up and at least one week before first acceptance test. Manual shall have been submitted at least two weeks prior to training so that the Owner’s personnel can start to familiarize themselves with the system before classroom instruction.
   2. First Four Hour Follow-up - approximately two weeks after initial training, and before Formal Acceptance. These sessions will deal with more advanced topics and answer questions.
   3. Two Day Warranty Follow-Up - 8 hours in no less than 4 hour increments, to be scheduled at the request of the Owner during the warranty period. These sessions shall cover topics as requested by the Owner, including how to install additional points and add local control modules.

3.5 OPERATION AND MAINTENANCE MANUAL

A. Provide the Owner with the manual containing all instructions for operations and maintenance of all components at least 30 days prior to substantial completion and/or at least 15 days prior to Initial Training sessions.

B. Manual will contain all copies of AS-BUILT control drawings and schematics.

C. Manual shall contain manufacturer's catalog data and shop drawings for all control components.

D. Post a copy of the final sequence of operation and control drawings, under glass, in the mechanical room adjacent the main control panel.

E. Provide the list of spare parts in the manual.

END OF SECTION
PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS

A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, and Section 230500 - Basic Materials and Methods, and other Sections in Division 23 specified herein.

1.2 SCOPE

A. Furnish complete and operational VFD systems as shown on the plans. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to, the following:
   1. Variable frequency drives (VFDs).
   2. Controls and control connections.
   3. Electrical power connections.

1.3 RELATED WORK IN OTHER SECTIONS

A. Section 230500: Basic Materials and Methods
B. Section 230593: Testing, Adjusting and Balancing
C. Section 230900: Controls and Instrumentation
D. Section 232123: Pumps and Hydronic Specialties
E. Section 233412: Air Handling Equipment
F. Division 26: Coordination of interface items between the Mechanical equipment and controls and the Electrical Work specified in Division 26.

1.4 QUALITY ASSURANCE

A. Supplier of VFD shall be solely responsible for assuring that the VFD shall work properly with the motor(s) being controlled. VFD supplier shall provide all materials and labor required to replace motors, bearing, shafts, etc. that may be incompatible with VFD or become damaged by VFD at no additional cost to the owner. VFD supplier shall reimburse Architect and Engineer at their standard hourly rates for their involvement in resolving failures due to their VFDs.

B. Manufacturer shall have a minimum of 15 years experience building similar equipment for controlling the speed for induction motors and at least one hundred successful installations with a variety of VFD sizes and applications.

C. To reduce the known problem of bearing failures by "fluting" the VFD switching rates shall be 6-8 KHz wherever possible. Manufactured VFDs at switching rates of 12-15 KHz shall be accompanied by an additional extended warranty to cover bearings and motors to a period of ten (10) years. Should it be impossible to provide matched motor and VFD’s provide a shaft grounding system for the driven motor. Acceptable manufacturer are Shaft Grounding Systems (www.shaft-grounding-systems.com) or Aegis Shaft Grounding Ring (www.est-aegis.com).

D. To insure quality and minimize infantile failures at the job site, the VFD shall be burned in at the factory at an ambient of 104°F minimum for at least 8 hours. The VFD shall be operating a dynamometer and the load speed shall be cycled during the test. All optional and special features shall be functionally tested at the factory for proper operation.

E. Codes and Standards: Provide VFDs conforming to the requirements of the latest addition of the following:
   1. ANSI/EIA 508 Electrical Performance Standards for Television Broadcast Transmitters

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2. UL508. All VFD equipment provided under this section must be labeled as UL508 approved.

1.5 SUBMITTALS

A. Prior to construction submit for approval the following materials:
   1. VFD supplier shall provide reference list showing at least ten years of prior manufacturing experience in production of VFDs and a list of at least twenty successful installations with a variety of VFD sizes and applications.
   2. Manufacturer's data, installation instructions, and maintenance and operational instructions for variable frequency drives. Indicate electrical service and special requirements. Include manufacturer's descriptive literature, repair data, and parts listing.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver units to the site in containers with manufacturer's stamp or label affixed.
B. Protect units against dirt, water, chemical, and mechanical damage. Do not install damaged units. Remove damaged equipment from site.

1.7 WARRANTY

A. Provide two-year (24 months) warranty under provisions of Division 01. Provide extended ten (10) year warranty on motors and bearings as described above, if applicable. The warranty shall include parts, labor, travel costs, and living expenses incurred by the manufacturer to provide factory authorized service.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. ABB or approved equal by Owner..

2.2 GENERAL

A. Furnish a complete VFD as scheduled on the plans. Refer to plans for locations of variable speed controllers. Each fan or pump motor shall have a dedicated VFD unit. All standard and optional features shall be included within the VFD enclosure unless otherwise specified. The VFD enclosure shall be provided to match the environment requirements where the VFD will be mounted and operated. Provide NEMA rated enclosure as required.
B. The adjustable frequency controller shall convert three-phase, 60 Hz utility power to adjustable voltage and frequency, three-phase, AC power for stepless motor speed control from 10% to 100% of the motor's 60 Hz speed.
C. The VFD shall include a converter and an inverter section. The converter section shall convert fixed frequency and voltage AC utility power to a DC voltage. Drive shall utilize a single surface mount micro-processor.
D. The VFD shall be of the pulse width modulation (PWM) type. VFDs shall be provided with an advanced flux vector frequency control to limit noise at drive and motor.
E. Drive manufacturer or sales representative shall evaluate electrical system of the project. Any additional protective equipment such as line filters, reactors or input isolation transformers required to prevent interference from drive with other electrical equipment in the building shall be included as part of the bid. No additional expense shall be incurred by Owner for provision or installation of

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VARIABLE FREQUENCY DRIVES (VFD)

despite being required for electrical system operation after drive has been purchased. Units shall include factory mounted input line reactors.

F. The VFD maximum output current rating shall be 110% of the motor nameplate full load current. VFD shall be able to start into a rotating load in either direction without trip.

G. The VFD and options shall be tested to ASNI/EIA Standard 508 and listed by a nationally recognized testing agency such as UL or ETL.

H. The VFD and options shall comply with the applicable requirements of the latest standards of ANSI, IEEE, and the National Electrical Code.

I. Power line noise shall be limited to a voltage distortion factor and line notch depth as defined in ANSI/IEEE Standard 519.

J. The drive efficiency shall be 97% (minimum) and have a fundamental power factor of 0.98 at all speeds.

2.3 BASIC FEATURES

A. The VFD shall be housed in a NEMA enclosure appropriate to the mounting location.

1. NEMA 12 enclosure shall be used for dusty locations, plenum mechanical rooms, penthouses, or air stream mounting.

2. NEMA 3R is required for all locations exposed to falling rain, snow or ice or to indoor locations subject to falling water.

3. If NEMA 1 enclosure is suitable it shall be vented through cabinet and equipped with an integral cooling fan with thermostat control, and arranged so that units can be mounted back to back on a frame and/or side to side on a wall. Venting fans shall be supplied in enclosure if required. If a different NEMA enclosure is indicated the enclosure shall provide means of maintaining the drive at temperature acceptable to the drive manufacturer in exterior ambient temperatures. Enclosure shall be complete with no requirements for low voltage wiring. Factory mounted main circuit breaker disconnect shall be included.

B. The following operator controls shall be located on the front of the enclosure:

1. Door mounted operator digital controls consisting of auto/manual switch, start/stop switch with reset and manual speed control. In the auto position, the drive will start/stop from a remote contact closure and motor speed is determined by the follower signal. In the manual position, motor speed is determined by manual speed selection. Manual potentiometers are not acceptable.

2. Power on pilot light to indicate that the VFD is being supplied by the power line.

3. Fault digital display to indicate that the VFD has tripped on a fault condition. The drive shall retain in memory the last three (3) fault conditions that caused the drive to trip. Indication should include but not be limited to the following: Under voltage, over voltage, overcurrent, over temperature, phase loss, phase imbalance and external trip.

4. Digital display to indicate voltage, current, frequency or RPM. Selectable by the operator while the VFD is running.

C. VFD shall be provided with two (2) each form C dry contacts for indication of run and fault starters. In addition each drive shall have an analog output signal 0 to 10 \( \text{VDC} \) (or 4-20 \( \text{MA} \)) to indicate drive speed (percent of full load).

D. While in the remote mode, the VFD will attempt at least five (5) restarts after a power outage, drive fault or external fault before requiring manual reset. After ten minutes of runtime, the restart attempts return to zero. The VFD shall display a countdown timer when auto restart is being attempted, or incorporate programming to select number of restarts, number of faults per time period, and time between restarts.
VARIABLE FREQUENCY DRIVES (VFD)

2.4 PROTECTIVE FEATURES

A. Protection against input transient voltage spikes.
B. Overload protection for the motor. If power input or output is interrupted while the control is in operation, no damage shall result. The unit shall be able to operate without any equipment connected to the inverter output. The drive must protect itself against all phase-to-phase short circuits and ground faults.
C. Protection against input power undervoltage, overvoltage and phase loss.
D. Protection against output current overload and overcurrent.
E. Protection against over-temperature within the VFD enclosure.
F. Protection against overvoltage on the DC bus.
G. Drive shall have an auxiliary contact to permit a remote trip.
H. DC bus discharge circuit and warning light for protection of service personnel or meet UL requirements for DC bus discharge.
I. Drive shall be capable of operating and insensitive to imbalance or out-of-rotation incoming power phase
J. Lockable main fused input disconnect shall be factory mounted as specified on the drawings or as required by the application.

2.5 ADJUSTMENTS

A. Maximum speed, adjustable to 100% base speed.
B. Minimum speed, adjustable to 10% base speed.
C. Acceleration time, adjustable 1 to 360 seconds (minimum) factory set at 20 seconds.
D. Deceleration time, adjustable 1 to 360 seconds (minimum) factory set at 20 seconds.
E. Current limit, adjustable 50 to 110%.
F. Adjustable speed lock-outs for three (3) operating ranges.
G. Capable of following 0-5\text{mAh}, 4-20\text{MA}, 10-50\text{MA}, 0-4\text{VDC}, 0-8\text{VDC}, 0-10\text{VDC} grounded or ungrounded signal as required to interface with the building control system.

2.6 SERVICE CONDITIONS

A. The VFD shall be designed to operate within the following service conditions:
   1. Ambient temperature, 32°F-104°F.
   2. Relative humidity, 5-95%, non-condensing.
   3. Elevation to 3,300 feet without derating.
   4. AC line voltage variation, -10% to +10% of nominal.

2.7 SPECIAL FEATURES

A. All control wiring, and accessories shall be factory installed in the drive casing so that only the connection of the remote auxiliary start/stop and override contacts is required to provide override control as described above.
B. All drives shall be equipped with fail safety speed control (adjustable 20-100%), factory installed and wired, that operates as follows: If the drive is on (in either normal or override mode) and no signal is detected from the building control system, the drive shall operate at a preset adjustable speed. On resumption of the building control system signal, the drive shall operate as normal. Fail safe speed shall be adjusted through digital keyboard mounted on the outside drive cabinet.
VARIABLE FREQUENCY DRIVES (VFD)

C. Drives shall be protected with input line reactors factory mounted.

D. Provide drive with a communications board enabling it to communicate with the building management system (BMS) over a serial RS-485 interface or with a BACNET, LonWorks, Modbus, Profinet or BMS proprietary interface.

2.8 BYPASS (WHEN SCHEDULED)

A. Provide a manual 3-contactor bypass consisting of a door interlocked main fused disconnect padlockable in the off position, a built-in motor starter and a three position DRIVE/OFF/BYPASS/TEST switch controlling three contactors. In the DRIVE position the motor is operated at an adjustable speed from the VFD. In the OFF position, the motor and VFD are disconnected. In the BYPASS position, the motor is operated at the full speed from the AC power line and power is disconnected from the VFD so that service can be performed. Include motor thermal overload and fuse or circuit breaker protection while in bypass operation.

B. Service personnel shall be able to defeat the main power disconnect and open the bypass enclosure without disconnecting power using a specially designed tool and mechanism while meeting all local and national code requirements for safety.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Verify that mounting surface is ready to receive work. Mount the VFD(s) on the wall or at supports in locations identified on the drawings. Provide a layout drawing of VFD locations to electrical installer.

B. If the disconnect for the equipment powered by the VFD is in a location where it is probable that it will be placed in an off position prior to shutting down the VFD, the contractor is to provide electrical protection for the VFD. This may be in the form of a conduit and wire interlock between disconnect and drive or internal protection integral to the VFD.

C. Coordinate wiring and control with Control Contractor. Control installers shall install all wiring associated with control signals into the VFD and for interlock control wiring between disconnects and VFDs.

D. Electrical installer shall install all line voltage power wiring and conduit from electrical switchgear and from the VFD to the disconnect at the controlled motor. The only exception to this is when the motor and drive are factory installed on a packaged piece of equipment. In that case the wiring from drive to motor is to be installed in the factory to meet the requirements herein. Coordinate with Division 26 work.

E. Line length between VFD and driven motor shall be as short as possible. Line length shall not exceed twenty (20) feet without prior approval from Engineer.

F. Input and output power wiring shall be installed in separate grounded conduit. In addition, control wiring shall be installed in its own separate grounded conduit.

G. Use symmetric motor cable between the VFD and motor, with low inductance shield or conduit, and with all joints joined with bonding straps. MC metal clad 3 phase type cable per NEC 334-1, UL approved, 3 phase conductors and 3 ground conductors. Sheath to be continuous corrugated aluminum. Manufacturer and type to be BICC 2 kV rated Drives Cable, Anixter series 7V, or approved equal.

H. Use cable connectors with 360 degree connections to the armor conduit at both ends of motor cable. Verify electrical path from inverter cabinet entry plate to armor / conduit to motor terminal box.
VARİABLE FREQUENCY DRIVES (VFD)

I. Install an auxiliary high frequency bonding connection for potential equalization between VFD frame and building steel.

J. Unless absolutely necessary do not install disconnect between VFD and connected motor. VFD is to be furnished with a lockable disconnect.

K. Installation in “Fan Wall “ Air Handlers: When a single VFD supplies multiple fans, assemble and prewire units at the factory, installing conduit and conductors between the fan motor, VFD, and terminal strips. Wiring from the VFD output terminals to the fan motor shall be Belden VFD Cable installed in conduit (295XX Series).

3.2 MANUFACTURER'S START-UP SERVICES

A. The manufacturer shall provide start-up service in the form of a factory trained service technician. The service technician shall verify correct installation, verify control wiring, verify power wiring, start-up the drive, and check for proper operation. The service technician shall provide final adjustments to meet the specified performance requirements. Fully staffed parts and service personnel shall be within four hours travel from the jobsite.

B. Carrier Frequency Set up:
   1. Set initial carrier frequency at 2 kHz.
   2. Manually raise VFD speed output from 10 Hz to 60 Hz by 10 Hz increments, allowing at least 15 seconds between each adjustment. If excessive motor noise is heard at any speed, raise carrier frequency by 2 kHz increments until motor noise is no longer excessive. Do not set carrier frequency higher than 10 kHz.
   3. If excessive motor noise continues to be heard at or below 10 kHz, inform owner. If the motor is provided by the VFD manufacturer, either repair, replace, or provide 5 year extended warranty on the effected motor.

C. Lockout of resonant frequencies:
   1. With carrier frequency set per the above specification, manually and slowly raise VFD speed output from 10 Hz to 60 Hz by 1 Hz increments. If excessive motor, frame, or driven load noise is heard at any speed, lock out that frequency.
   2. Each frequency skip shall be programmed with as narrow a bandwidth as possible, while still avoiding the most objectionable range of resonant frequencies. Each frequency skip bandwidth shall not exceed 5 Hz without approval by Engineer.

D. Training:
   1. Provide 1 hour training session to the owner’s representative.
   2. Training to include
      a. Demonstration of operation of bypass switch and door-mounted disconnect switches. Explain emergency operation.
      b. Demonstrate operation of operator keypads for viewing data and setting parameters.
      c. Demonstrate operation in manual mode, including setting of specific speeds.
      d. Explain the drive parameters that might require operator adjustment.
      e. Describe troubleshooting techniques and warranty procedure.

END OF SECTION
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. This Section includes control sequences for HVAC systems, subsystems, and equipment.

B. Related Sections include the following:

1. Section 230900 "Building Automation System (BAS) Controls " for control equipment and devices and for submittal requirements.

1.3 DEFINITIONS

A. BAS: Building Automation System

B. DDC: Direct digital control.

C. VAV: Variable air volume.

1.4 ABBREVIATIONS

A. The following abbreviations may be used in graphics, schematics, point names, and other UI applications where space is at a premium.

1. AC - Air Conditioning
2. ACU - Air Conditioning Unit
3. AHU - Air Handling Unit
4. AI - Analog Input
5. AO - Analog Output
6. AUTO – Automatic
7. AUX – Auxiliary
8. BI/DI – Binary/Digital Input
9. BO/DO – Binary/Digital Output
10. C – Common
11. CHW - Chilled Water
12. CHWP - Chilled Water Pump
13. CHWR - Chilled Water Return
14. CHWS - Chilled Water Supply
15. COND – Condenser
16. CW - Condenser Water
17. CWP - Condenser Water Pump
18. CWR - Condenser Water Return
19. CWS - Condenser Water Supply
20. DA - Discharge Air
21. EA - Exhaust Air
22. EF - Exhaust Fan
23. EVAP – Evaporators
24. FCU - Fan Coil Unit
25. HOA - Hand / Off / Auto
26. HP - Heat Pump
27. HRU - Heat Recovery Unit
28. HTEX - Heat Exchanger
29. HW - Hot Water
30. HWP - Heating Water Pump
SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

31. HWR – Heating Water Return
32. HWS - Heating Water Supply
33. MAX – Maximum
34. MIN – Minimum
35. MISC – Miscellaneous
36. NC - Normally Closed
37. NO - Normally Open
38. OA - Outdoor Air
39. RA - Return Air
40. RF - Return Fan
41. RH - Relative Humidity
42. RTU - Roof-top Unit
43. SA - Supply Air
44. SF - Supply Fan
45. SP - Static Pressure
46. TEMP – Temperature
47. UH - Unit Heater
48. UV - Unit Ventilator
49. VAV - Variable Air Volume
50. VVTU - Variable Volume Terminal Unit
51. W/ - with
52. W/O – without
53. WSHP - Water Source Heat Pump

PART 2 - PRODUCTS (NOT APPLICABLE – REFER TO 230900)

PART 3 - EXECUTION

3.1 MAKEUP AIR UNIT, MUA-M1

A. Run Conditions - Scheduled:
   1. The unit shall run based upon an operator adjustable schedule.

B. Freeze Protection:
   1. The unit shall shut down and generate an alarm upon receiving a freezestat status.

C. Smoke Detection:
   1. The unit shall shut down and generate an alarm upon receiving a smoke detector status.

D. Outside Air Damper:
   1. The outside air damper shall open anytime the unit runs and shall close anytime the unit stops. The supply fan shall start only after the damper status has proven the damper is open. The outside air damper shall close 4sec (adj.) after the supply fan stops.

E. Alarms shall be provided as follows:
   1. Outside Air Damper Failure: Commanded open, but the status is closed.
   2. Outside Air Damper in Hand: Commanded closed, but the status is open.

F. Cooling Recovery Mode:
   1. The heat pipe operates continuously. The controller shall operate the face/bypass dampers to face mode whenever:
      a. Return air temperature is 5°F (adj.) or more below the outside air temperature.
      b. AND the unit is in a cooling mode.
      c. AND the supply fan is on.
SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

G. Heating Recovery Mode:
   1. The heat pipe operates continuously. The controller shall operate the face/bypass dampers to face mode whenever:
      a. Return air temperature is 5°F (adj.) or more above the outside air temperature.
      b. AND the unit is in a heating mode.
      c. AND the supply fan is on.

H. Bypass Mode:
   1. The heat pipe operates continuously. The controller shall operate the face/bypass dampers to bypass mode whenever:
      a. Return air temperature is 5°F (adj.) or more above the outside air temperature.
      b. AND the unit is in a cooling mode.
      c. AND the supply fan is on.
      OR
      d. Return air temperature is 5°F (adj.) or more below the outside air temperature.
      e. AND the unit is in a heating mode.
      f. AND the supply fan is on.

I. Frost Protection:
   1. 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 exhaust air coil whenever:
      a. Run-around loop temperature drops below 33°F (adj.)
      b. OR the exhaust air temperature drops below 30°F (adj.).
   2. Alarms shall be provided as follows:
      a. Run-Around Loop Pump Failure: Commanded on, but the status is off.
      b. Run-Around Loop Pump in Hand: Commanded off, but the status is on.
      c. Run-Around Loop Pump Runtime Exceeded: Status runtime exceeds a user definable limit (adj.).

J. Supply Fan:
   1. The supply fan shall run anytime the unit is commanded to run. To prevent short cycling, the supply fan shall have a user definable (adj.) minimum runtime, unless shutdown on safeties. The supply fan will maintain 1.5" (adj.) positive pressure in the supply ductwork during occupied hours.
   2. Alarms shall be provided as follows:
      a. Supply Fan Failure: Commanded on, but the status is off.
      b. Supply Fan in Hand: Commanded off, but the status is on.
      c. Supply Fan Runtime Exceeded: Status runtime exceeds a user definable limit (adj.).

K. Exhaust Fan:
   1. The exhaust fan shall run whenever the supply fan runs, unless shutdown on safeties. The exhaust fan will maintain -1" (adj.) negative pressure in the exhaust ductwork during occupied hours.
   2. Alarms shall be provided as follows:
      a. Exhaust Fan Failure: Commanded on, but the status is off.
      b. Exhaust Fan in Hand: Commanded off, but the status is on.
      c. Exhaust Fan Runtime Exceeded: Status runtime exceeds a user definable limit (adj.).
L. Supply Air Temperature Setpoint - Outside Air Reset:
   1. The controller shall monitor the supply air temperature and shall maintain supply air temperature setpoint. The supply air temperature setpoint shall reset for cooling as follows:
      a. As outside air temperature drops from 85°F (adj.) to 20°F (adj.) the supply air temperature setpoint shall reset upwards from 55°F (adj.) to 80°F (adj.).

M. Cooling Coil Valve:
   1. The cooling coil valve shall be locked into an open position. Valve provided for future temperature control use.

N. Heating Coil Valve:
   1. The controller shall measure the supply air temperature and modulate the heating coil valve to maintain its heating setpoint.
   2. The heating shall be enabled whenever:
      a. Outside air temperature is less than 65°F (adj.).
      b. AND the supply air temperature is below heating setpoint.
      c. AND the fan status is on.
   3. The heating coil valve shall open to 100% (adj.) whenever the freezestat is on.

O. Supply Air Temperature:
   1. The controller shall monitor the supply air temperature.
   2. Alarms shall be provided as follows:
      a. High Supply Air Temp: If the supply air temperature is greater than 120°F (adj.).
      b. Low Supply Air Temp: If the supply air temperature is less than 45°F (adj.).

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<th>Point Name</th>
<th>Hardware Points</th>
<th>Software Points</th>
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<tr>
<td>Supply Duct Pressure</td>
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NOTICE OF ALTERNATE BILLING CYCLE: The Contract will allow the Owner to require the submission of billings or estimates in billing cycles other than 30-day cycles. Billing or statements shall be submitted monthly ending on the last day of the month.

NOTICE OF EXTENDED CERTIFICATION PROVISION: The Contract will allow the Owner to certify billings and estimate within 20 days after the billings and estimates are received from the original contractor.

NOTICE OF EXTENDED PAYMENT PROVISION: The Contract will allow the Owner to make payment within 30 days after the date a billing or estimate is received.
### SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

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<th>Point Name</th>
<th>Hardware Points</th>
<th>Software Points</th>
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<td>Face/Bypass Air Damper Failure</td>
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<tr>
<td>Supply Fan Smoke Detector</td>
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<tr>
<td>Supply Fan in Hand</td>
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<tr>
<td>Supply Fan Runtime Exceeded</td>
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<td>Exhaust Fan High Static</td>
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<td>Exhaust Fan Smoke Detector</td>
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<tr>
<td>Exhaust Fan in Hand</td>
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<td>Prefilter Change Required</td>
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<td>Final Filter Change Required</td>
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<td>High Supply Air Temp</td>
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<td></td>
</tr>
<tr>
<td>Low Supply Air Temp</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3.2 EXHAUST FAN - EF-1,2,3

A. Run Conditions - On/Off:
   1. The fan shall run via on/off wall switch located outdoors near canopy hoods.

B. Fan Status:
   1. The controller shall monitor the fan status.
   2. Alarms shall be provided as follows:
      a. Fan Failure: Commanded on, but the status is off.
      b. Fan Runtime Exceeded: Runs longer than a user adj. period.

<table>
<thead>
<tr>
<th>Hardware Points</th>
<th>Software Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Point Name</td>
<td>AI</td>
</tr>
<tr>
<td>Fan Status</td>
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</tr>
<tr>
<td>Fan Failure</td>
<td></td>
</tr>
<tr>
<td>Fan Runtime Exceeded</td>
<td>x</td>
</tr>
</tbody>
</table>

3.3 EXHAUST FAN - EF-4

A. Run Conditions - Scheduled:
   1. The fan shall run continuously at minimum speed. The fan shall run at maximum speed
during positive input from occupancy sensor.

B. Fan Status:
   1. The controller shall monitor the fan status.
   2. Alarms shall be provided as follows:
      a. Fan Failure: Commanded on, but the status is off.
      b. Fan in Hand: Commanded off, but the status is on.

<table>
<thead>
<tr>
<th>Hardware Points</th>
<th>Software Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Point Name</td>
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<tr>
<td>Fan Status</td>
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<td>Fan Start/Stop</td>
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<tr>
<td>Fan Speed</td>
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<td>Occupancy Sensor</td>
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<tr>
<td>Schedule</td>
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<td>Fan Failure</td>
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<tr>
<td>Fan in Hand</td>
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</tr>
<tr>
<td>Fan Runtime Exceeded</td>
<td>x</td>
</tr>
</tbody>
</table>

3.4 UNIT HEATER UH-1

A. Run Conditions - Continuous:
   1. The unit shall run continuously and shall maintain a heating setpoint of 55°F (adj.).
   2. Alarms shall be provided as follows:
      a. Low Zone Temp: If the zone temperature is less than the heating setpoint by a user definable amount (adj.).
B. Fan:
   1. The fan shall run anytime the zone temperature drops below heating setpoint, unless shutdown on safeties.

C. Heating Coil Valve:
   1. The controller shall measure the zone temperature and modulate the heating coil valve to maintain its heating setpoint.
   2. The heating shall be enabled whenever:
      a. Outside air temperature is less than 65°F (adj.).
      b. AND the zone temperature is below heating setpoint.
      c. AND the fan is on.

<table>
<thead>
<tr>
<th>Hardware Points</th>
<th>Software Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Point Name</td>
<td>AI</td>
</tr>
<tr>
<td>Zone Temp</td>
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</tr>
<tr>
<td>Heating Valve</td>
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<td>Fan Start/Stop</td>
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<td>Heating Setpoint</td>
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</tr>
<tr>
<td>Low Zone Temp</td>
<td></td>
</tr>
</tbody>
</table>

3.5 VARIABLE AIR VOLUME - TERMINAL UNIT

A. Refer to control matrix on drawings for zone control strategies.

B. Run Conditions - Scheduled:
   1. The unit shall run according to a user definable time schedule in the following modes:
      a. Occupied Mode: The unit shall maintain
         1) A 74°F (adj.) cooling setpoint
         2) A 70°F (adj.) heating setpoint.
      b. Unoccupied Mode (night setback): The unit shall maintain
         1) A 85°F (adj.) cooling setpoint.
         2) A 55°F (adj.) heating setpoint.

C. Alarms shall be provided as follows:
   1. High Zone Temp: If the zone temperature is greater than the cooling setpoint by a user definable amount (adj.).
   2. Low Zone Temp: If the zone temperature is less than the heating setpoint by a user definable amount (adj.).

D. Zone Setpoint Adjust:
   1. The occupant shall be able to adjust the zone temperature heating and cooling setpoints at the zone sensor.

E. Zone Optimal Start:
   1. The unit shall use an optimal start algorithm for morning start-up. This algorithm shall minimize the unoccupied warm-up or cool-down period while still achieving comfort conditions by the start of scheduled occupied period.
SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

F. Variable Volume Terminal Unit - Flow Control:
   1. The unit shall maintain zone setpoints by controlling the airflow through one of the following:
      a. Occupied:
         1) When zone temperature is greater than its cooling setpoint, the zone damper shall modulate between the minimum occupied airflow (adj.) and the maximum cooling airflow (adj.) until the zone is satisfied.
         2) When the zone temperature is between the cooling setpoint and the heating setpoint, the zone damper shall maintain the minimum required zone ventilation (adj.).
         3) When zone temperature is less than its heating setpoint, the controller shall enable heating to maintain the zone temperature modulating control valve at its heating setpoint and shall maintain the minimum required zone ventilation (adj.).
      b. Unoccupied:
         1) When the zone is unoccupied the zone damper shall control to its minimum unoccupied airflow (adj.).
      c. Override:
         1) When the exhaust airflow is required to match hood airflow operation

<table>
<thead>
<tr>
<th>Point Name</th>
<th>Hardware Points</th>
<th>Software Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone Temp</td>
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<td></td>
</tr>
<tr>
<td>Zone Setpoint Adjust</td>
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</tr>
<tr>
<td>Supply Air Temp</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Airflow</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Zone Damper</td>
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<td></td>
</tr>
<tr>
<td>Zone Override</td>
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<td>Airflow Setpoint</td>
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<tr>
<td>Heating Mode</td>
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</tr>
<tr>
<td>Schedule</td>
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<td>x</td>
</tr>
<tr>
<td>Heating Setpoint</td>
<td></td>
<td>x</td>
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<tr>
<td>Cooling Setpoint</td>
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<td>x</td>
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<tr>
<td>High Zone Temp</td>
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<td></td>
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<tr>
<td>Low Zone Temp</td>
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</tr>
</tbody>
</table>

3.6 VARIABLE AIR VOLUME - FAN POWERED BOX

A. Refer to control matrix on drawings for zone control strategies.

B. Run Conditions - Scheduled:
   1. The unit shall run according to a user definable time schedule in the following modes:
      a. Occupied Mode: The unit shall maintain
         1) A 74°F (adj.) cooling setpoint
         2) A 70°F (adj.) heating setpoint.
      b. Unoccupied Mode (night setback): The unit shall maintain
         1) A 85°F (adj.) cooling setpoint.
         2) A 55°F (adj.) heating setpoint.
2. Alarms shall be provided as follows:
   a. High Zone Temp: If the zone temperature is greater than the cooling setpoint by a user definable amount (adj.).
   b. Low Zone Temp: If the zone temperature is less than the heating setpoint by a user definable amount (adj.).

C. Zone Setpoint Adjust:
   1. The occupant shall be able to adjust the zone temperature heating and cooling setpoints at the zone sensor.

D. Zone Optimal Start:
   1. The unit shall use an optimal start algorithm for morning start-up. This algorithm shall minimize the unoccupied warm-up or cool-down period while still achieving comfort conditions by the start of scheduled occupied period.

E. Zone Unoccupied Override:
   1. A timed local override control shall allow an occupant to override the schedule and place the unit into an occupied mode for an adjustable period of time. At the expiration of this time, control of the unit shall automatically return to the schedule.

F. Fan Powered Box - Flow Control:
   1. The unit shall maintain zone setpoints by controlling the airflow through one of the following:
   2. Occupied:
      a. When zone temperature is greater than its cooling setpoint, the zone damper shall modulate between the minimum occupied airflow (adj.) and the maximum cooling airflow (adj.) until the zone is satisfied.
      b. When the zone temperature is between the cooling setpoint and the heating setpoint, the zone damper shall maintain the minimum required zone ventilation (adj.).
      c. When zone temperature is less than its heating setpoint, the controller shall enable heating to maintain the zone temperature modulating control valve at its heating setpoint and shall maintain the minimum required zone ventilation (adj.).
   3. Unoccupied:
      a. When the zone is unoccupied the zone damper shall close.
      b. When zone temperature is less than its heating setpoint, the controller shall enable heating to maintain the zone temperature modulating control valve at its heating setpoint and zone damper shall close and the fan shall operate.

<table>
<thead>
<tr>
<th>Hardware Points</th>
<th>Software Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Point Name</td>
<td>AI</td>
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<tr>
<td>Zone Temp</td>
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</tr>
<tr>
<td>Zone Setpoint Adjust</td>
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</tr>
<tr>
<td>Supply Air Temp</td>
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</tr>
<tr>
<td>Airflow</td>
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<tr>
<td>Zone Damper</td>
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<tr>
<td>Zone Override</td>
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<td>Fan Start</td>
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<tr>
<td>Airflow Setpoint</td>
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<tr>
<td>Heating Mode</td>
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</tbody>
</table>

SERA Architects, Inc.
### SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

<table>
<thead>
<tr>
<th>Point Name</th>
<th>Hardware Points</th>
<th>Software Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schedule</td>
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</tr>
<tr>
<td>Heating Setpoint</td>
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<td>x</td>
</tr>
<tr>
<td>Cooling Setpoint</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Fan Failure</td>
<td></td>
<td></td>
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<tr>
<td>High Zone Temp</td>
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<td>x</td>
</tr>
<tr>
<td>Low Zone Temp</td>
<td></td>
<td>x</td>
</tr>
</tbody>
</table>

#### 3.7 VARIABLE VOLUME EXHAUST - TERMINAL UNIT

A. Refer to control matrix on drawings for zone control strategies.

B. Run Conditions - Scheduled:
   1. The unit shall run according to a user definable time schedule in the following modes:
      a. Occupied Mode: The unit shall maintain
         1) A 74°F (adj.) cooling setpoint
         2) A 70°F (adj.) heating setpoint.
      b. Unoccupied Mode (night setback): The unit shall maintain
         1) A 85°F (adj.) cooling setpoint.
         2) A 55°F (adj.) heating setpoint.
   2. Alarms shall be provided as follows:
      a. High Zone Temp: If the zone temperature is greater than the cooling setpoint by a
         user definable amount (adj.).
      b. Low Zone Temp: If the zone temperature is less than the heating setpoint by a user
         definable amount (adj.).

C. Demand Limiting - Zone Setpoint Optimization:
   1. To lower power consumption, the zone setpoints shall automatically relax when the facility
      power consumption exceeds definable thresholds. The amount of relaxation shall be
      individually configurable for each zone. The zone setpoints shall automatically return to
      their previous settings when the facility power consumption drops below the thresholds.

D. Zone Setpoint Adjust:
   1. The occupant shall be able to adjust the zone temperature heating and cooling setpoints
      at the zone sensor.

E. Zone Optimal Start:
   1. The unit shall use an optimal start algorithm for morning start-up. This algorithm shall
      minimize the unoccupied warm-up or cool-down period while still achieving comfort conditions
      by the start of scheduled occupied period.

F. Zone Unoccupied Override:
   1. A timed local override control shall allow an occupant to override the schedule and place
      the unit into an occupied mode for an adjustable period of time. At the expiration of this
      time, control of the unit shall automatically return to the schedule.

G. Reversing Variable Volume Terminal Unit - Flow Control:
   1. The unit shall maintain zone setpoints by controlling the airflow through one of the following:
      a. Occupied:
         1) When zone temperature is greater than its cooling setpoint, the zone damper shall modulate to match the supply terminal unit airflow.
SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

2) When the zone temperature is between the cooling setpoint and the heating setpoint, the zone damper shall maintain the minimum required zone ventilation (adj.).

3) When zone temperature is less than its heating setpoint, the controller shall enable heating to maintain the zone temperature modulating control valve at its heating setpoint and shall maintain the minimum required zone ventilation (adj.).

b. Unoccupied:
1) When the zone is unoccupied the zone damper shall control to its minimum unoccupied airflow (adj.).

c. Override:
1) When the exhaust airflow is required to match hood ventilation operation.

<table>
<thead>
<tr>
<th>Hardware Points</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Airflow</td>
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<tr>
<td>Zone Damper</td>
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<tr>
<td>Zone Override</td>
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<td>Occupancy Sensor</td>
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<tr>
<td>Zone Switch</td>
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<td>Zone Temperature</td>
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<tr>
<td>Airflow Setpoint</td>
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</tr>
<tr>
<td>Schedule</td>
<td></td>
</tr>
</tbody>
</table>

3.8 VARIABLE FREQUENCY DRIVE INTERFACE

A. Variable Frequency Drive (VFD) Interface Monitor:
1. Current VFD status and operating conditions shall be monitored through its communications interface port. The interface shall monitor and trend the points as shown on the Points List.

<table>
<thead>
<tr>
<th>Hardware Points</th>
<th>Software Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor Speed RPM</td>
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<tr>
<td>Motor Frequency Hertz</td>
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</tr>
<tr>
<td>Motor Current Amps</td>
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<tr>
<td>Motor Runtime</td>
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<tr>
<td>VFD Status</td>
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<tr>
<td>In Fault Condition</td>
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</tr>
<tr>
<td>In Bypass</td>
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</tr>
</tbody>
</table>
3.9 HOT WATER LOOP PUMPS

A. Hot Water Pump Run Conditions:
   1. The hot water pumps shall be enabled whenever:
      a. A definable number of hot water coils need heating.
      b. AND outside air temperature is less than 54°F (adj.).

B. The pumps shall run for freeze protection anytime outside air temperature is less than 38°F (adj.).

C. To prevent short cycling, the pump shall run for a minimum time and be off for a minimum time (both user adjustable).

D. Hot Water Pump Operation:
   1. The variable speed hot water pumps shall operate when required by pressure and schedule.
   2. Alarms shall be provided as follows:
      a. Hot Water Pump
         1) Failure: Commanded on, but the status is off.
         2) Running in Hand: Commanded off, but the status is on.
         3) Runtime Exceeded: Status runtime exceeds a user definable limit.
         4) VFD Fault.

E. Hot Water Differential Pressure Control:
   1. The controller shall measure hot water differential pressure and modulate the hot water pump VFD in sequence to maintain its hot water differential pressure setpoint.
   2. The following setpoints are recommended values. All setpoints shall be field adjusted during the commissioning period to meet the requirements of actual field conditions.
   3. The controller shall modulate hot water pump speeds to maintain a hot water differential pressure of 12lbf/in² (adj.). The VFDs minimum speed shall not drop below 20% (adj.).
   4. On dropping hot water differential pressure, the VFDs shall stage on and run to maintain setpoint as follows:
      a. The controller shall modulate the lead VFD to maintain setpoint.
   5. On rising hot water differential pressure, the VFDs shall stage off as follows:
      a. The lead VFD shall continue to run to maintain setpoint.
   6. Alarms shall be provided as follows:
      a. High Hot Water Differential Pressure: If 25% (adj.) greater than setpoint.
      b. Low Hot Water Differential Pressure: If 25% (adj.) less than setpoint.

F. Hot Water Temperature Monitoring:
   1. The following temperatures shall be monitored:
      a. Hot water supply.
      b. Hot water return.
   2. Alarms shall be provided as follows:
      a. High Hot Water Supply Temp: If the hot water supply temperature is greater than 200°F (adj.).
      b. Low Hot Water Supply Temp: If the hot water supply temperature is less than 100°F (adj.).
### 3.10 CHILLED WATER LOOP PUMPS

**A. Chilled Water Pump System - Run Conditions:**

1. The chilled water pumps shall be enabled whenever:
   a. A definable number of chilled water coils need cooling.
   b. AND the outside air temperature is greater than 54°F (adj.).

2. To prevent short cycling, the chilled water pump system shall run for and be off for minimum adjustable times (both user definable).

3. The pumps shall run for freeze protection anytime the outside air temperature is less than 38°F (adj.).

**B. Chilled Water Pump:**

1. The chilled water pump shall run anytime it is requested to run. The chilled water pump shall also run for freeze protection whenever the outside air temperature is less than a user definable setpoint (adj.).

2. The chilled water pump shall have:
   a. A user adjustable delay on start.
   b. AND a user adjustable delay on stop.

3. The delay times shall be set appropriately to allow for orderly chilled water system start-up, shutdown and sequencing.

4. Alarms shall be provided as follows:
   a. Chilled Water Pump Failure: Commanded on, but the status is off.
   b. Chilled Water Pump Running in Hand: Commanded off, but the status is on.
SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

c. Chilled Water Pump Runtime Exceeded: Status runtime exceeds a user definable limit.
d. Chilled Water Pump VFD Fault.

C. Chilled Water Differential Pressure Control:
1. The controller shall measure chilled water differential pressure and modulate the chilled water pump VFD to maintain its chilled water differential pressure setpoint. The following setpoints are recommended values. All setpoints shall be field adjusted during the commissioning period to meet the requirements of actual field conditions.
2. The controller shall modulate chilled water pump speed to maintain a chilled water differential pressure of 12lb/in² (adj.). The VFD minimum speed shall not drop below 20% (adj.).
3. Alarms shall be provided as follows:
   a. High Chilled Water Differential Pressure: If the chilled water differential pressure is 25% (adj.) greater than setpoint.
   b. Low Chilled Water Differential Pressure: If the chilled water differential pressure is 25% (adj.) less than setpoint.

<table>
<thead>
<tr>
<th>Hardware Points</th>
<th>Software Points</th>
<th>Show On Graphic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Point Name</td>
<td>AI</td>
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<td>Chilled Water Differential Pressure</td>
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<tr>
<td>Chilled Water Pump VFD Speed</td>
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<tr>
<td>Chilled Water Pump Status</td>
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<tr>
<td>Chilled Water Pump VFD Fault</td>
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<td>Chilled Water Pump Start/Stop</td>
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<td>Chilled Water Pump Runtime Exceeded</td>
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<tr>
<td>High Chilled Water Differential Pressure</td>
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<tr>
<td>Low Chilled Water Differential Pressure</td>
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</tr>
</tbody>
</table>

3.11 FAN COIL UNIT

A. Run Conditions - Scheduled:
1. The unit shall run continuously:
   a. A 74°F (adj.) cooling setpoint
2. Alarms shall be provided as follows:
   a. High Zone Temp: If the zone temperature is greater than the cooling setpoint by a user definable amount (adj.).
   b. Low Zone Temp: If the zone temperature is less than the heating setpoint by a user definable amount (adj.).
B. Fan:
1. The fan shall run anytime the unit is commanded to run, unless shutdown on safeties.
2. Cooling Coil Valve:
   a. The controller shall measure the zone temperature and modulate the cooling coil valve to maintain its cooling setpoint.
   b. The cooling shall be enabled whenever:
      1) the zone temperature is above cooling setpoint.
      2) AND the fan is on.

C. Fan Status:
1. The controller shall monitor the fan status.
2. Alarms shall be provided as follows:
   a. Fan Failure: Commanded on, but the status is off.
   b. Fan in Hand: Commanded off, but the status is on.
   c. Fan Runtime Exceeded: Fan status runtime exceeds a user definable limit (adj.).

<table>
<thead>
<tr>
<th>Hardware Points</th>
<th>Software Points</th>
</tr>
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<tbody>
<tr>
<td><strong>Point Name</strong></td>
<td><strong>AI</strong></td>
</tr>
<tr>
<td>Zone Temp</td>
<td>x</td>
</tr>
<tr>
<td>Cooling Valve</td>
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<td>Fan Status</td>
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<tr>
<td>Fan Start/Stop</td>
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</tr>
<tr>
<td>Schedule</td>
<td></td>
</tr>
<tr>
<td>Cooling Setpoint</td>
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<tr>
<td>High Zone Temp</td>
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<td>Fan Failure</td>
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<tr>
<td>Fan in Hand</td>
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<tr>
<td>Fan Runtime Exceeded</td>
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</tbody>
</table>

END OF SECTION
PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS

A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 230500 - Basic Materials and Methods, and other Sections in Division 23 specified herein.

1.2 SCOPE

A. All work to be furnished and installed under this section shall include, but not necessarily be limited to, the following:

1. Pipe and Fittings
   a. Chilled water piping above grade
   b. Condenser water piping above grade
   c. Heating water piping above grade
   d. Low pressure steam piping above grade
   e. Medium pressure steam above grade
   f. High pressure steam above grade
   g. Steam condensate above grade
   h. Boiler feed
   i. Temperature and Pressure relief
   j. Radiant heating piping
   k. Refrigerant piping
   l. Cold condensate drainage piping (refer to section 222113 Plumbing Piping)

2. Valves
   a. HVAC Service Valves (125 psig max. working pressure)
   b. HVAC Service Valves (250 psig max. working pressure)
   c. Balancing Valves (125 psig working pressure)
   d. Combination HVAC terminal unit valve line sets
   e. Hydronic Service Pressure Reducing Valves
   f. Hydronic Service Pressure Relief Valves

3. Thermometers, gauges and accessories

4. Piping specialties
   a. Pipe escutcheons
   b. Strainers
   c. Drip pans
   d. Air vent
   e. Dielectric unions and flanges
   f. Unions
   g. Flanges
   h. Pipe sleeves
   i. Sleeve seals
   j. Valve boxes

5. Pipe coating

6. Expansion Compensators

B. In addition, provide the following:
   1. Furnish accessories and labor for flushing and cleaning HVAC piping.
   2. Install water treatment systems.
   3. Furnish material, accessories and labor for antifreeze charging of HVAC piping.

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Division 01: General Requirements
NOTICE OF ALTERNATE BILLING CYCLE: The Contract will allow the Owner to require the submission of billings or estimates in billing cycles other than 30-day cycles. Billing or statements shall be submitted monthly ending on the last day of the month.

NOTICE OF EXTENDED CERTIFICATION PROVISION: The Contract will allow the Owner to certify billings and estimates within 20 days after the billings and estimates are received from the original contractor.

NOTICE OF EXTENDED PAYMENT PROVISION: The Contract will allow the Owner to make payment within 30 days after the date a billing or estimate is received.
4. All work shall be completely coordinated, and all lines, grades, slopes and vertical and horizontal locations of pipes shall be exactly determined in the field and cleared with the Owner's Representative before the installation of these items is begun. No extra compensation shall be made for failure to observe this clause.

5. The Drawings and Specifications do not undertake to list every item that will be installed. When an item is necessary for the satisfactory operation of the system, it shall be furnished without extra cost. Work called for in the Specifications, but not on the Drawings, or vice versa, shall be done as though required by both. Lack of specific mention of any work necessary for proper completion of the work in the Specifications and/or Drawings, shall not lessen the Contractor's responsibility.

6. Obtain Owner's Representative's approval prior to rerouting of existing services. Refer to Division 01 sections for alterations, shutdown and temporary construction for existing services.

7. Pipe spaces provided in the design shall be utilized and the work shall be kept within the spaces established on the Drawings.

8. Manufacturers' directions shall be followed in all cases where manufacturers of articles used in this Contract furnish directions covering points not shown on the Drawings or specified herein. Manufacturers' directions do not take precedence over the Drawings and Specifications. Where manufacturers' directions are in conflict with the Drawings and Specifications, submit these conflicts to the Engineer and receive clarification before installing the work.

9. Do not permit or cause any work to be covered or enclosed until it has been inspected, tested, and approved. Should any of the work be enclosed or covered before inspection and test, Contractor shall, at his/her own expense, uncover the work; and, after it has been inspected, tested and approved, make all repairs with such materials as may be required. Restore all work to its original and proper condition.

10. Be responsible for damage to any of this work before acceptance. Securely cover all openings, both before and after setting into place, to prevent obstructions in the pipes and breakage.

11. Repair all damage to the premises occasioned by the work. All damage to any part of the premises caused by leaks or breaks in the pipe installed under this Section of the work for a period of one (1) year after date of final acceptance of the work, shall be repaired.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data for all piping, valves and specialties indicating dimensions, valve CV, flow capacity, pressure setting, tolerances etc.

B. Maintenance Data: Submit maintenance instructions, including instructions for lubrication, valve replacement, and spare parts lists. Include this data, product data, and shop drawings in operating and maintenance manuals.

C. Grooved joint couplings and fittings shall be shown on drawings and product submittals, and be specifically identified with the applicable Victaulic style number.

PART 2 - PRODUCTS

2.1 GENERAL

A. Furnish and install all new material, equipment, and apparatus hereinafter specified unless specifically noted otherwise. All material, equipment, and apparatus shall be identified by the manufacturer's name, nameplate, and pertinent data. All pipe, pipe fittings and valves shall be manufactured in North America. Alternatives may be acceptable, but must be submitted and approved by the Engineer prior to bidding.
2. Upon request, the engineer shall be furnished certification by the manufacturer, stating samples representing each lot have been tested and inspected as indicated in governing ASTM specifications have been met. Certification shall be accompanied by test reports as prepared in accordance with relevant ASTM sections governing Test Methods and Inspection. Tension Tests reports shall include breaking load, machined diameter of the test bars, and calculated tensile strength. Certification shall include the legal name and address of the manufacturer.

B. Type M copper piping is not acceptable for any pressure water piping unless specifically noted otherwise.

C. All materials, equipment, and apparatus are mentioned as standards unless noted otherwise. The words "or approved equal" shall be considered to be subsequent to all manufacturers' names used herein, unless specifically noted that substitutes are not allowed.

D. Hydronic and Steam Piping Pressure Classifications:

1. Chilled Water, Condenser Water, Heating Water:
   a. "Normal Pressure" shall be working fluid pressure up to 50 psig.
   b. "Medium Pressure" shall be working fluid pressure up to 100 psig.
   c. "High Pressure" shall be working fluid pressure up to 200 psig.

2. Steam:
   a. "Low Pressure" shall be working steam pressure up to 20 psig.
   b. "Medium Pressure" shall be working steam pressure 20-80 psig.
   c. "High Pressure" shall be working steam pressure greater than 80 psig.

2.2 PIPE AND FITTINGS

A. Chilled Water Piping: (Above grade)

1. Steel Pipe:
   a. Pipe Material: ASTM A53 Grade B, Schedule 40 black steel up to 10" diameter. Standard weight black steel for 12" and larger.
   b. Fittings:
      1) Steel normal pressure application: 150 lb. rating. ANSI B16.3, malleable iron threaded for pipe 2-inch and under; ANSI B16.5, flanged; ANSI B16.9, steel bevel welding
      2) Steel high pressure application: 300 lb. rating. ANSI B16.3, malleable iron threaded; ANSI B16.5, flanges; ANSI B16.9, steel bevel welding.
      3) Steel grooved end system: Painted, grooved end system, for applications to 300 psi.
         a) Grooved joint couplings shall be ASTM A395 and A536 ductile iron. Victaulic rigid Style 107 ("Installation Ready" stab-on design) and 07 (standard coupling), or flexible Style 177 ("Installation Ready" stab-on design and 77 (standard coupling), Tyco-Grinnell rigid Fig. 772 or flexible Fig 705 and 707, or Gruvlok FIG 7001 flexible or FIG 7401 rigid.
         b) Rigid Type: Coupling housings shall be used to provide system rigidity and support and hanging in accordance with ANSI B31.1 and B31.9. Victaulic Style 107 or 07, Grinnell Fig 772, or Gruvlok FIG 7401.
         c) Flexible Type: Use in locations where vibration attenuation and stress relief are required. Flexible couplings may be used in lieu of flexible connectors at equipment connections. Three couplings shall be
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placed in close proximity to the vibration source. Victaulic Style 177, 077, or W77, Grinnell 705 and 707, or Gruvlok FIG 7001.

d) Gasket as recommended for the intended service by the manufacturer. Gaskets shall be pressure responsive synthetic rubber, Grade “EHP” or Grade “E” EPDM or EHP.

e) Grooved fittings shall be ASTM A395 and A536 ductile iron; ASTM A234 forged steel; or fabricated from carbon steel pipe conforming to ASTM A53.

f) All grooved couplings, fittings, valves and specialties shall be the products of a single manufacturer.

g) Grooved manufacturer must be ISO 9001 certified.

2. Copper Tubing:

   a. Pipe Material: ASTM B88, Type K or Type L hard drawn copper water tube for normal pressure above grade.

   b. Fittings:

       1) Copper system: ASME B16.23 cast brass or ANSI/ASME B16.22 wrought copper with the following connection methods.

           a) Soldered or brazed: ASTM B32, solder, Grade 95TA.

           i) 2” and smaller: Make connections using 95%-5% tin-antimony solder joints above grade and sil-fos brazing below grade.

           ii) 2-1/2” and larger: Sil-Fos brazing or brazed and flanged.

           b) With prior approval a grooved or pressed copper tubing connection system

               i) Grooved couplings: Victaulic Style 607 (Quick Vic), Grinnell Fig. 672, Gruvlok FIG 6400.

               (1) Coupling gaskets shall be pressure responsive type, Grade “EHP” EPDM.

               (2) Fittings shall be wrought copper per ANSI B16.22, or bronze sand castings per ANSI B16.18.

               (3) Grooved manufacturer must be ISO 9001 certified.

               (5) Flaring of copper tube to IPS dimensions is unacceptable.

               ii) Pressed Fitting: As an alternate to soldered copper, threaded, or flanged steel, Vic Press 304™ pipe, couplings, and fittings may be used on the 2” and smaller chilled water piping system for normal pressure systems. Pipe shall be ASTM A312, Schedule 10S, Type 304/304L, certified for use with Vic Press 304™ products. Couplings and fittings shall be manufactured of precision cold drawn austenitic stainless steel, with EPDM O-ring or HNBR seals.

   c) Joints: 2” and smaller, threaded or Vic Press 304™ (except in the case of piping located in shafts which must be welded); 2-1/2” and larger, ANSI B16.25 bevel weld, ANSI B16.5 flanges, or ANSI B16.11 socket weld, grooved.

3. Stainless Steel: ASTM A312, Stainless Steel Type 304/304L, Schedule 10S, for above grade piping systems with operating pressures to a maximum of 300 psi.

B. Heating Water Piping (Above Grade):
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1. Steel Pipe: ASTM A53 Grade B, Schedule 40 black steel up to 10" diameter, and Std. Wt. Black steel for 12" diameter and greater.
   a. Fittings:
      1) Steel normal pressure application: 150 lb. rating. ANSI B16.3, malleable iron threaded; ANSI B16.5, flanged; ANSI B16.9, steel bevel welding
      2) Steel high-pressure application: 300 lb. rating. ANSI B16.3, malleable iron threaded; ANSI B16.5, flanges; ANSI B16.9, steel bevel welding.
      3) Steel grooved end system (MECHANICAL ROOM ONLY): Painted, grooved end system, for applications to 230 deg. F and 300 psi.
         a) Grooved joint couplings shall be ASTM A395 and A536 ductile iron. Victaulic rigid Style 07 or flexible Style 77.
            i) Rigid Type: Coupling housings cast with offsetting, angle-pattern bolt pads shall be used to provide system rigidity and support and hanging in accordance with ANSI B31.1 and B31.9. Victaulic Style 07.
            ii) Flexible Type: Use in locations where vibration attenuation and stress relief are required. Flexible couplings may be used in lieu of flexible connectors at equipment connections. Three couplings shall be placed in close proximity to the vibration source. Victaulic Style 77.
      b) Gasket as recommended for the intended service by the manufacturer. Gaskets shall be pressure responsive synthetic rubber, Grade EPDM, for service up to 230 deg F.
      c) Grooved fittings shall be ASTM A395 and A536 ductile iron; ASTM A234 forged steel; or fabricated from carbon steel pipe conforming to ASTM A53.
      d) All grooved couplings, fittings, valves and specialties shall be the products of a single manufacturer.
      e) Grooved manufacturer must be ISO 9001 certified.
   b. Joints: 2" and smaller, threaded (except in the case of piping located in shafts which must be welded); 2-1/2" and larger, ANSI B16.25 bevel weld, ANSI B16.5 flanges, ANSI B16.11 socket weld.

2. Copper: ASTM B88, Type K or Type L hard drawn copper water tube for normal pressure above grade.
   a. Fittings:
      1) Copper system: ANSI B16.22, wrought copper with the following connection methods.
         a) Soldered or brazed:
            i) 2" and smaller: Make connections using 95%-5% tin-antimony solder joints above grade and sil-fos brazing below grade.
            ii) 2-1/2" and larger: Sil-Fos brazing or brazed and flanged.
         b) Grooved copper tubing connection system (MECHANICAL ROOM ONLY): Victaulic CTS, may be used for above grade joint. Used on normal pressure only.
            i) Grooved couplings shall be ASTM A395 and A536 ductile iron, and must be of the angle bolt pad type. (Coupling coated with copper colored alkyd enamel.) Tongue and recess type couplings are unacceptable.
            ii) Coupling gaskets shall be pressure responsive FlushSeal® type, Grade EPDM.
            iii) Fittings shall be wrought copper per ANSI B16.22, or bronze sand castings per ANSI B16.18.
            iv) Grooved manufacturer must be ISO 9001 certified.
Flaring of copper tube to IPS dimensions is unacceptable.

As an alternate with prior approval to soldered copper, threaded, or flanged steel, Vic Press 304™ pipe, couplings, and fittings may be used on the 2” and smaller heating water piping in mechanical room applications only. Pipe shall be ASTM A312, Schedule 5S, Type 304/304L, certified for use with Vic Press 304™ products. Couplings and fittings shall be manufactured of precision cold drawn austenitic stainless steel, with EPDM O-ring seals for service up to 230 deg F.

With prior approval a pressed copper tubing connection system is acceptable for mechanical room application only.

C. Temperature and Pressure Relief Valve Discharge Piping:

1. Hydronic Water System (150 psig and 212 deg. F. maximum):
   a. Pipe: Type M or L copper ASTM B88
   b. Pipe: Schedule 40 black steel, ASTM A53 Grade B.
   e. Joints: ANSI B16.22, wrought copper, with 95%-5% tin-antimony solder joints.
   f. Joints: 2” and smaller, threaded (except in the case of piping located in shafts which must be welded); 2-1/2” and larger, ANSI B16.25bevel weld, ANSI B16.5 flanges, or ANSI B16.11 socket weld.

2.3 VALVES: GENERAL

A. General: Valve ratings shall exceed respective system operating pressures by 50% (minimum). All valves shall be line size unless otherwise noted.

B. Product Data: Submit manufacturer's technical product data, including installation instructions for each type of valve. Include pressure drop curve or chart for each type and size of balancing valve or circuit setter. Submit valve schedule showing manufacturer's figure number, size, location, and valve features for each required valve.

C. Shop Drawings: Submit manufacturer's assembly-type (exploded view) shop drawings for each type of valve, indicating dimensions, weights, materials, and methods of assembly of components.

D. Acceptable Manufacturers (manufacturer and model number listed for individual valves indicates minimum acceptable by all manufacturers):
   1. Gate, Globe, Check, or Butterfly: Crane, Delta Control Products, Hammond, Gruvlok, Milwaukee, Victaulic, Tyco-Grinnell, Nibco.
   3. Lubricated Natural Gas Service Plug Valves: Homestead, Resun, or Rockwell.
   5. Steam System Pressure Reducing Valves: Sarco, Fischer, Hoffman, or Spence.
   6. Hydronic Pressure Relief Valves: Cash-Acme, Cla-Val, Watts, or Wilkins.
   7. Steam System Pressure Relief Valves: Sarco, Fischer, Spence, or Lonergan-Kunkle.
   8. Hydronic Balancing valves and Circuit Setters: Griswold (Venturi with characterized ball valve only), Wheatley (Y-globe type only), Armstrong, Nibco (globe style), or Victaulic/Tour & Anderson, Gruvlok, Tyco-Grinnell.

E. Valve Identification: Provide valves with manufacturer's name (or trademark) and pressure rating clearly marked on the valve body.

F. Operators:
   1. Provide standard handwheel for gate, globe valves.
   2. Provide 90 degree lever operator for ball valves.
3. Provide 90 degree lever operator for lubricated natural gas plug valves. Exterior located natural gas plug valves shall be provided with removable manual wrench handle, one wrench for each 10 valves.
4. Provide 90 degree locking lever operator for butterfly valves up through 6” size. For 8” size and greater, provide gear operator and handwheel.
5. Provide valve stem extension for lever-operated valves on insulated piping, so handle will clear insulation.
6. For valves sizes 2-1/2” and larger, located more than 10 feet from floor in equipment room areas, provide chain operated sheaves. Provide chain and extend down to 5ft above floor and hook clips on chain arranged to clear walking aisles.

G. Valve Features:
1. General: Provide valves with features indicated and, where not otherwise indicated, provide proper valve features. Comply with ASME B31.9 for building services piping and ASME B31.1 for power piping.
2. Bypass: On valves 6” and larger comply with MSS SP-45, and except as otherwise indicated, provide manufacturer’s standard bypass piping and valving. Provide a 3-valve bypass, minimum 1” size, to consist of two threaded shut-off valves and a plugged drain valve.
3. Drain: Comply with MSS SP-45, and provide ¾” threaded pipe end with cap on chain.
5. Grooved: Valves shall be joined using grooved joint couplings of the same manufacturer. Copper tubing valve grooved ends shall be copper tubing sized.

2.4 HVAC SERVICE VALVES: MAXIMUM 125 PSIG SYSTEM WORKING WATER PRESSURE

A. Gate Valves:
1. 2” and Smaller: Class 150, MSS SP-80, ASTM B62 cast bronze body, bronze union bonnet, bronze wedge, rising stem, brass packing gland, non-asbestos packing and aluminum or malleable iron hand-wheel. Threaded steel pipe: Milwaukee #1151. Soldered copper pipe: Milwaukee #1169.
2. 2-1/2” and Larger: Class 125, MSS SP-70, ASTM A126 Grade B cast iron body, flanged ends, bolted bonnet and disc, bronze trim, OS & Y, brass packing gland, non-asbestos packing and cast iron hand-wheel. Milwaukee #F-2885-M.

B. Globe Valves:
1. 2” and Smaller: Class 150, MSS SP-80, ASTM B62 cast bronze body, bronze union bonnet, bronze wedge, rising stem, brass packing gland, non-asbestos packing and aluminum or malleable iron hand-wheel. Threaded steel pipe: Milwaukee #590T. Soldered copper pipe: Milwaukee #1590T.
2. 2-1/2” and Larger: Class 125, MSS SP-70, ASTM A126 Grade B cast iron body, flanged ends, bolted bonnet and disc, bronze trim, OS & Y, brass packing gland, non-asbestos packing and cast iron hand-wheel. Milwaukee #F-2981-M.

C. Butterfly Valves:
1. 2-1/2” and Larger:
   a. MSS SP-67, lug type, ductile iron body, stainless steel disc, stainless steel stem, EPDM seat, memory stop control, lever handle thru 5” size and worm gear operator for 6” and larger. Mount stem in horizontal position. Milwaukee #ML32E
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b. 2-1/2" through 12" grooved end type, Black enamel coated ASTM A395 and A536 ductile iron body, elastomer encapsulated or nickel-plated ductile iron disc offset to provide continuous 360 degree seating, with integrally cast or Type 416 stainless steel stem, memory stop control, lever handle thru 5" size and worm gear operator for 6" and larger. Mount stem in horizontal position. Victaulic Vic®-300 MasterSeal, Tyco Grinnell Model B302, Gruvlok FIG 7700 Series.

c. 14" through 24" grooved end type, PPS (Polyphenylene Sulfide) coated ASTM A395 and A536 ductile iron body, PPS coated ASTM A395 and A536 ductile iron disc with mounted elastomer seal, stainless steel stem, with gear operator. Victaulic Vic®-300 AGS (300 psi maximum pressure.), Tyco-Grinnell Model B308, Gruvlok FIG 7700 series.

d. 2-1/2" through 6" copper tube dimensioned grooved end type, CDA-836 cast bronze body, elastomer encapsulated ductile iron disc with integrally cast stem, memory stop control, lever handle thru 5" size and worm gear operator for 6". Mount stem in horizontal position. Victaulic Series 608, Tyco-Grinnell Model B680, or Gruvlok BFV.

D. Ball Valves:

1. 2" and Smaller:
   a. 600 psi, 2-piece brass body, stainless steel ball, Teflon seat, brass stem, steel handle, full port. Threaded steel ends for iron pipe and soldered ends for copper pipe. Threaded steel pipe: Milwaukee #BA-100. Soldered copper pipe: Milwaukee #BA-150.
   b. 300 psi maximum operating pressure, 2-piece brass body, chrome plated brass ball and stem, TFE seats, steel handle, standard port. Vic Press 304™ ends for stainless steel pipe. Victaulic Series 589.

E. Check Valves:

1. 2" and Smaller: Class 125, MSS SP-80, ASTM B62 and ASTM B16, cast bronze body, screwed cap, swing type, Teflon bronze disc. Threaded steel ends for iron pipe and soldered ends for copper pipe. Threaded steel pipe: Milwaukee #1509T. Soldered copper pipe: Milwaukee #1509.

2. 2-1/2" and Larger:
   a. Class 125, MSS SP-71, ASTM A126 class B cast iron body, bolted bonnet flanged ends, bolted cap, swing type, cast iron disc with bronze face rings. Milwaukee #F-2974M
   b. 300 psi maximum operating pressure, ASTM A395 and A536 ductile iron body and closure, grooved ends, coupled cap, swing type, stainless steel disc with elastomer seat. Victaulic Series 712, Gruvlok FIG 7800.

3. Silent Check 2-1/2" and Larger:
   a. Class 125, ASTM A126 class B cast iron body, flanged globe style, silent non-slam design, spring loaded, center guided, bronze trim, stainless steel spring and screws. Milwaukee #1800
   b. 365 psi maximum operating pressure, ASTM A395 and A536 ductile iron body, grooved ends, stainless steel spring and shaft.
      1) 2-1/2" and 3": Black enamel coated, stainless steel aluminum bronze disc with mounted elastomer seal and machined seat. Victaulic Series 716H, or Gruvlok FIG 7800.
      2) 4" – 12": Black enamel coated body, elastomer encapsulated ductile iron disc with welded-in nickel seat. 300 psi maximum operating pressure, Victaulic Series 716, Tyco-Grinnell Model 590, or Gruvlok FIG 7800.
      3) 14" – 24": Black enamel coated body, stainless steel disc, with EPDM seal bonded to the valve body, 230 psi maximum operating pressure, AGS grooved ends. Victaulic Series W715.
F. Drain Valves:
1. Threaded or soldered ends, Class 125, ASSE 1005, bronze body, screw-in bonnet, rising stem, composition disc, ¾" hose outlet.
2. Threaded or soldered ends, Class 600, bronze body, 2-piece ball valve, ¾" hose outlet with cap and chain. Milwaukee #BA-100/150H.

2.5 HVAC SERVICE VALVES: MAXIMUM 250 PSIG SYSTEM WORKING WATER PRESSURE

A. Gate Valves:
1. 2" and Smaller: Class 200, MSS SP-80, ASTM B61, threaded ends, cast bronze body, cast iron union bonnet, cast iron wedge, rising stem, brass packing gland, non-asbestos packing and aluminum or malleable iron hand-wheel. Milwaukee #1153 or equal.
2. 2-1/2" and Larger: Class 200, MSS SP-70, ASTM A126 Grade B cast iron body, flanged ends, OS&Y, cast iron bonnet, cast iron wedge, bronze trim, rising stem, brass packing gland, non-asbestos packing and cast iron hand-wheel. Milwaukee #F-2984 or equal.

B. Globe Valves:
1. 2" and Smaller: Class 200, MSS SP-80, ASTM B62 cast bronze body, bronze union bonnet, bronze wedge, rising stem, brass packing gland, non-asbestos packing and aluminum or malleable iron hand-wheel. Threaded steel pipe: Milwaukee #570.
2. 2-1/2" and Larger: Class 200, MSS SP-70, ASTM A126 Grade B cast iron body, flanged ends, bolted bonnet and disc, bronze trim, OS & Y, brass packing gland, non-asbestos packing and cast iron hand-wheel. Milwaukee #F-2983-M.

C. Ball Valves:
1. 2" and Smaller:
   a. MSS SP-110, 1000 psig WOG rating up to 300 deg. F., Carbon steel 3-piece body, threaded ends, stainless steel ball, reinforced Teflon with 15% glass fiber seat, stainess steel stem, stainless steel lever handle, conventional port. Milwaukee #30CSOF or equal.
   b. 300 psi maximum operating pressure, 2-piece brass body, chrome plated brass ball and stem, TFE seats, steel handle, standard port. Vic Press 304™ ends for stainless steel pipe. Victaulic Series 589 or equal.
2. 2-1/2" and Larger:
   a. 200 lb. WOG, MSS SP-71, ASTM A126 Class B cast iron body, bolted cap, swing type, bronze disc with bronze face rings. Milwaukee # 2970
   b. 300 psi maximum operating pressure, ASTM A395 and A536 ductile iron body and closure, grooved ends, coupled cap, swing type, stainless steel disc with elastomer seat. Victaulic Series 712.
   c. 365 psi maximum operating pressure, ASTM A395 and A536 ductile iron body, grooved ends, stainless steel spring and shaft.
      1) 2-1/2" and 3": Black enamel coated, stainless steel aluminum bronze disc with mounted elastomer seal and machined seat. Victaulic Series 716H.
      2) 4" – 12": Black enamel coated body, elastomer encapsulated ductile iron disc with welded-in nickel seat. 300 psi maximum operating pressure, Victaulic Series 716, Tyco-Grinnell Model 590.
      3) 14" – 24": Black enamel coated body, stainless steel disc, with EPDM seat bonded to the valve body. 230 psi maximum operating pressure, AGS grooved ends. Victaulic Series W715.
2.6 BALANCING VALVES: MAXIMUM 125 PSIG SYSTEM WORKING WATER PRESSURE

A. Pressure Independent Water Flow in Variable Flow Systems:
   1. 1/2" and Larger: Construction and attachment style as required by piping system. Internal working parts and movable flow cartridge shall be stainless steel. Valves shall be factory set and shall automatically limit the flow to specified capacities with 5% +/- accuracy over the entire operating pressure differential. Quick disconnect valves shall be extended to outside of insulation. Griswold.

B. Pressure Dependent Water Flow in Constant Flow Systems:
   1. 1/2" and Larger: Construction and attachment style as required by piping system. Characterized ball valve or Y-type globe valve design with memory stop. Valves shall be field adjustable. Quick disconnect valves shall be extended to outside of insulation. Install in pipe with minimum length of unrestricted straight pipe equivalent to five pipe diameters upstream and two pipe diameters downstream. Preso Venturi B-Plus series, Griswold (Venturi with characterized ball valve only), Wheatley (Y-globe type only), Armstrong, Nibco (Globe style), Tyco-Grinnell, or Victaulic/Tour & Andersson or Gruvlok (Y-globe type only), Series 786 (soldered), Series 787 (threaded), Series 788 (flanged or Series 789 (grooved).

2.7 PRESSURE INDEPENDENT TEMPERATURE CONTROL VALVES (COIL CONTROL VALVES)

A. Modulating control valves shall be pressure independent characterized two-way actuated flow control valves. The flow rate through the valve shall not vary more than + or - 5% due to system pressure fluctuations across the valve in the selected operating range.

B. Electronic valves at all variable air volume terminals, constant volume terminals, fan powered terminals, and zone reheat coils with valve connections of 1" (18 gpm) or less in size may utilize floating point control. All air handler coils shall utilize proportional control electronic valves.

C. The rangeability of the valve shall be 90:1 (minimum).

D. The valve bodies shall be of cast brass and rated for 200 PSI working pressure (minimum). All internal parts shall be stainless steel, teflon, brass, or bronze. The valves shall be serviceable without removing them from the piping system. Valve flow characteristics shall be able to be changed without removing the valve from the piping system.

E. Balancing valves shall not be required where these control valves are installed. Flow performance curves shall be provided with each valve.

F. The actuator shall modulate the control valve from 0 to 100% design flow. The actuator shall be directly coupled to the valve at the factory.

G. Pressure/temperature ports (Pete's Plugs) shall be installed at the factory in each valve larger than 1" or be integral to the valve. Two ports shall be used to measure inlet and outlet pressure to the valve.

H. Manufacturer: Delta Control Products AutoTouch, Honeywell VRN, Belimo PICCV, Victaulic T/A 793/794 used in conjunction with Victaulic T/A balancing valves, or approved equal by Flow Control Industries, Inc. or Griswold. Valves shall be provided by controls provider and installed by piping.

2.8 HYDRONIC SYSTEM PRESSURE REDUCING VALVES

A. Single seated, direct operated type; high capacity, having bronze body with strainer, by-pass feature, pressure gauge tappings and complying with requirements of ASSE Standard 1003. Select proper size for maximum flow rate and fall-off at inlet and outlet pressure indicated.
   1. 25-75 psig range: Watts #U5 series.
   2. 10-25 psig range: Watts #N256
3. Provide with asbestos-free insulating cover, with silicone treated fiberglass cover, 1” insulation, and Velcro fasteners. Suitable for temperatures up to 550 deg. F.
4. Spence #Series E or equal.

2.9 HYDRONIC SYSTEM PRESSURE RELIEF VALVES
A. Pressure Relief Valves: Constructed in accordance with ASME, 125-pound setting, and so stamped. Size as required. Watts #740 Series.
B. Temperature and Pressure Relief Valve: Constructed in accordance with ASME, 125-pound setting (or pressure setting as indicated on construction documents), and so stamped. Size as required. Watts #100XL, 40XL, 140, N240, or 340 Series.

2.10 HYDRONIC SYSTEM REDUCED PRESSURE BACKFLOW PREVENTION VALVES
A. General: All backflow prevention valves shall be State approved. Coordinate with plumbing system for provision of domestic water to reduced pressure backflow prevention to protect domestic water system from connection to hydronic piping systems.
B. Reduced Pressure Backflow Preventer
   1. 2” and Smaller: Assembly shall consist of shutoff ball valves in inlet and outlet, and strainer on inlet. Assemblies shall include test cocks and pressure-differential relief valve located between two positive seating check valves and shall comply with requirements of ASSE Standard 1013 and AWWA C506. Bronze construction, threaded ends, stainless steel internal parts, and air gap fitting. Route pipe from air gap fitting to approved waste receptor. Watts #909-QT-S-HW valve with #909AG air gap fitting.
   2. 2-1/2” and Larger: Assembly shall consist of shutoff OS&Y gate valves in inlet and outlet, and strainer on inlet. Assemblies shall include test cocks and pressure-differential relief valve located between two positive seating check valves and shall comply with requirements of ASSE Standard 1015 and AWWA C506. Epoxy coated cast iron body construction, flanged ends, stainless steel internal parts, bronze seats, and air gap fitting. Route pipe from air gap fitting to approved waste receptor. Watts #909-S-OSY valve with #909AG air gap fitting.

2.11 STEAM PRESSURE REDUCING VALVES
A. The pressure regulator shall be of the pilot-actuated diaphragm operated type. The main valve shall be single seated with hardened stainless steel trim: the regulator body shall be cast iron or steel. The pilot shall be bolted directly to the regulator body. The regulator shall be capable of dead-end shut-off.
   1. Size 1/2”-2”, NPT ends, cast iron, 250 psig maximum operating pressure, 450 deg. F. maximum temperature.
   2. Size 2-1/2” and greater, ANSI 250 lb flanged ends, 250 psig maximum operating pressure, 450 deg. F. maximum temperature.
   3. Spring shall be selected to provide outlet pressure as indicated in equipment schedules or on construction documents.

2.12 THERMOMETERS AND GAUGES
A. General:
   1. Certification: Provide meters and gauges whose accuracies, under specified operating conditions, are certified by manufacturer.
   2. No mercury shall be used in thermometers due to hazardous material classification.
B. Thermometers:
1. Bi-Metal Type: Provide bi-metal glass thermometers of materials, capacities, and ranges indicated, designed and constructed in service indicated. Accuracy shall be 1% +/- full scale with adjustable recalibration.
   a. Case: Type 300 series stainless steel, hermetically sealed, glass window, 3” diameter dial, with adjustable angle.
   b. Adjustable Joint: Die cast aluminum, finished to match case, 180° adjustment in vertical plane, 360° adjustment in horizontal plane, with locking device.
   c. Scale: Satin faced, non-reflective aluminum, permanently etched markings.
   d. Stem: Stainless steel, adjustable angle socket, length to suit installation.

2. Glass Thermometer: Provide adjustable angle 9” thermometer of materials, capacities and ranges as appropriate to medium being measured and designed and constructed for service indicated. Accuracy to be 1% +/- of full scale.
   a. Case: Aluminum or Valox
   c. Scale: Aluminum painted white with black markings.
   d. Connection: 3/4” NPT with thermowell, 1-1/4” UNF swivel nut without thermowell.

3. Photovoltaic Cell Powered LCD Thermometer
   a. Case: ABS Plastic
   b. Accuracy: 1% of full scale
   c. Display: 16 LUX rating LCD display. Switchable Fahrenheit and Celsius.
   d. Connection: 3/4” NPT with thermowell 1-1/4” UNF swivel nut without thermowell.

4. Range: Conform to the following:
   a. Hot Water: 20°F - 240°F with 2°F scale divisions.

C. Thermometer Test Wells:
   1. Provide thermometer test wells as indicated, constructed of brass or stainless steel, pressure rated to match piping system design pressure. Provide 2 inch extension for insulated piping. Provide cap nut with chain fastened permanently to thermometer well.

D. Temperature/Pressure Gauge Connector Test Plugs (Pete’s Plugs):
   1. Provide temperature gauge connector plugs pressure rated for 500 psi and 200° F (93° C). Construct of brass or stainless steel, equip with 1/2” NPT fitting, with self-sealing valve core type neoprene gasketed orifice suitable for inserting 1/8” O.D. probe assembly from dial type insertion thermometer or pressure gauge. Equip orifice with gasketed screw cap and chain. Provide extension, length equal to insulation thickness, for insulated piping.

E. Pressure Gauges:
   1. General: Provide pressure gauges of materials, capacities, and ranges indicated, designed and constructed for use in service indicated.
   2. Type: General use, 1% accuracy ANSI B40.1 grade A, phosphor bronze bourbon type, bottom connection.
   3. Case: Drawn steel or brass, glass lens, 4-1/2” diameter.
   4. Connector: Brass with 1/4” male NPT.
   5. Scale: White coated aluminum, with permanently etched markings.
   6. Pressure differential range shall be 100 psig minimum for the appropriate application with maximum 1 psig divisions.

F. Pressure Gauge Cocks:
   1. General: Provide pressure gauge cocks between pressure gauges and gauge tees on piping systems. Gauge cock shall be 1/4-1/2” threaded end, 2-piece bronze body ball valve. Milwaukee #BA-100.
   2. Siphon: 1/4” straight coil constructed of brass tubing with 1/4” male NPT on each end.
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3. Snubber: 1/4" brass bushing with corrosion resistant porous metal disc, through which pressure fluid is filtered. Select disc material for fluid served and pressure rating.

2.13 PIPING SPECIALTIES

A. General:
1. Provide factory fabricated piping specialties recommended by manufacturer for use in service indicated. Provide piping specialties of types and pressure ratings indicated for each service, or provide proper selection to comply with installation requirements. Provide sizes as indicated, and connections, which properly mate with pipe, tube, and equipment connections. Where more than one type is indicated, selection is installer’s option.

B. Pipe Escutcheons:
1. Provide pipe escutcheons as specified herein with inside diameter closely fitting pipe outside diameter, or outside of pipe insulation where pipe is insulated. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls, or ceilings; and pipe sleeve extension, if any. Furnish pipe escutcheons with nickel or chrome finish for occupied areas, prime zinc base paint finish for unoccupied areas.
2. Pipe Escutcheons for Moist Areas: For waterproof floors, and areas where water and condensation can be expected to accumulate, provide stainless steel, cast brass or sheet brass escutcheons, solid or split hinged.
3. Pipe Escutcheons for Dry Areas: Provide stainless steel escutcheons, solid or split hinged.

C. Low Pressure Y-Type Pipeline Strainers:
1. Provide strainers full line size of connecting piping, with ends matching piping system materials. Select strainers for 125% of the working pressure of piping system, with Type 304 stainless steel screens, with 3/64" perforations at 233 0.045" perforations per square inch.
2. Threaded Ends, 2" and Smaller: Cast-iron body, screwed screen retainer with centered blowdown fitted with hose bibb. Sarco, Keckley, Wheatley or Mueller.
3. Flanged Ends, 2-1/2" and Larger: Cast-iron body, bolted screen retainer with off-center blowdown fitted with 3/4" drain valve. Sarco, Keckley, Wheatley or Mueller.
4. Grooved Ends, 2-1/2" and Larger: Ductile iron body, bolted screen strainer with off center blowdown fitted with 3/4" drain valve. Victaulic style 730/731/732, Tyco-Grinnell Fig. S853 and S55, Gruvlok FIG 7260/758G, or approved equal.

D. Drip Pans:
1. Provide drip pans fabricated from 16-gauge galvanized sheet metal with watertight joints, and with edges turned up 2-1/2". Reinforce top by structural angles. Provide hole, gasket, and flange at low point for watertight joint and 1" copper drain line connection.

E. Air Vent with Valves:
1. Install in all closed and open loop water systems at high points of systems and at any other point necessary to free system of air. A shut-off valve shall be provided in riser to each automatic vent valve to facilitate servicing. A minimum 3/8 inch type “L” copper tubing drain line shall be run to floor sink, floor drain or other approved drain receptacle to carry away water that valve discharges. Manual type vent may be used in lieu of automatic type, where specifically shown on the Drawings. Provide Hoffman #79 or equal by Amtrol, Watts, or Dole.

F. Dielectric Waterways:
1. To effectively isolate ferrous from non-ferrous piping (electrical conductance), prevent galvanic action, and stop corrosion.
2. Steel to copper, with thermoplastic dielectric lining.
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3. 250 psig rated pressure at 210 deg. F.
4. Connection: screwed, grooved, sweat, or flanged to match pipe.
5. Victaulic style 47, Gruvlok FIG 7088/7089 or approved equal.

G. Dielectric Flanges: Provide dielectric flanges and dielectric bolt sleeves for flanged transitions between dissimilar metal piping. Watts Series 3100 or approved equal.

H. Unions:
   1. Unions shall be of type specified in following schedule:
      a. Black Steel, 2" and smaller: 250 lb. screwed malleable iron, ground joint, brass to iron seat.
      b. Black Steel, 2-1/2" and larger: 150 lb. cast iron screwed flanged, flat faced, full faced gasket.
      c. Soldered Copper or Brass Pipe, 2" and smaller: 150 lb. cast bronze or copper, ground joint, non-ferrous seat with soldered ends.
      d. Screwed Copper or Brass Pipe, 2" and smaller: 150 lb. cast brass, ground joint, brass to brass seat, with threaded ends.
      e. Flanged Copper or Brass Pipe, 2-1/2" and larger: two (2) 150 lb. cast bronze flanges.
      f. Manufacturer: EPCO, Mueller, Stanley G. Flagg, Tyco-Grinnell, or Watts.

I. Flanges:
   1. Provide flanges at flanged connections to equipment, tanks and valves. Faces of flanges being connected shall be alike in all cases. Connection of raised-face flange to flat-faced flange not permitted.
   2. Use ASTM A307, Grade B, bolts and nuts for cast iron flanges and ASTM A193 for steel flanges. Regular square head unfinished bolts with heavy semi-finished hex nuts ASTM A194. Cadmium plated where exposed to weather. Rating: 150 lb. or 300 lb. in high pressure portions.
   3. Type of pipe and corresponding flanges as follows:
      a. Screwed Black Steel Pipelines: 125 lb. black cast iron screwed flange, flat faces.
      b. Welded Steel Pipe, 150 lb. black forged steel welding flanges, 1/16" raised face ASTM A181 Grade I. Use flat face when connected to flat faced companion flange.

J. Flange Gaskets:
   1. Type: full faced or flat ring to suit flange facings.
   2. Shall conform to ASTM F-104
   3. Minimum thickness: 1/16"
   4. Flange gaskets for medium and high pressure steam service shall be provided with metallic rim.
   5. Manufacturer: Garlock style 3200, or approved equal.

K. Pipe Sleeves:
   1. Provide fire proof sleeve assemblies utilizing UL rated sealant systems at all fire rated penetrations. For non-rated sleeve penetrations pack the annular space between the pipe and sleeve with fiberglass and/or mastic.
   2. Sleeves shall provide a minimum ½ inch annular clearance around pipe.
   3. Sheet metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate from the following gauges: 3" and smaller, 20 gauge; 4" to 6", 16 gauge; over 6", 14 gauge.
   4. Steel pipe: Fabricate from Schedule 40 galvanized steel pipe; remove burrs.
   5. Iron pipe: Fabricate from cast iron or ductile-iron pipe; remove burrs.
   6. Plastic and copper pipe: Fabricate from Schedule 80 PVC plastic pipe; remove burrs.
   7. Sleeves through interior concrete walls and floors: Telescopic, submerged, adjustable sleeves by Adjust-to-Crete, AMI or Shamrock. Floor sleeves to extend a minimum of 1" above finished floor.
8. Through exterior walls and floor on grade: 150-pound class cast-iron pipe sleeve. Where waterproof membranes are used, provide membrane clamps. For insulated piping, sleeve diameter shall not be less than diameter of insulated pipe.

   a. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbard Enterprises/HOLDRITE; Hydro Preseal, or a comparable product by one of the following:
      1) <Insert manufacturer's name.>
   b. Outer Sleeves: [EPDM] [NBR] <Insert other> attached to the mid-body seal forming an area with which to attach the device to the structural reinforcing rod determining the position of sleeve in the wall.
   c. Water Stop Mid-body Seal: Flexible polymer seal with radial extended flange consisting of one to three concentric raised rings which lock into concrete, maintaining seal over time as concrete contracts from sleeve. <Describe size and type of pipe to be inserted in sleeve seal>.

L. Sleeve Seals:
   1. All sleeves shall be sealed to prevent intrusion of moisture, dust or insects.
   2. Underground: For sleeves passing through exterior or foundation walls, provide mechanical link seal assembly.
   3. Aboveground: For sleeves passing through walls or floors provide a non-toxic 3-hour rated fire resistant silicone foam sealant with a Flame Spread Rating of 20. Sealant to be tested and approved under UL 263, ASTM E119, and NFPA 251 Standards. All fire rated penetrations shall be sealed with approved UL System.
   4. Local Approvals: All seals to be provided shall be in accordance with the regulations of all governing agencies of the city, county, and State Fire Marshal's Office.

2.14 EXPANSION COMPENSATORS AND FLEXIBLE PIPING CONNECTIONS

A. General: Pipe expansion, in general, is to be absorbed in bends, swing joints, expansion loops, and offsets. All piping mains, branches and runouts shall be installed to allow for free expansion and contraction without developing leaks or undue stressing of pipe. Stresses shall be within allowable limits of ANSI B31.1 for pressure piping. Vertical piping for domestic hot water, chilled water, heating water, steam and steam condensate shall be provided with expansion joints at each floor. Expansion products to conform to the standards of the Expansion Joint Manufacturer's Association. Expansion joints shall not require packing. Installer shall select materials and pressure/temperature ratings to suit intended service. Select packless expansion joints to provide 150% absorption capacity of calculated maximum piping expansion between anchors. All connections shall have ends to match piping system application.

B. Expansion Compensators (Pipe Compression and Extension): Multiple stainless steel bellows and stainless steel liner with shroud and end fittings. Keflex #311 series or approved equal.

C. Flexible Expansion Joint/Seismic Connector for Steel Pipe: Stainless steel hose and braid, 180° return, CSA approved, and end fittings. Metraflex #Metraloop, Unisource V-SF21 Style, or approved equal.

D. Flexible Connection for Steel Pipe (Piping and Equipment Located Outside the Building): Stainless steel hose and braid, with threaded or flanged ends. Metraflex #SST or approved equal. Provide steel supports to prevent sagging is required.
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E. Flexible Connection for Copper Pipe: Bronze hose and braid, copper tube ends. Metraflex #BBS, Unisource V-BF11 Style, or approved equal. Provide steel supports to prevent sagging is required.

F. Flexible Rubber Connectors (Pump Connections): Concentric spool type expansion joint, single or double arch. Chlorobutyl tube and cover, meeting ASTM specification D2000 Grade 2AA610AB, L13. The body shall be reinforced with rectangular body rings and a minimum of six bias plies of polyester fabric. A hypalon coating shall be applied completely and uniformly to the cover. All expansion joints shall be rated 190 PSI/26 inch vacuum at 250° F for sizes up to and including 12 inch.

1. For heating hot water service and critical pump connections. Furnish with fluorelastomer tube and cover to ASTM D2000 Grade 1HK710. The body shall be reinforced with rectangular body rings and six bias plies of fiberglass/kevlar fabric rated 190#/26 inch vacuum at 400° F. Provide galvanized flat (not L shaped) back up rings and control rods to limit maximum axial extension. Manufacturer shall provide documentation utilizing oven aged and cold flexibility tests to verify elastomer capability. Each batch of compound manufactured shall be tested to verify it conforms to the ASTM specifications listed below. Garlock #204HP. No known equals.

<table>
<thead>
<tr>
<th></th>
<th>CHLOROBUTYL</th>
<th>VITON</th>
</tr>
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<tbody>
<tr>
<td>Specific Gravity</td>
<td>ASTM D792</td>
<td>ASTM D792</td>
</tr>
<tr>
<td>Durometer Shore A</td>
<td>ASTM D2240</td>
<td>ASTM D2240</td>
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<tr>
<td>Tensile</td>
<td>ASTM D412</td>
<td>ASTM D412</td>
</tr>
<tr>
<td>Elongation</td>
<td>ASTM D412</td>
<td>ASTM D412</td>
</tr>
</tbody>
</table>

2. For chilled water, condenser water, and non-critical pump connections. Furnish with fluorelastomer tube and cover to ASTM D2000 Grade 1HK710. The body shall be reinforced with rectangular body rings and six bias plies of fiberglass/kevlar fabric rated 190#/26 inch vacuum at 250° F. Provide galvanized flat (not L shaped) back up rings and control rods to limit maximum axial extension. Garlock #206 EZ-FLO or equal.

<table>
<thead>
<tr>
<th></th>
<th>POLYESTER</th>
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</thead>
<tbody>
<tr>
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<td>ASTM 1910</td>
</tr>
<tr>
<td>Gauge</td>
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<td>ASTM D1777</td>
</tr>
<tr>
<td>Weight</td>
<td>ASTM D3776</td>
<td>ASTM 1910</td>
</tr>
<tr>
<td>Breaking Strength</td>
<td>ASTM D1682</td>
<td>ASTM D1682</td>
</tr>
</tbody>
</table>

G. Flexible Ball Pipe Joints: Provide flexible ball pipe joints where indicated for piping systems, with materials and pressure/temperature ratings selected by installer to suit intended service. Design joints for 360° rotation, and with minimum of 50° angular flexing movement for sizes ¼” to 4". Provide two composition gaskets for each joint. Barco or approved equal.

1. Certify carbon steel joints for environmental shock testing in accordance with MIL-S-4456 or MIL-S-901C.
2. Comply with Section II of ASME Boiler and Pressure Vessel Code and ASME B31 Power Piping for materials and design of pressure containing parts and bolting.
3. Test each assembly with steam at working pressure of piping system for zero leaks before shipment.

H. Expansion Joints for Grooved Piping: For piping systems fabricated from grooved pipe and couplings, use one of the following methods for expansion compensation:

1. Combination Couplings and Nipples: Provide expansion joints constructed of grooved short pipe nipples and flexible couplings, designed by manufacturer to suit intended service. Provide removable ties to hold joint compressed or expanded during piping fabrication, depending on application. Total joint end movement is dependent on the number of couplings/nipples in the joint. Select couplings and gasket materials to match balance of piping system. Victaulic Series 155 or Gruvlok FIG 7240.
2. Slip-Type Expansion Joints: Provide slip-type expansion joints constructed of carbon steel pipe and couplings, designed by manufacturer to suit intended service. Joint shall be gasketed expansion joint, with grooved ends. Slide section coated with PTFE modified PPS (Polyphenylene Sulfide) coating. Joint suitable for axial end movement up to 3”. Victaulic Style 150. Select couplings and gasket material to match balance of piping system.

3. Three flexible couplings: Use three flexible couplings (Victaulic 177, 75 or 77, Tyco-Grinnell Fig. 705 and 707, or Gruvlok FIG 7401) for the first three connections in close proximity to a pump or chiller to eliminate flexible rubber connectors.

I. Pipe Alignment Guides: Provide pipe alignment guides on both sides of expansion joints, and elsewhere as indicated on drawings. Guide shall be of carbon steel construction with split guiding cylinder and integral anchor base and internal four finger two-piece spider. Cylinder wall thickness shall be equal to schedule 40 wall thickness of pipe being guided. Spider shall be capable of clamping directly to pipe and moving only in an axial direction while inside cylinder. Anchoring directly to building substrate. Metraflex #Style IV or equal.

J. Expansion Loops: Provide field fabricated pipe expansion loops as detailed on the drawings or in place of mechanical expansion joints. Expansion loops in IPS steel and roll grooved copper tubing systems shall be accommodated with loops or bends consisting of (8) Victaulic or Gruvlok couplings, (4) 90 degree elbows, and (3) grooved end pipe spools provided in water systems up to 250 deg F in accordance with recommendations for expansion compensation.

2.15 TRACER WIRE PIPE LOCATING WIRE AND MARKER

A. Pipe Locating Wire: Bare AWG No. 10, soft drawn, single strand copper wire.

B. Provide at least six mil PVC electrical tape insulation around wire where adjacent to metal pipe, valves, and in all valve boxes.

C. Pipe marker shall be internal with locating wire color coded for use with different utility pipe systems, and marked with the utility tape every 24 inches. Provide 4 mil thick, 4"inch wide polyethylene marker.

2.17 SUPPORTS AND ANCHORS (SEE SECTION 230500)

PART 3 - EXECUTION

3.1 GENERAL

A. Workmanship shall be performed by licensed journeymen or master mechanics and shall result in an installation consistent with the best practices of trades.

B. Install work uniform, level and plumb, in relationship to lines of building. Do not install any diagonal or otherwise irregular work unless so indicated on Drawings or approved by Architect.

3.2 MANUFACTURER'S DIRECTIONS

A. Follow manufacturer’s directions and recommendations in all cases where the manufacturers of articles used on this Contract furnish directions covering points not shown on the Drawings or covered in these Specifications.
3.3 INSTALLATION

A. Coordinate the work between the various Mechanical Sections and with the work specified under other Divisions of the work or contracts toward rapid completion of the entire project. If any cooperative work must be altered due to lack of proper supervision or failure to make proper provisions in time, then the work hereunder shall include all expenses of such changes as are necessary in the work under other contracts, and such changes shall be directly supervised by and made to the satisfaction of the Engineer.

B. The cooperative work not included in the Mechanical Division related to the general construction work is as follows:
   1. All formed concrete work
   2. Framed openings in masonry and other Architectural and Structural elements
   3. Wood grounds and nailing strips in masonry and concrete

C. Inspect all material, equipment, and apparatus upon delivery and do not install any that may be subject to rejection as a result of damage or other defects. Provide tarps and visqueen cover to protect equipment and piping delivered to and stored at the site.

3.4 WORKING PRESSURES

A. All fittings, valves, pipe, specialties equipment shall be rated for the working pressure subjected in the installed locations.

B. Drawings indicate working pressure in each system. The rating of the equipment and material shall not be less than that of the system pressures.

3.5 PIPE SIZES TO EQUIPMENT

A. General: Pipe sizes indicated on drawings shall be carried full size to equipment served. Any change of size to match equipment connection shall be made within one foot of equipment.

B. At temperature control valves with sizes smaller than connected lines, reduction shall be made immediately adjacent to valve.

3.6 PIPING INSTALLATION

A. General: Install pipes and pipe fittings in accordance with recognized industry practices which will achieve permanently leakproof piping systems, capable of performing each indicated service without piping failure. Install each run with minimum joints or couplings, but with adequate and accessible unions for disassembly and maintenance/replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings. Align piping accurately at connections, within 1/16 inch misalignment tolerance. Comply with ASME B31 Code for Pressure Piping.

B. Locate piping runs, except as otherwise indicated, vertically and horizontally (pitched to drain) and avoid diagonal runs wherever possible. Orient horizontal runs parallel with walls and column lines. Locate runs as shown or described by diagrams, details, and notations or, if not otherwise indicated, run piping in shortest route which does not obstruct space or block access for servicing building and its equipment. Hold piping close to walls, overhead construction, and other structural and permanent-enclosure elements of building. Limit clearance to 1/2 inch where furring is shown for enclosure or concealment of piping, but allow for insulation thickness, if any. Where possible, locate insulated piping for 1 inch clearance outside insulation. Whenever possible in finished and occupied spaces, conceal piping from view, by locating in column enclosures, in hollow wall construction, or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as indicated.

C. Elevator Machine Rooms, Switchgear, Generator, Telecommunications, Telephone Rooms, and Electrical Equipment Spaces: Do not run piping through transformer vaults and other electrical or electronic equipment spaces and enclosures unless unavoidable. Install drip pan under piping that must be run through electrical spaces.
D. Cleaning: Clean exterior surfaces of installed piping systems of superfluous materials, and prepare for application of specified coatings (if any).

3.7 FLUSHING AND CLEANING PIPING SYSTEMS

A. Steam, Steam Condensate, and Vent Piping: No flushing or chemical cleaning required. Accomplish cleaning by pulling all strainer screens and cleaning all scale/dirt legs during start-up operation.

B. Water Piping (condenser, chilled, heating, heat recovery, process cooling piping): Clean systems with chemicals specified in Section 232500 HVAC Water Treatment. Follow the method provided below or a method recommended by the suppliers of the chemicals specified in Section 232500.

1. Initial flushing: Remove loose dirt, mill scale, metal chips, weld beads, rust, and similar deleterious substances without damage to any system component. Provide temporary piping or hoses to bypass coils, control valves, exchangers and other factory cleaned equipment unless acceptable means of protection are provided and subsequent inspection of hide-out areas takes place. Isolate or protect clean system components, including pumps and pressure vessels, and remove any components which may be damaged. Open all valves, drains, vents and strainers at all system levels. Remove plugs, caps, spool pieces, and components to facilitate early debris discharge from system. Sectionalize system to obtain debris-carrying velocity of 2.5 to 6 feet per second, if possible. Connect dead-end supply and return headers as necessary. Flush bottoms of risers. Install temporary strainers where necessary to protect down-stream equipment. Supply and remove flushing water and drainage by various type hose, temporary and permanent piping and contractor’s booster pumps. Flush until clean as approved by the Owner, Architect or Engineer.

2. Cleaning: Using products specified in Section 232500, circulate systems at normal temperature to remove adhering organic soil, hydrocarbons, flux, pipe mill varnish, pipe joint compounds, iron oxide, and similar substances not removed by flushing, without chemical or mechanical damage to any system component. Removal of tightly adherent mill scale is not required. Before cleaning isolate equipment which is “clean” and where dead-end debris accumulation must not occur. Sectionalize system if possible, to circulate at velocities not less than 6 feet per second. Circulate each section for not less than four hours. Blow-down all strainers, or remove and clean as frequently as necessary. Drain and prepare for final flushing.

3. Final Flushing: Return systems to conditions required by initial flushing after all cleaning solution has been displaced by clean make-up. Flush all dead ends and isolated clean equipment. Gently operate all valves to dislodge any debris in valve body using the velocity of this throttling action. Flush for not less than one hour.

C. Close and fill systems as soon as possible after final flushing to minimize corrosion.

3.8 WELDING

A. Qualifications of Welders: Welders performing work under this Contract shall be certified and qualified in accordance with tests prescribed by the National Certified Welding Bureau (NCWB) or by other approved test procedures using methodology and procedures covered in the ASME Boiler and Pressure Vessel Code, Section IX, “Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators”. Installation shall conform to ANSI 31.1 “Power Piping”. Welders shall be tested and certified for all positions.

3.9 PIPING SYSTEM JOINTS

A. All piping shall be cut squarely, free of rough edges and reamed to full bore. Piping shall be mechanically cleaned prior to make-up of joints and fully inserted into fittings.

B. Provide joints of type indicated in each piping system.
C. Thread pipe in accordance with ANSI B2.1. Cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Remove excess cutting oil from piping prior to assembly. Apply pipe joint compound, or pipe joint tape (Teflon) where recommended by pipe/fitting manufacturer, on male threads at each joint and tighten joint to leave not more than 3 threads exposed.

D. Solder copper tube and fitting joints with lead free nickel/silver bearing solder meeting ASTM. B-32, in accordance with IAPMO IS 3-93, ASTM B-828 and Copper Development Association recommended procedures. Joints shall be cleaned by other than chemical means prior to assembly. "Shock" cooling is prohibited. Fluxes shall be applied liberally to the outside of the pipe and the solder cup of the fitting. Fluxes shall be water soluble for copper and brass potable water applications, and shall meet CDA standard test method 1.0 and ASTM B813-91. Solder shall be applied until a full fillet is present around the joint. Solder and flux shall not be applied in such excessive quantities as to run down interior of pipe. Lead solder or corrosive flux shall not be present at the jobsite.

1. Manufacturers:
   a. Solder: JW Harris "Bridgit" or Englehard "Silvabrite 100".
   b. Flux: Laco "Flux-Rite 90", MW Dunton "Nokorode CDA Flux", Hercules "Fluid Action Solder Flux".

E. Braze copper tube and fitting socket or extrude joints (T-drill) with BCUP series filler metal without flux. Listed brazing flux shall be used for joining of copper tube to brass or bronze fittings and shall meet AWS FB3A or FB3C. "Shock" cooling is prohibited. A continuous fillet shall be visible around the completed joint. After cooling, flux residue shall be thoroughly removed with warm water and a brush prior to testing. Do not use BCUP filler on copper alloys containing over 10% nickel.

F. Piping shall be capped during construction to prevent entry of foreign material.

G. Grooved Joints:
   1. All grooved couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall meet AWWA C-606 requirements.
   2. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Gaskets shall be molded and produced by the grooved coupling manufacturer.
   3. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove.
   4. Grooved coupling manufacturer's factory trained field representative shall provide on-site training for contractor's field personnel in the proper use of grooving tools, application of groove, and installation of grooved piping products. Factory trained representative shall periodically inspect the product installation. Contractor shall remove and replace any improperly installed products.

H. Weld pipe joints in accordance with recognized industry practice and as follows:
   1. Weld pipe joints only when ambient temperature is above 0° F.
   2. Bevel pipe ends at a 37.5° angle where possible, smooth rough cuts, and clean to remove slag, metal particles, and dirt.
   3. Use pipe clamps or tack-weld joints with 1 inch long welds, 4 welds for pipe sizes to 10", 8 welds for pipe sizes 12" to 20".
   4. Build up welds with stringer-bead pass, followed by hot pass, followed by cover or filler pass. Eliminate valleys at center and at edges of each weld. Weld by procedures which will ensure elimination of unsound or un-fused metal, cracks, oxidation, blow-holes, and non-metallic inclusions.
   5. Do not weld out piping system imperfections by tack-welding procedures. Re-fabricate to comply with requirements.
   6. At Installer's option, install forged branch-connection fittings whenever branch pipe is indicated, or install regular T-fitting.
HVAC PIPING, VALVES AND SPECIALTIES

I. Flanged Joints: Match flanges within piping system, and at connections with valves and equipment. Clean flange faces and install gaskets. Tighten bolts to provide uniform compression of gaskets.


K. Adhesive Bonded Joints:
   1. All joints installed or constructed in the field shall be assembled by employees of the contractor who have been trained and certified to the bonding procedure specification provided by the pipe manufacturer. This specification shall meet or exceed the requirements of ASME B31.3, Section A328.2.1. The pipe manufacturer or their authorized representative shall train the contractor’s employees in the proper joining and assembly procedures required for the project including hand-on participation by the contractor’s employees in accordance with the manufacturer’s specification.

3.10 VALVES

A. General: Except as otherwise indicated, comply with the following requirements.
   1. Install valves where required for proper operation of piping and equipment, including valves in branch lines where necessary to isolate sections of piping. Locate valves so as to be accessible and so that separate support can be provided as necessary.
   2. Install valves, except butterfly valves, with stems pointed up, in vertical position where possible, but in no case with stems pointed downward from horizontal plane without prior written approval. Install valve drains with hose-end adapter for each valve that must be installed with stem below horizontal plane.
   3. Install butterfly valves with stems mounted horizontally.
   4. All valves mounted higher than 10 feet above floor in mechanical rooms and where indicated shall be installed with stem horizontal and equipped with chain wheels and chains extending to 5 feet above floor.

B. Insulation: Where insulation is indicated, install extended-stem valves, arranged in proper manner to receive insulation.

C. Selection of Valve Ends (Pipe Connections): Except as otherwise indicated, select and install valves with the following ends of types of pipe/tube connections:
   1. Copper Pipe, 2-1/2" and Smaller: One of the following, at installer's option:
      a. Soldered-joint valves
      b. Grooved-joint valves
   2. Copper Pipe, 2-1/2” and Larger: Grooved-joint valves.
   4. Steel Pipe, 2” and Smaller: Threaded joint valves.
   5. Steel Pipe, sizes 2 ½” and larger: One of the following, at installer's option:
      a. Flanged valves
      b. Lug valves
      c. Grooved-end valves

D. Non-Metallic Disc: Limit selection and installation of valves with non-metallic discs to locations indicated and where foreign material in piping system can be expected to prevent tight shutoff of metal seated valves.

E. Renewable Seats: Select and install valves with renewable seats, except where otherwise indicated.

F. Fluid Control: Except as otherwise indicated, install gate, globe, ball, plug, circuit setter, glove, and butterfly valves to comply with ASME B31.9.

G. Swing Check Valves: Install in horizontal position with hinge pin horizontally perpendicular to center line of pipe. Install for proper direction of flow.

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H. Wafer Check: Install between 2 flanges in horizontal or vertical position.

I. Ball Valve: Ball valve used on gas systems shall be UL listed, CSA approved for pressure of system, no exception

J. Valve Adjustment: After piping systems have been tested and put into service, but before final testing, adjusting, and balancing, inspect each valve for possible leaks. Adjust or replace packing to stop leaks, replace valve if leak persists.

K. Valve Identification: Tag each valve in accordance with "Mechanical Identification" section.

L. Cleaning: Clean factory-finished surfaces. Repair marred or scratched surfaces with manufacturer's touch-up paint.

M. Install so handles are readily available. Locate valves and valve handles for appropriate maintenance access.

N. Gasket and O Ring Material: Valve manufacturer is responsible for submittals. Provide gasket and O ring material best suited for the both piping systems.

3.11 TEMPERATURE GAUGES

A. General: Install temperature gauges in vertical upright position, and tilted so as to be easily read by observer standing on floor without supplemental illumination. All gages to be installed with snubbers to absorb system shock.

B. Install in the following locations, and elsewhere as indicated:
1. At inlet and outlet of hot water heaters
2. At inlet and outlet of boilers
3. At inlet and outlet of chillers and cooling towers
4. At inlet and outlet of heat exchangers
5. At inlet and outlet of process equipment. (Unless equipment is provided with digital readout.)

3.12 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide [1-inch (25-mm)] <Insert dimension> annular clear space between piping and concrete slabs and walls. Retain subparagraph below when cast-in-place watertight sleeve seals are required.
1. When cast-in-place watertight sleeve seals are required, select sleeve size to match the size and type of pipe to be installed. Retain subparagraph below if applicable.
2. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
1. Cut sleeves to length for mounting flush with both surfaces.
   a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas [2 inches (50 mm)] <Insert dimension> above finished floor level.
2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.
1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 07 Section "Joint Sealants."

4. 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 for firestopping specified in Division 07 Section "Penetration Firestopping." Exception: When fire-resistance-rated cast-in-place watertight sleeve seals are required for floor penetrations, additional firestopping is not necessary.

3.13 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

C. Aboveground, Cast-in-Place Watertight Sleeves. Select sleeve size based on pipe size and material to be inserted, and thickness of wall.
1. Install cast-in-place watertight sleeves for pipes NPS 6 (DN 150) and smaller in diameter.
2. Position cast-in-place water tight sleeve in wall space securing sleeve to reinforcing steel using tie wire.

D. Underground, Exterior-Wall, Cast-in-Place Watertight Penetrations. Select sleeve size based on pipe size and material to be inserted, and thickness of wall.
1. Install cast-in-place watertight sleeves for pipes NPS 6 (DN 150) and smaller in diameter.
2. Secure sleeve to the reinforcing steel using tie wire.

E. Fire-Resistance Rated, Cast-in-Place Sleeve Installation: Select sleeve size based on size and type of pipe and thickness of the floor. Position and secure sleeve to concrete form using nails or staples. Place concrete, and finish even with top of sleeve.

3.14 EXPANSION LOOPS

A. Expansion Loops: Fabricate expansion loops as indicated, in locations indicated, and elsewhere as determined by installer for adequate expansion of installed piping system. Subject loop to cold spring which will absorb 50% of total expansion between hot and cold conditions. Provide pipe anchors and pipe alignment guides as indicated, and elsewhere as determined by installer to properly anchor piping in relationship to expansion loops.

B. Expansion Compensation for Risers and Terminals: Install connection between piping mains and risers with at least five pipe fittings including tee in main. Install connections between piping risers and terminal units with at least four pipe fittings including tee in riser.

3.15 EXPANSION COMPENSATORS

A. Install as noted on plans. Where plans do not indicate spacing of guides or other pertinent information, install per manufacturer’s recommendations.

3.16 EXCAVATION AND BACKFILL

A. Underground piping shall be installed in stable, open trenchwork. Trench excavations shall be a minimum of 16 inch wide, true to line and grade. Contractor shall exercise all due shoring and safety procedures. No stones larger than 1 inch may be present in the trench to a minimum depth of 4 inch below the trench bottom. The trench shall be free of job site debris, and free of corrosive media. Pipe crown shall be not less than 36 inch below the finished ground surface for metallic pipe, and 40 inch for non-metallic pipe, unless otherwise indicated on the drawings or directed by

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NOTICE OF ALTERNATE BILLING CYCLE: The Contract will allow the Owner to require the submission of billings or estimates in billing cycles other than 30-day cycles. Billing or statements shall be submitted monthly ending on the last day of the month.

NOTICE OF EXTENDED CERTIFICATION PROVISION: The Contract will allow the Owner to certify billings and estimate within 20 days after the billings and estimates are received from the original contractor.

NOTICE OF EXTENDED PAYMENT PROVISION: The Contract will allow the Owner to make payment within 30 days after the date a billing or estimate is received.
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the Architect. Trenches shall be kept free of excess moisture, and shall be kept open for only a short a time as necessary for installation, testing and inspection. Dispose of surplus excavation and seepage water as directed by the Architect.

B. Piping shall be properly bedded and backfilled over stable trench bottom to a level of at least 12 inch above the pipe crown with thin layers of unwashed sand, dampened but not puddled, and free of organic or corrosive materials and excessive moisture. Backfill shall be placed in thin layers not to exceed 6 inch and tamped by mechanical tampers to a minimum 90% Standard Proctor Density, in accordance with ASTM D-1557-58T. Trenches shall be backfilled to a minimum depth of 36 inch prior to being wheel loaded. Replace to their original condition all turf, plants, concrete, asphalt, or other improvements which constitute landscaping, traffic areas or other improved areas which become disturbed by excavation. In graded and undeveloped areas, in addition to procedures specified above, backfill trenches with crown 8 inch above the surrounding surface.

C. Excavated and backfill in soils of unstable nature shall be provided as directed by Architect.

3.17 PIPE INSPECTIONS

A. It is the intent of the Contract Documents that systems be inspected at completion of each phase while under tests required for administrative authorities, and prior to concealment, i.e. "Rough-in" "Top-out" and final.

B. Inspection - Below Grade: All piping installed below grade shall be inspected prior to burial by the Architect, the Owner’s Representative or the Engineer. Provide photographs of underground piping in Operation and Maintenance Manuals including location and depth of pipes. Contractor must notify Architect no less than 24 working hours prior to inspection time. Should the piping be buried without approval the contractor may be requested to uncover the piping at no delay to the project and at no additional cost to the Owner.

C. Inspection - Above Grade: All piping installed above grade shall be inspected upon completion and prior to finish of walls and ceilings by the Architect, the Owner’s Representative or the Engineer. Contractor must notify Architect no less than 24 working hours prior to inspection time. Should the piping be hidden within the structure prior to inspection approval the contractor may be requested to uncover the piping at no delay to the project and at no additional cost to the Owner.

3.18 PAINTING (SEE SECTION 230500)

3.19 IDENTIFICATION MARKERS (SEE SECTION 230500)

3.20 WATER ANALYSIS AND TREATMENT

A. Upon completion of systems installation, cleaning, and filling, engage a qualified water treatment firm, acceptable to the Architect and Engineer. The water treatment firm shall perform a chemical analysis on each system listed hereinafter, and shall submit to the Engineer a report, including the following:
   1. Analysis of heating water, chilled water, and condenser water systems
   2. Initial treatment of each system
   3. Recommendations regarding subsequent, periodic, or continuous treatment on each system

B. Contractor is to furnish and install initial treatment.

C. For all systems except steam and condenser water, contractor is to provide for periodic testing at 6 months and 12 months after startup and shall provide all recommended treatment for full first year of system operation. For steam and condenser water systems provide monthly testing and report.
3.21 TESTING

A. Provide all tests specified hereinafter and as otherwise required. Provide all test equipment, including test pumps, gauges, instruments, and other equipment required. Test all rotational equipment for proper direction of rotation. Upon completion of testing, certify to the Architect, in writing, that the specified tests have been performed and that the installation complies with the specified requirements and provide a report of the test observations signed by qualified inspector.

B. Piping: Remove from the system, during testing, all equipment which would be damaged by test pressure. Replace removed equipment when testing has been accomplished. The systems may be tested in sections as the work progresses; however, any previously tested portion shall become a part of any latter test of a composite system. Correct leaks by remaking joints with new material.

C. Test time will be accrued only while full test pressure is on the system, unless indicated otherwise. "Tolerance" shall be no pressure drop, except that due to temperature change in a 24-hour period. Inspect and test all work prior to burying or concealing. Test pressure shall be one and one-half times (1.5x) the system operating pressure or the listed test pressure below, whichever is greater. Do not exceed the maximum pressure rating of the piping.

<table>
<thead>
<tr>
<th>SYSTEM</th>
<th>TEST MEDIUM</th>
<th>TEST PRESSURE</th>
<th>TOLERANCE – TEST PERIOD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chilled Water</td>
<td>Water</td>
<td>100 psig</td>
<td>None - 8 hours</td>
</tr>
<tr>
<td>Condenser Water</td>
<td>Water</td>
<td>100 psig</td>
<td>None - 8 hours</td>
</tr>
<tr>
<td>Tanks</td>
<td>Water</td>
<td>1.5 x working pressure</td>
<td>None - 24 hours</td>
</tr>
<tr>
<td>Heating Water</td>
<td>Water</td>
<td>100 psig</td>
<td>None - 8 hours</td>
</tr>
<tr>
<td>Steam</td>
<td>Air</td>
<td>200 psig</td>
<td>None – 8 hours</td>
</tr>
<tr>
<td>Condensate</td>
<td>Water</td>
<td>150 psig</td>
<td>None – 8 hours</td>
</tr>
<tr>
<td>Refrigerant Piping</td>
<td>Air</td>
<td>200 psig</td>
<td>None – 8 hours</td>
</tr>
<tr>
<td>Ground Source Heat Rejection: See Section 232133.33.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

D. Valves: Test all valve bonnets for tightness. Test operate all valves at least once from closed-to-open-to-closed position while valve is under test pressure. Test all automatic valves, including solenoid valves, and temperature and pressure relief valves, safety valves, and temperature and pressure relief valves not less than three (3) times.

E. Piping Specialties: Test all thermometers, pressure gauges, and water meters for accurate indication; automatic water feeders, and air vents for proper performance. Test all air vent points to ensure that all air has been vented.

END OF SECTION
PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS
A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, and Section 230500 - Basic Materials and Methods, and other Sections in Division 23 specified herein.

1.2 SCOPE
A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to, the following:
   1. Flexible coupled end suction pumps.
   2. Close coupled end suction pumps.
   3. In-line flexible coupled pumps.
   4. In-line close coupled pumps.
   5. Vertical split cased double suction pumps.
   6. Horizontal split cased pumps.
   7. In-line circulators.
   8. Condensate return pump and receiver sets.
   10. Expansion tanks - diaphragm type pre-pressurized.
   11. Air separators.
   12. Air elimination valve.
   15. Wet pit condenser water pumps.

1.3 RELATED WORK SPECIFIED ELSEWHERE
A. Section 230500: Basic Materials and Methods
B. Section 230593: Testing, Adjusting and Balancing
C. Section 230900: Controls and Instrumentation
D. Section 230902: Variable Frequency Drives (VFD)
E. Section 233113: Air Distribution
F. Section 233412: Air Handling Equipment
G. Section 235200: Heat Generation
H. Section 238239: Heat Transfer
I. Division 26: Electrical

1.4 QUALITY ASSURANCE
A. Manufacturer's Qualifications: Provide systems that are the standard product of an equipment manufacturer regularly engaged in the production of such units who issues complete catalog information on such products.
B. Codes and Standards: Provide pumps which conform to the requirements of:
   1. Hydraulic Institute (HI): Manufacturer pumps in accordance with "Standards for Centrifugal Rotary and Reciprocating Pumps."
   2. National Electrical Manufacturers Association (NEMA): Provide electrical components which comply with NEMA Standards.
PUMPS AND HYDRONIC SPECIALTIES

   a. 70: National electrical Code

4. Underwriters Laboratories (UL):
   a. UL-778: Motor Operated Water Pumps

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data for units showing dimensions, weights (shipping, installed, and operating), capacities, ratings, performance with operating point clearly indicated, motor electrical characteristics, finishes of materials, and installation instructions.

1. Parallel pump plots: For all parallel and series pump applications submit a combined pump curve showing parallel pump operation and single pump non-overloaded operation verifying that the pump selections operate non-overloading on curve in a single pump operation.

2. Submittal information to verify all scheduled characteristics are met including efficiency.

B. Shop Drawings: Submit manufacturer's shop drawings indicating dimensions, weight (shipping, operating), required clearances, methods of assembly of components, and location and size of each field connection.

C. Maintenance Data: Submit maintenance instructions, including instructions for lubrication, tube replacement, motor and drive replacement, and spare parts lists. Include this data, product data, shop drawings, and wiring diagrams in operating and maintenance manuals.

D. Wiring Diagrams: Submit manufacturer's ladder-type wiring diagrams for power and control wiring required. Differentiate between factory-installed and field-installed wiring.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver units to the site in containers with manufacturer’s stamp or label affixed.

B. Store and protect products and units against dirt, water, chemical, and mechanical damage. Do not install damaged units - remove from project site.

C. Rigging: Comply with the manufacturer's rigging and installation instructions.

1.7 WARRANTY

A. Provide general one year (12 months) warranty. The warranty shall include parts, labor, travel costs, and living expenses incurred by the manufacturer to provide factory authorized service.

PART 2 - PRODUCTS

2.1 IN-LINE CLOSE COUPLED PUMPS

A. Furnish and install pumps with capacities as shown on plans. Pumps shall be in-line type, close coupled, single stage design, for installation in vertical or horizontal position, and capable of being serviced without disturbing piping connections.

B. Pump casing shall be Class 30 cast iron, and impeller shall be of cast bronze enclosed type, dynamically balanced, keyed to the shaft and secured by a locking capscrew. Impeller trim shall be no greater than 85% of the maximum impeller size for the pump.

C. The liquid cavity shall be sealed off at the motor shaft by an internally flushed mechanical seal with ceramic seal seat and carbon seal ring, suitable for continuous operation at 225°F. A bronze shaft sleeve shall completely cover the wetted area under the seal.

D. Pumps shall be rated for minimum of 175 psi working pressure. The pump case shall have gauge tappings at the suction and discharge nozzles and will include vent and drain ports.
E. Motor shall meet NEMA specifications and shall be of the size, voltage and enclosure called for on the plans. It shall have heavy duty grease lubricated ball bearings, completely adequate for the maximum load for which the motor is designed. Provide premium efficiency motor in accordance with Section 230500.

F. Each pump shall be factory tested. It shall then be thoroughly cleaned and painted with at least one coat of high grade machinery enamel prior to shipment.

G. Manufacturer: Bell & Gossett series "80" or approved equal by TACO, PACO, Peerless or Armstrong.

2.2 IN LINE WATER LUBRICATED CIRCULATING PUMPS (SECONDARY PUMPING AND BOOSTER APPLICATIONS)

A. Furnish and install pumps with capacities as shown on plans. Pumps shall be in-line type for installation in vertical or horizontal piping. Pump must be capable of being serviced without disturbing piping connections.

B. Pump body shall be of all bronze construction, rated 175 psi working pressure, with gauge ports at nozzles, and with vent and drain ports.

C. Impeller shall be non-ferrous material, enclosed type, dynamically balanced, keyed to the shaft and secured by a locking capscrew or nut.

D. The liquid cavity shall be sealed off at the motor shaft by an internally-flushed mechanical seal with ceramic seal seat, and carbon seal ring, suitable for continuous operation at 225° F. A non-ferrous shaft sleeve shall completely cover the wetted area under the seal.

E. Motor shall meet NEMA specifications and shall be the size, voltage and enclosure called for on the plans.

F. Each pump shall be factory tested. It shall then be thoroughly cleaned and painted with at least one coat of high-grade machinery enamel prior to shipment.

G. Provide H-O-A switch with overload protection. Pump shall run continuously. Wiring between switch and pump provided under Division 23, as stated in Section 230500.


2.3 EXPANSION TANKS

A. Diaphragm Type Pre-pressurized:
   1. The pressurization system shall include a diaphragm-type expansion tank which will accommodate the expanded water of the system generated within the normal operating temperature range, limiting this pressure increase at all components in the system to the maximum allowable pressure at those components. It shall maintain minimum operating pressure necessary to eliminate all air. The only air in the system shall be the permanent sealed-in air cushion contained in the diaphragm-type tank.
   2. The expansion tank shall be welded steel, constructed, tested and stamped in accordance with Section VIII of the ASME Code for a working pressure of 125 psi and precharged to the minimum operating pressure.
   3. The manufacturer shall be Wessels, Amtrol or approved equal with at least five years experience in the fabrication of diaphragm-type ASME expansion tanks.

2.4 AIR SEPARATORS

A. Tangential and coalescing media type:
   1. All free air originally contained in the system, and all entrained air bubbles carried by system water shall be eliminated at all system points as indicated on the drawings.
2. The air separator shall be welded steel, constructed, tested and stamped in accordance with Section VIII of the ASME Code for a working pressure of 125 psi.
3. Air separators shall be sized as indicated on plans.
4. Provide with strainer unless otherwise noted.
5. Manufacturer: Bell & Gossett, TACO, Wheatley, Armstrong, Spirovent or approved equal.
6. All fittings shall be fabricated steel, rated for 150 psig design pressure and be selected for less than 1 foot of water pressure drop and entering velocity not to exceed 4 feet per second at specified GPM.
7. Units shall eliminate 99.6% of system air (including entrained air and microbubbles). Performance curves from the unit manufacturer shall be furnished as part of the submittal for each unit. Units may include internal copper coalescing medium to facilitate maximum air elimination and suppress turbulence or be furnished with galvanized steel strainer and stainless steel collector tube for a similar purpose.
8. Provide integral high capacity float actuated air vent at top fitting of tank or cast iron float actuated air vent rated at 150 psig which shall be threaded to the top of the separator. Unit shall have bottom blow down connection.

2.5 AIR ELIMINATION VALVE (AUTOMATIC)
A. Air shall be eliminated to the atmosphere as fast as it is separated from system water, through a float activated remote pressure operated, air elimination valve installed at the top of the air separator.
B. The air elimination valve shall have a high removal rate at low pressure differentials and shall be fully open for the removal of air at all pressures in the operating range from 2 to 150 psig. It shall be tightly sealed against loss of system water and prevent entrance of air in negative pressure situations.
C. The air elimination valve shall be constructed of metal and all working parts shall be non-corrosive. Working pressure shall be 125 psi.
D. Provide minimum 3/8" drain line from vent and route to nearest floor drain or floor sink or other approved drainage location.
E. Manufacturer: Amtrol, Hoffman or approved equal.

2.6 SUCTION DIFFUSERS
A. Furnish and install as shown on plans, an angle pattern flow straightening fitting equipped with a combination diffuser-strainer-orifice cylinder, flow straightening vanes, start-up strainer, permanent magnet and adjustable support foot. The combination diffuser-strainer-orifice cylinder shall be designed to withstand pressure differential equal to the system pump shutoff head and shall have a free area equal to five times the cross section area of the pump suction opening. The length of the flow straightening vanes shall be no less than 2-1/2 times the diameter of the system suction connection.
B. Fitting to be of cast iron construction with flanged connections unless otherwise noted. See plan for sizes.
C. The fitting shall have a stainless steel combination diffuser-strainer-orifice cylinder with 3/16 inch diameter perforation to protect system pump. Provide with stainless steel straightening vanes. Start-up strainer to be 16 mesh bronze. All internal components to be replaceable.
D. Manufacturer: Bell & Gossett, TACO, Wheatley, Victaulic or approved equal.

2.7 CHEMICAL POT FEEDER
A. Provide five gallon pot feeder with removable cover, bottom drain valve, and shut-off valves. Provide balancing valve and check valves as shown on Drawings.
B. Mount on support stand or to the wall and pipe between the supply and return piping as shown on Drawings. Provide clearance under the pot feeder for draining.

C. Manufacturer: Dearborn, Garrett-Callahan, J.L Wingert or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All equipment, unless otherwise shown or noted on the Drawings, is to be installed in accordance with industry standards and manufacturer's recommended installation instructions.

B. Grouting Pump Base: For all base mounted flexibly coupled pumps fill the pump base frame with grout after completing pump/motor alignment.

C. Provide vibration isolation, inertia bases, seismic snubber, flexible pipe connections, etc, as specified in related specification sections.

D. For variable flow pumping applications, see Section 230902 for additional requirements.

E. Mechanical contractor to assist testing and balancing contractor in verifying correct pump rotation and system operation.

F. Flush and clean equipment, in accordance with manufacturer's start-up instructions, and in presence of manufacturer's representative. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls.

G. Isolation for Service: Provide pump installations with a discrete isolation valve on both the supply and intake side of the pump to permit service of the pump and any related strainer, check or balancing valves. Triple duty valves are not equivalent for this shut-off service.

H. Balancing Coordination and Impeller Trimming: Coordinate final pump flow with test and balance contractor. For pumps larger than 5 horsepower, if the system tests and balance indicate that flow exceeds the specified flow by greater than 20%, it is not acceptable to reduce flow merely by adjusting balance valves to create additional head or reducing VFD peak flows. Excess system flow must be reduced by trimming the impeller to match the load.

3.2 MANUFACTURER’S START-UP SERVICES

A. The manufacturer shall provide start-up service in the form of a factory trained service technician. The service technician shall verify correct installation, verify pump systems mounting, verify piping installation, verify control wiring, verify power wiring, and check for proper operation. The service technician shall provide final adjustments to meet the specified performance requirements. Fully staffed parts and service personnel shall be within four hours travel from the jobsite.
PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS

A. All work to be furnished and installed under this Section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 230500 - Basic Materials and Methods, and other Sections in Division 23 specified herein.

1.2 SCOPE

A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to, the following:
1. Ductwork - Rigid, Flexible and Fabric
2. Chimneys, Stacks and Flue Vents
3. Ductwork Specialties
4. Flexible Connections
5. Sealants, Adhesives and Tapes
6. Flashings
7. Bird Screens
8. Duct Access Panels and Doors
9. Control Dampers
10. Backdraft Dampers
11. Louvers
12. Diffusers, Grilles, and Registers
13. Fire and Smoke Dampers
14. Sound Traps
15. Fan Powered Terminal Units
16. Variable Air Volume (VAV) Terminal Units
17. Elevator Shaft Vents

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Section 230500: Basic Materials and Methods
B. Section 230593: Testing, Adjusting and Balancing
C. Section 230700: Mechanical Insulation
D. Section 230900: Controls and Instrumentation
E. Division 26: Electrical

1.4 QUALITY ASSURANCE

A. Codes and Standards: Provide products conforming to the requirements of the following:
1. ARI 885-98 “Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminal and Air Outlets.”
3. ANSI S1.23 - Designation of Sound Power Emitted by Machinery and Equipment.
8. TIMA AAC-101 - Standard for fiberglass duct liner with erosion proof facing.

B. Conform to NFPA 90A "Standards for the Installation of Air Conditioning and Ventilating Systems".

C. Provide and construct ductwork systems in conformance with the latest editions of the following documents:
   1. SMACNA "HVAC Duct Construction Standards-Metal and Flexible - 2005"
   2. SMACNA "Accepted Industry Practice for Industrial Duct Construction" for duct pressures above +5" W.G. positive pressure or below -5" W.G. negative pressure. Where differences exist between SMACNA and the prevailing building code, the gauge or construction method of the submitted ductwork shall be the more stringent of the two standards
   3. ASHRAE Systems and Equipment Handbook "Duct Construction" chapter
   4. ASHRAE Fundamentals Handbook "Duct Design" chapter

D. Alternatives: The SMACNA standards and publications referenced in this Section of the specifications establish ductwork construction requirements.
   1. Alternatives to these standards and publications may be submitted. Approval will be based on demonstration that such alternatives are equivalent and satisfy the functional requirements described in the referenced standards.
   2. Such demonstration shall include evidence that the alternatives proposed were tested in accordance with SMACNA procedures and with test results certified by an independent testing laboratory.

E. All ductwork and equipment shall be seismically supported and braced per the SMACNA "Seismic Restraint Manual: Guidelines for Mechanical Systems".

F. Flame/Smoke Rating: All materials, including sealants and adhesives, exposed within plenum shall have a flame-spread index of 25 or less, and smoke developed index of 50 or less, as tested by ASTM E84 (NFPA 255) method.

1.5 SUBMITTALS

A. Prior to construction, submit for approval on all materials and equipment:
   1. Ductwork - Rigid, Flexible and Fabric
   2. Ductwork Specialties
   3. Flexible Connections
   4. Sealants, Adhesives and Tapes
   5. Flashings
   6. Bird Screens
   7. Duct Access Panels and Doors
   8. Backdraft Dampers
   9. Control Dampers
   10. Diffusers, Grilles, and Registers
   11. Fire and Smoke Dampers - Schedule of selected dampers must include the location, nominal size, free area velocity, and static pressure drop at free area velocity for each damper.
   12. Sound Traps
   13. VAV Boxes
   14. SMACNA "HVAC Duct Construction Standards - Metal and Flexible"

B. Shop Drawings: Provide shop drawings of sheet metal ductwork and plenums as follows:
   1. Draw to a scale not less than ¼" to one foot, with sheet sizes equal to Contract Drawings.
   2. Show duct sizes, where possible use even duct sizes.
   3. Show fitting details.
   4. Show coordination with lighting fixtures, fire dampers, smoke dampers, piping, diffusers, grilles, registers, fans, major electrical runs, cable trays and bus ducts.
C. Shop Drawings: Provide shop drawings for field erected mechanical equipment:
   1. Draw to a scale of ½” to one foot, with sheet sizes equal to Contract Drawings.
   2. Show plan, sections, elevations and details of all joints and enclosures.
   3. Detail access doors and hardware.
   4. Detail coil, damper, humidifier, filter and fan installations.
   5. Show access space for electrical components that are part of the equipment provided
      and/or installed such as power and control panels on humidifiers. This shall be
      coordinated with Division 26 and NEC.

D. Certifications: Provide a duct schedule, certified by an officer of the sheet metal fabrication
   subcontractor, that the ductwork conforms to SMACNA standards, and for each sheet metal system
   furnished on the project include:
   1. System name.
   2. Duct material.
   3. Duct gauge.
   4. SMACNA rectangular reinforcement number.
   5. SMACNA intermediate reinforcement number.
   6. SMACNA transverse reinforcement number.
   7. Rod diameter and type.
   8. Sealant type.
  10. Duct system design pressure.

E. Construction IAQ Management Plan: Collaborate with the general contractor to submit and
   implement an IAQ Management Plan for the construction process meeting the requirements of the
   SMACNA IAQ Guidelines. This plan should address the protection of the ventilation system
   components during construction and cleanup of contaminated components after construction is
   complete. SMACNA IAQ Guideline recommends control measures in five areas. The IAQ
   Management Plan should address how compliance has been achieved in these required five areas
   as follows:
   1. HVAC Protection
      a. Shutdown of return side of existing HVAC system in areas affected by heavy
         construction.
      b. Provision of temporary filters if existing or new systems must remain operational
         during construction.
      c. Dampering of supply and returns and sealing of openings in areas subject to
         construction dust.
   2. Source Control
      a. How will reduction of contaminants be reduced at the source?
      b. What steps will be taken to employ low emitting products and sealants.
      c. How will air handling equipment be cycled off when not needed?
   3. Pathway Interruption
      a. Describe how the construction space will be ventilated as required to dilute
         contaminants.
      b. Describe how occupied spaces adjacent to construction areas will be kept at
         positive pressure relative to spaces under construction.
   4. Housekeeping: Describe how the following housekeeping objectives will be implemented:
      a. Reduction of dust generated by work will be suppressed.
      b. Maintaining a frequent cleaning frequency for dust and particulates.
      c. Remove spills or excess applications of solvent-containing products as soon as
         possible.
      d. Remove accumulated water and keep work areas as dry as possible.
      e. Protect insulation materials from exposure to moisture.
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5. Scheduling: Describe how overlap of construction activity and ongoing building occupancy activities will be minimized.

F. Field Manual: Submit one copy of the SMACNA "HVAC Duct Construction Standards - Metal and Flexible". Maintain a second copy on the project site.

G. Any ductwork installed without prior approval by the specifier, shall be replaced at the expense of the contractor.

H. The contractor must comply with the enclosed specification in its entirety. If on inspections, the specifier finds changes have been made without prior approval, the contractor will make the applicable changes to comply with this specification, at the contractor’s expense.

I. At the discretion of the specifier, sheet metal gauges, and reinforcing may be checked at various times to verify all duct construction is in compliance.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the site in containers with manufacturer’s stamp or label affixed.

B. Store and protect products against dirt, water, chemical, and mechanical damage. Do not install damaged components. Remove damaged products from project site.

PART 2 - PRODUCTS

2.1 DUCTWORK

A. Construct all ducts and plenum of gauges, and with joints, bracing, reinforcing, and other construction details in accordance with the latest construction standards previously listed. Metals shall be manufactured by United States Steel, Kaiser, Rolok or equal.

B. Duct dimensions indicated on drawings are net, inside, clear dimensions. For internally lined ducts, add lining thickness to determine metal duct dimensions.

C. Ducts shall be constructed of material gauges and reinforcement per SMACNA pressurization classifications to meet 150% of the pressure requirements for external static pressure scheduled on drawings for the fans serving each system. Where differences exist between SMACNA and the prevailing building code, the gauge or construction method of the submitted ductwork shall be the more stringent of the two standards. See also Part III Execution for matrix of materials and pressure requirements.

2.2 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 A653/A653M.
   a. Galvanized Coating Designation: [G60 (Z180)] [G90 (Z275)]
   b. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. PVC-Coated, Galvanized Sheet Steel: Comply with ASTM A653/A653M.
   1. Galvanized Coating Designation: [G60 (Z180)] [G90 (Z275)]
   2. Minimum Thickness for Factory-Applied PVC Coating: 4 mils (0.10 mm) thick[ on sheet metal surface of ducts and fittings exposed to corrosive conditions, and minimum 1 mil (0.025 mm) thick on opposite surface].
   3. Coating Materials: Acceptable to authorities having jurisdiction for use on ducts listed and labeled by an NRTL for compliance with UL181, Class 1.
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D. Carbon-Steel Sheets: Comply with ASTM A1008/A1008M, with oiled, matte finish for exposed ducts.

E. Stainless-Steel Sheets: Comply with ASTM A480/A480M, 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.

F. Aluminum Sheets: Comply with ASTM B209 (ASTM B209M) Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

G. Reinforcement Shapes and Plates: ASTM A36/A36M, 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.

H. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

2.3 DUCTWORK FABRICATION

A. Joints – Sealing
   1. Duct tape is not allowed. Rolled elastomeric duct sealants are not allowed.
   2. Solvent-based and oil-based sealants are not allowed indoors.
   3. Seal all transverse joints - this includes mechanical joints similar to Ductmate on all supply, return, exhaust, and outside air intake ducts.
   4. All sealant systems for outdoor application to be suitable for use in exposure to water.
   5. All sealant systems for indoor application to be meet VOC limits as specified in South Coast Air Quality Management District (SCAQMD) Rule #1168 limiting VOC’s to 80 gram/Liter for ductliner adhesives and 250 grams/Liter for duct sealants.
   6. Manufacturers: Tremco, Dure Dyne, Hardcast, Ductmate, Mon-Eco Industries, McGill AirSeal LLC, or equal, as recommended for ductwork application.
   7. Water-Based Joint and Seam Sealant: Flexible, adhesive sealant, suitable for high velocity and high pressure applications, UL 181B-M listed, UL 723 classified, and complying with NFPA requirements for Class 1 ducts.
      a. Outdoor Application: Not permitted where subject to moisture exposure.
      b. Indoor Application: Hardcast Iron Grip, Ductmate PROseal, Mon-Eco EZ Seal 44-44, or equal.
   8. Two-Part Tape Sealing System: Woven-fiber tape impregnated with gypsum mineral compound and modified acrylic/silicone activator to react exothermally with tape to form hard, durable airtight seal. Hardcast Two Part II, McGill Uni-Cast, or equal.

B. Joints - Rectangular Ducts
   1. Slip drive joints, standard seams, flanges or welding as required by SMACNA HVAC Duct Construction Standards for system static pressure. Ductmate, MEZ Industries, or equal are acceptable joint methods, but must be sealed as described previously. Transverse joints shall be constructed per Figure 2-1 for types T-8 through T-25. T-1 and T-5 slip joints are NOT allowed. Joint T-2, T-3, T-6 and T-7 reinforced slip joints are allowed below 2” static pressures.

C. Joints - Round
   1. Exposed Ductwork: Slip drive and sheet metal screws.
   2. Concealed Ductwork: Sheet metal screws.

D. Elbows
   1. Construct long radius elbows with centerline not less than 1.5 times the duct width. Shorter radius elbows may be used where required to fit in restricted spaces, or as shown. Provide single thickness turning vanes on all short rectangular radius elbows less
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than 25° wide. Provide double thickness turning vanes for short rectangular radius elbows 25° wide and greater. Number of vanes per SMACNA. Elbows with square throat and radius heel are NOT allowed.

E. Transitions
1. Construct transitions with minimum slope of 1 to 5 ratio and in conformance to SMACNA.

F. Branch Connections
1. Provide 45° entry boots or radius taps for rectangular duct take-offs and conical or bellmouth taps for round duct take-offs. Straight 90° taps are not allowed, except where round take-off duct size equals round branch duct size. Provide volume dampers at take-offs for balancing if not specifically noted as provided at outlet or inlet. Provide insulation guards at transitions to lined ductwork.

2.4 RECTANGULAR DUCTWORK
A. Construct rectangular ductwork to meet all functional criteria defined in Section VII, of the SMACNA “HVAC Duct Construction Standards Metal and Flexible” 1995 Edition. This shall be subsequently referred to as the SMACNA Manual. All ductwork must comply with all local, code requirements. Ductwork shall be constructed of galvanized steel. Diagonally cross break all panels on ducts 30 inches wide and larger, or bead using automatic bead machine with beads at 12 inches on center or less. All connections shall utilize 45° boot take-offs. Bullhead tees and straight taps are not permitted.

2.5 ROUND AND OVAL DUCTWORK
A. Round and oval ductwork shall be constructed to SMACNA round ductwork requirements of galvanized sheet steel. 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. Longitudinal seams shall be spiral lock seams or continuous welded. Flat oval shall be utilized in space-restricted areas. Elbows shall be 5-piece mitered and welded. All elbows shall be long radius type with centerline radius to duct diameter of 1.5, exceptions will only be allowed at restricted space locations.

B. Round or oval duct and fitting manufacturers:
1. McGill Airflow Corporation
2. Lindab
3. Semco
4. Sheet Metal Connectors
5. Spiral Manufacturing
6. Or equal.

C. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).

D. Transverse Joints: Fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible", Figure 3-1, "Round Duct Transverse Joints", 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." All transverse joints to be externally sealed at all joints.
1. Exception: internal manufactured single or dual EPDM rubber gasket fittings do not require external sealant.
2. Transverse joints in ducts larger than 50" diameter require flanged joints.
3. Lap or snap lock seams are not permitted for round ductwork of any size.

E. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible", Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals,
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and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." All longitudinal joints shall be sealed air tight with sealant or continuous welding.

1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.

F. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible", Figure 3-5, "45 Degree Tees and Laterals", and Figure 3-6, "Conical Tees" and "45 Degree Boot 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."
1. Spin-in type or other types of butt tees, bullhead tees or straight taps are not permitted.

2.6 FLEXIBLE DUCTWORK

A. Flexible one-inch thick insulated round ductwork may be utilized where shown on the Drawings and at the last seven (7') feet to each air outlet and inlet, unless shown otherwise on the plans. Maximum of only one 90° bend in any length. Elbows in flex ductwork are to be supported using Flexmaster Item #41650 duct support. No intermediate joints are allowed. Connect each end with stainless steel screw operated drawbands. Support duct to maintain smooth shape without sagging. All connections shall utilize welded conical tees, aluminum conical fitting, Flexmaster #CB, or 45° boot take-offs by Flexmaster #STO. Spin-in type or other types of butt tees, bullhead tees or straight taps are not permitted. Dampers are to be Ventlok dampers with end bearings.

B. Flexible ductwork for low pressure systems with positive static pressure at or below 2" w.g. positive pressure shall be a trilaminate of aluminized foil, fiberglass insulation, and aluminized polyester, mechanically locked to galvanized steel helix without adhesives, exterior 1” fiberglass insulation and fire retardant plastic outer jacket. Flexmaster #Type 5B, Thermaflex Model M-KC or approved equal.

C. Flexible ductwork for medium and high pressure systems with static pressures above 2” w.g. through 10” w.g. positive pressure shall be a heavy coated fiberglass cloth fabric mechanically locked to galvanized steel helix without adhesives, exterior 1” fiberglass insulation and fire retardant plastic outer jacket. Flexmaster #Type 4B, Thermaflex Model M-KC or approved equal.

D. Flexible aluminum ductwork for use in magnetic/electrically sensitive room environments, such as MRI rooms, in low pressure systems with static pressure at or below 2” w.g. positive pressure shall be a trilaminate of aluminized foil with aluminum helix with exterior 1” aluminum jacket fiberglass insulation. Flexmaster #TL-B or approved equal.

2.7 ACOUSTICAL DUCT LINER

A. Acoustic Duct Lining shall be installed where shown on the drawings and as specified for low velocity supply, return and exhaust ductwork. Liner is to be utilized to line vertical supply duct risers, mechanical shafts conveying return air, terminal box discharge plenums, and other horizontal duct runs where shown on drawings. Dimensions of lined ducts given on the drawings indicate the inside dimensions of duct after the lining has been installed. Black-coated (vinyl, acrylic or neoprene) duct lining shall be adhered by 100% covering of a fire retardant adhesive (3M EC-1128, Benjamin-Foster 85-20, or equal). When width of duct exceeds 12” and also on sides when height exceeds 24”, use non-ferrous mechanical fasteners such as welded pins and speed clips, 12” on center maximum lateral spacing and 18” on center maximum longitudinal spacing. Start fastening within 3” of upstream transverse edge of the liner and within 3” of the longitudinal joint. Mechanical fasteners shall not pierce the duct walls. The pins shall be cut off flush, washers shall be used and installation made so that no gaps or loose edges occur in the insulation. Apply a brushcoat of Benjamin-Foster 30-36 to washers, extending onto lining surface a minimum of 2”. Top pieces shall
be supported by the side pieces. Provide insulated build out frames for attaching dampers at running vanes where required.

B. All transverse and longitudinal abutting edges of duct lining shall be sealed and lapped 3” with a heavy coat of Foster 30-36, in accordance with the manufacturer’s recommendations. All exposed edges shall be installed with sheet metal nosings. At all openings in the ductwork there shall be a galvanized metal flange, equal in depth to adjacent lining and having a 1½” lip to hold lining in place. All bolt holes shall be sealed airtight.

C. Internal Duct lining shall be installed in complete accordance with the Sheet Metal and Air-Conditioning Contractors National Association (SMACNA) Duct Lining Application Standard. Mechanical fasteners shall conform to Mechanical Fastener Standard MF-1 from SMACNA. Adhesive shall be water-based and conform to Adhesive and Sealant Council Standards for Adhesives for Duct Liner ASC-A-7001C.

D. Internal Duct Lining shall be 1” unless otherwise called out, matte-faced, 1.5 lb/ft³ minimum density and shall meet the requirements of NFPA90-A.

E. Acoustical duct liners shall comply with the following requirements and standards:
   1. ASTM C 1071, Type 1.
   2. NFPA 90A and 90B.
   3. Resist fungal growth.
   4. Support air velocities up to 5,000 fpm.
   5. Per UL 723 test method, flame spread shall not exceed 25, and smoke developed shall not exceed 50.
   6. Per test method ASTM C423 using Type A mounting, minimum allowable NRC shall be 0.45.

F. The following are acceptable, subject to the above:
   1. Internal Duct Lining:
      a. Aeroflex Type 150 from Owens-Corning Fiberglass, Toledo, OH.
      b. Linacoustic/Spiracoustic Type 150 from Manville Products Corp., Denver, CO.
      c. Ultralite Type 150 from Certain Teed Corp., Valley Forge, PA.
      d. Pre-approved equal to above.
   2. Mechanical Fasteners:
      a. Gemco TYPE IH-A from Goodloe E. Moore, Inc., Danville, IL.
      b. Eckoustic-Klip from Eckel Industries, Inc., Cambridge or MA.
      c. Pre-approved equal to above.

2.8 PLENUMS AND EQUIPMENT CASINGS

A. Construct casings and plenums in conformance with SMACNA.

B. Minimum Pressure Class: Unless otherwise indicated construct plenums and casings to withstand either a negative or positive static pressure of 4” W.G.

C. Single-Wall: Provide single-wall, casings and plenums where indicated on the drawings.
   1. Construct in accordance with SMACNA Standards.
   2. Use steel-angle-reinforced standing-seam construction.
   3. Locate intermediate bracing angles bolted to the casing 24 inches on centers.
   4. Construct for static pressure indicated or for the maximum fan static pressure whichever is less.
   5. Bolt to 3” high concrete pads using 1½” x 1½” x ¼” thick galvanized steel structural sections.

D. Double-Wall: Provide where indicated on the drawings, constructed as follows:
   1. Provide 4” thick prefabricated double wall insulated metal panel assemblies, with 16MS gauge aluminum or 18 gauge minimum galvanized steel outer sheets.
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2. Provide 22 gauge Type 304 stainless steel inner sheets.
3. Casings shall be fully metal enclosed, insulated with 4" thick rigid fiberglass insulation and conforming to NFPA 90A, with maximum flame spread of 25 and maximum smoke developed of 50.
4. Field or factory fabricate to size and configuration indicated on the drawings, using field verified dimensions.
5. Provide coordinated shop drawings.
6. Reinforce spans 10' or greater with structural steel sections to yield maximum deflection ¼" at minus 10" or plus 10" W.G. static pressure.
7. Provide openings and doors, all factory framed, and reinforced with 304 stainless steel structural sections.
8. Construct doors of same material as casings, of sizes and locations indicated on the drawings but not smaller than 18" by 54", and conforming to SMACNA.
9. Provide doors, hinges and hardware factory fabricated and mounted.
10. Door swings shall open against air pressure, with door latches operable from either side.
11. Provide door seals with neoprene gaskets, which have an airtight seal.
12. Provide each door with a 10" by 10" wire reinforced double pane window.
13. Bolt base channel to 3" high concrete pads.

2.9 DUCTWORK SPECIALTIES

A. General: Where specifically called for, materials for use in fabricating ductwork specialties shall be identical to that used to fabricate ductwork. See drawings and Part 3, Execution for schedule.

B. Volume and Splitter Dampers: Galvanized sheet metal blade and frame with Ventfabrics Inc., Ventlok operating hardware. For accessible dampers, provide #641 self-locking dial regulators and #644 self-locking dial regulators for insulated ductwork, #637 square end bearing, and #635 spring end bearing, as applicable. For inaccessible dampers, provide #666 or #677 concealed locking damper regulator with bearings as above. For static pressures above 3" W.G., provide #640 HiVel dial regulator and #609 HiVel end bearing for accessible dampers. Regulators shall extend to and through ceiling with neatly installed hardware at the finished ceiling. For inaccessible dampers requiring adjustment through diffusers use Young Regulator, Bowden cable control system.

C. Multi-louver Volume Dampers: 16 gauge galvanized steel frame. Opposed, 6" wide, 16 gauge galvanized steel blades. Concealed linkage in frame. Ruskin #CD35/OBD or equal.

D. Flexible Connections: Provide flexible connectors at the discharge and inlet of fans, air handlers, rotating mechanical equipment, and where shown on the Drawings for proper vibration isolation. Neoprene impregnated glass cloth with 24 gauge galvanized metal frame. Neoprene-only connectors are not allowed. Minimum dimensions - 3" metal, 3" fabric, 3" metal. Ventfabrics #Ventglas or approved equal by Duro Dyne, Q Industries, consolidated Kinetics, Ductmate Proflex or Elgen.

E. Ducts through roof shall be 16 gauge (or minimum of 2 gauges heavier than attaching ductwork), flashed and counterflashed, and provided with storm collars to secure a watertight construction.

F. Bird Screens: 14 gauge, ¼”, galvanized wire mesh, set in a galvanized steel frame, screw set.

2.10 DUCT ACCESS PANELS AND DOORS

A. In sheet metal work, hollow core double construction of same or heavier gauge material as duct in which installed. Use no door smaller than 12" by 12" for simple manual access or smaller than 24" by 24" where personnel must pass through infrequently. Use 24" by 60" minimum for filters and more frequent maintenance. Use Ventlok or approved hinges and latches on all doors; 100 Series hinges and latches on low pressure system doors up to 18" maximum dimension, 200 Series on larger low pressure system doors and 333 Series on high pressure systems. Construct doors up to 18" maximum dimension with one inch overlap fit and gasket with ¾" by ¼" sponge rubber, fit larger
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doors against 1½" by ⅛" flat stock or angle frame and gasket with ¾" by ¾" sponge rubber or felt. Door swing to be opposite airflow. CESCO, Vent Products, Air Balance, Ductmate Sandwich or equal. Access doors smaller than 12" x 12" can be used for visual inspection of dampers, etc. on small ductwork less than 12" wide but must be of maximum size that will fit on duct with 6" x 6" as minimum size. All access doors smaller than 12" x 12" must be approved by Engineer for the specific application prior to ordering.

2.11 CONTROL DAMPERS

A. General: Low leakage dampers are to have a maximum leakage rate of 3 cfm/ft² at 1.0 in w.g. pressure difference when tested to AMCA Standard 500.

B. Airfoil Low Leakage Dampers

1. Application: Commercial supply, return, and general exhaust air systems up to 3,000 fpm velocity.
2. Frames to be 5" x 1" x 16 gauge steel channel
3. Blades to be 6" wide, 14 gauge galvanized steel design.
4. Axles to be ⅛" diameter plated steel.
5. Bearings to be stainless steel sleeve type pressed into frame.
6. Linkage to be concealed in frame
7. Crank lever for operator to be provided.
8. Provide with mill finish on blades and frame.
10. Flexible metal jamb seals.
11. Maximum temperature rating to be 300°F.
12. Edit options as applicable Required Options:
   a. Damper position indicator switch
13. Manufacturer: Ruskin #CD60, Swartout, NCA PBD/OPD-AF-101, American Warming, Air Balance, Greenheck or approved equal.

C. Heavy Duty

1. Application: Velocity over 3,000 fpm and fan outlet damper.
2. Frames to be 10" x 2" x 12 gauge steel channel.
3. Blades to be 7½" wide, 0.080 thick extruded aluminum airfoil design.
4. Axles to be ¾" diameter plated steel.
5. Bearings to be stainless steel sleeve type pressed into frame.
6. Linkage to be out of airstream with 10 gauge galvanized steel clevis type arms on 7/8" diameter brass trunnions at 3" radius. Tie bar to be ¾" diameter plated steel.
7. Crank lever for operator to be provided.
8. Provide with mill finish on blades and frame.
9. Maximum temperature rating to be 300°F.
10. Edit options as applicable Options:
   a. Silicone rubber blade seals.
   b. Flexible stainless steel jamb seals.
   c. Bearings with integral shaft seals.
   d. Bearings bolted to frame.
   e. Bolt holes in frame.
   f. Special finishes.
   g. Electric or pneumatic operator.
11. Manufacturer: Ruskin #CD102, Swartout, American Warming, Air Balance, Greenheck or approved equal.
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2.12 BACKDRAFT DAMPERS

A. Damper Types:
   1. Heavy Duty Backdraft Dampers: Provide counterweight type complete with frame, end bearings, counterbalance assembly, blades, and linkage. Pressure drop to be no more than 0.24"w.g. at 1000 fpm. Install at outside air intakes, exhaust outlets, and where shown on Drawings. Pacific Air Products #PRD-100AL, Ruskin #CBD2, NCA, or equal by Swartout, American Warming or Vent Products.

B. Application Requirements:
   1. Generator Discharge Damper: Heavy Duty Backdraft Damper. Size at no more than 1000 fpm velocity.
   2. Outside Air Intakes except where a control damper is required – Heavy Duty Backdraft Damper.

2.13 LOUVERS

A. Louvers are to be provided under Division 10. Where louvers are not covered on architectural plans and specifications, contractor is to provide under the following specification:
   1. Louvers to be 6" deep, 35° drainable fixed blade design, constructed of galvanized steel or extruded aluminum, or as specified on the plans.
   2. Frames to be constructed of 6" deep channel.
   3. Provide with ½" x ½” galvanized mesh birdscreen mounted on backside of louver.
   4. Finish/color per architect/engineer’s review.
   5. Manufacturer: American Warming, Industrial Louver, Vent Products, NCA, Swartout, Ruskin ELF6375DX Louvers & Dampers or equal.

2.14 DIFFUSERS, GRILLES AND REGISTERS

A. All diffusers, grilles, and registers shall be selected to provide proper air distribution for the intended occupant application. All supply air devices shall be selected to provide a maximum air velocity of 50 fpm at three feet above the floor, unless otherwise noted. Manufacturer’s representative shall carefully review Architectural and Mechanical drawings and ensure diffuser/grille/register selections will provide proper air distribution at NC 25 or less. Manufacturer at no additional expense to the Owner shall replace diffusers, grilles, and registers not providing proper distribution or excessive noise at scheduled airflow.

B. All frames shall be selected to fit the ceiling type. Verify with Architectural Drawing. Each diffuser, grille and register shall be individually capable of balancing via duct mounted balancing dampers or attached opposed blade dampers. Provide unit opposed blade damper where individual duct mounted balancing dampers are not provided.

C. Sizes, capacities and patterns shall be as shown on the Drawings. Manufacturer: Metal Aire, Titus, Krueger, Anemostat, Carnes, Price or Tuttle&Bailey.

2.15 DUCT SMOKE DETECTORS (DSD)

A. Duct mounted photoelectric smoke detector. One required for each heating or cooling system supplying air in excess of 2,000 cfm, for systems serving more than one occupancy type, and for control of each combination fire/smoke damper when not controlled by Div. 26 area wide detection system. Coordinate with Div 16. work and electrical installer for power to smoke detector. Detector shall be mounted in the supply air ductwork downstream of the air handler and filters, or upstream of combination dampers. Coordinate with control installer to assure that detector shall shut down the air-moving equipment when smoke is detected and close associated damper actuator(s). Sensor shall be selected to operate with air velocity rating from 100 to 4000 fpm. Provide with metal sampling tube. Provide remote test and reset station at ceiling or as otherwise indicated. Duct
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smoke detector shall be installed in compliance with the applicable mechanical or building code. Coordinate with Section 230900 and 230593 work. System Sensor #D2 series or approved equal.

B. Additional requirements for duct smoke detectors include requirements per Section 6.4 of NFPA-90A. Provide one duct smoke detector at each story to the connection to a common return and prior to any recirculation or fresh air inlet connection in air return systems having a capacity greater than 15,000 cfm and serving more than one story.

2.16 VARIABLE AIR VOLUME TERMINAL UNITS

A. Furnish and install variable volume zone boxes of the sizes and capacities shown on the Drawings.

B. The control assemblies shall be pressure independent and shall be able to be reset to any airflow between zero and maximum scheduled CFM. The valves shall be normally open. The differential static pressure of the basic assembly shall not exceed 0.25” W.G. for all sizes with inlet velocities of 2,000 FPM or less.

C. The air valve shall be galvanized steel or die cast aluminum; damper shafts shall operate in rustproof Delrin or equal, self-lubricating bearings. The air valve shall seat against durable gaskets and not exceed a 2% leakage rate per ARI standards.

D. The control device shall be designed to maintain constant flow regardless of inlet flow deflection. Duct inlets at 90° or less to the control device shall not alter the maximum or minimum factory setting by more than 10%. The assembly shall incorporate a multi-point averaging differential pressure sensor mounted on the inlet.

E. The assemblies shall be contained in a welded 26 gauge galvanized steel box internally lined with ½ inch, 1½ lb. insulation complying with NFPA 90A and UL 181 standards.

F. Acoustical lining is to be a scrim reinforced foil laminate using flexible 1½ lb. density insulation meeting the requirements of UL 181 and NFPA 90A. All edges are to be sealed from the airstream, and metal brackets used to secure discharge edges on single duct terminals. For acute care facilities or surgery centers the inside surface of terminal units shall be galvanized sheet metal for a cleanable surface.

G. Fabricate and install 5 foot (minimum) acoustically lined sheet metal discharge plenum on all air terminal units. Discharge plenum shall be mounted downstream of reheat coils where applicable. Inside dimension of plenum shall be 2” larger in height and 4” larger in width than the outlet of the air terminal unit or reheat coil, whichever is greater. Refer to detail on plans for additional information. This is required for acoustic noise dissipation.

H. Hot Water Coil: Where scheduled on drawings, provide a single or double row hot water heating coil with aluminum fins mechanically bonded to copper coils. Coil velocity shall not exceed 700 FPM and static pressure loss shall not exceed .35” w.g. for a double row coil or 0.20”w.g. for a single row coil. Coil shall be pressure tested to 200 PSIG. Coil section to be based on 180°FWT and 140°F LT unless otherwise noted on schedule. Maximum water pressure drop shall be limited to 5 feet w.g. unless otherwise noted.

I. Controls to be direct digital. Provide boxes without operator. Provide factory mounted low voltage transformer of sufficient capacity to power the DDC controls. Coordinate control with temperature Control Contractor. Provide factory mounted operator and thermostat control if not provided by Control Contractor.

J. Manufacturer: Titus ESV-3000, Price SDV, Trane VC, Enviro-Tec SSD, Carnes AV, Tuttle & Bailey SDV, Nailor 3000, or approved equal by Krueger or Anemostat.
2.17 FAN POWERED BOXES

A. Furnish and install fan powered boxes of the type, sizes and capacities shown on the Drawings.

B. Casing: 22 gauge galvanized steel with rectangular discharge with slip and drive type connection. One piece aluminum backdraft damper provided on fan discharge. Damper factory set and aligned for precise seal. Leak rate 2% at 0.5 WG.

C. Acoustical lining is to be standard ½”, 1½ lb. insulation complying with NFPA 90A and UL-181 standards. All exposed edges shall be coated with NFPA 90A approved sealant to prevent entainment of fibers in the air stream.

D. Acoustical lining is to be a scrim reinforced foil laminate using flexible 1½ lb. density insulation meeting the requirements of UL 181 and NFPA 90A. All edges are to be sealed from the air stream, and metal brackets used to secure discharge edges on single duct terminals. Titus “Fiber Free or equivalent.

E. Air Valve: Galvanized steel or cylindrical die cast aluminum airflow control device. Valve tapered to fit standard round flexible duct diameters. Normally open sequencing for reverse acting thermostat. Leak rate 4% at 2 WG. Integral flow ring taps, calibration chart for flow measurement, ±10% accuracy regardless of inlet condition.

F. Fan: Fan style galvanized steel wheel. Housing is 18 gauge steel and fan board is 16 gauge steel.

G. Motor to be an Electrically Commutated Motor (ECM) with a minimum efficiency of 70% throughout the operating range. Motor speed to be controlled for a constant delivery fan cfm regardless of varying external static pressure. Provide remote adjustment option for integration with DDC controls by others.

H. Fan Controls: Factory mounted on-off toggle switch, for disconnect and normally open P.O. switch to energize fan.

I. Disconnect Switch: Provide factory mounted fused disconnect switch with interlocking door handle on terminal box door.

J. Dust Cover: Integral control panel shall be gasketed for tight seal.

K. Hot Water Coil: Where scheduled on drawings, provide a single or double row hot water heating coil with aluminum fins mechanically bonded to copper coils. Coil velocity shall not exceed 700 FPM and static pressure loss shall not exceed .35″ W.G. for a double row coil or 0.20 for a single row coil. Coil shall be pressure tested to 200 PSIG.

L. VAV Control: Factory mounted and piped to electronic actuator. Regulator is thermostatically reset with velocity controller, which provides constant delivery air control within ±10% accuracy regardless of inlet condition. The velocity signal is input to the volume regulator, which will automatically adjust valve position to compensate for either increase or decrease in duct pressure. Adjustable set points provided to set maximum and minimum cfm. Reverse acting control sequence must be used. Bleed rate 25 scfm. Integral flow ring taps and calibration chart shall be provided on unit.

M. Manufacturer: Trane VFWC, Titus, Price FDV, FDVP, FDCLP, Carnes, Enviro-Tec, Nailor 35P (parallel boxes), 35SST (Series) or approved equal by Krueger or Anemostat.
2.18 ELEVATOR SHAFT VENTS

A. Furnish and install elevator shaft vents at top of each elevator shaft over 25’ high as required by code.

B. Vents to be sized with throat area equal to 3.5% of elevator shaft hoist way area with minimum size of 3 sq. ft.

C. Vents to be Greenheck model “GRS” with bird screen and prefab curb or Loren Cook Company or the equivalent. Minimum size to meet 3 square feet requirement is size GRS-24 (3.24SF Throat will handle 92SF shaft). Upsize as required.

D. Locate to miss beams and coordinate size and location of roof opening with structural.

PART 3 - EXECUTION

3.1 DUCTWORK MATERIAL APPLICATION SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:
      a. Material: Type 316L stainless steel, minimum 18 gage fully welded ductwork and fittings.
      b. Joints: TIG welded. Weld may be either butt-weld or swaged joint with lap weld with lap running in direction of airflow. Welding rod shall be type 316L material. MIG welding technique not allowed. Inert gas purging inside ductwork not required.
      c. All accessories shall be 316 stainless steel including dampers, air valves, damper hardware, etc.
      d. Pressure testing: refer to pressure classification and testing procedure table this specification section.

B. All duct system appurtenances are to be the same material as ductwork including volume dampers and access panels.

3.2 DUCTWORK AND SPECIALTIES INSTALLATION

A. Ductwork is generally diagrammatically indicated and shall be generally installed as indicated. Do not scale Drawings for exact location of ducts. Install ducts to best suit field conditions and cooperate with other trades. Do not penetrate Structural members without consent of Architect or Structural Engineer. Check with Structural drawings prior to locating any penetrations. Duct sizes are indicated as net inside dimensions on the Drawings. The indicated dimensions shall be altered at the job site for the purpose of avoiding interferences and clearance difficulties to other dimensions producing the same air handling characteristics, provided such altered dimensions are approved by the Architect. Ducts shall be constructed in accordance with the latest edition of codes and standards identified in Part 1 and as shown on the Drawings.

1. Clean and pretreat surfaces before application of sealant. Conform to the manufacturer's cleaning procedures. Install sealants in conformance with manufacturer's instructions.

2. Except where noted, vertical ducts or horizontal ductwork penetrating fire rated ceilings, roofs, walls and floors shall be fire separated with UL listed and labeled fire dampers installed per UL tested assembly including sleeves and retaining angles. Provide additional fire dampers indicated on the Drawings and as otherwise required by the IBC and building inspector. Provide approved firestopping between damper frames and firewalls. Install fire dampers in accordance with NFPA Standards, requirements of the State Fire Marshal, and applicable codes. Ensure that fire dampers are installed in the open position.

3. For penetration of fire rated partitions which meet the IBC Chapter Seven requirements of non-Group H occupancy penetration of tenant separation and corridor walls in buildings with fire sprinklers provide metal sleeves as follows: A minimum 12 inch-long (0.30 m) by...
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0.060 inch thick (1.52 mm) steel sleeve shall be centered in each duct opening. The sleeve shall be secured to both sides of the wall and all four sides of the sleeve with minimum 1 1/2" inch by 1 1/2" inch by 0.060 inch steel retaining angles. The retaining angles shall be secured to the sleeve and the wall with No. 10 screws. The annualar space between the steel sleeve and wall opening shall be filled with rock wool batting on all sides.

4. Grilles, Registers and Diffusers: Install flush, squared, tightly sealed, and entirely covering sheet metal ductwork and gaskets. Thread sheet metal mounting screws tightly into sheet metal. All frames shall be selected to fit the ceiling type. Verify with Architectural Drawing. Each diffuser, grille and register shall be individually capable of balancing via duct mounted balancing dampers or attached opposed blade dampers. Provide unit opposed blade damper only where individual duct mounted balancing dampers are specifically noted as not provided. Duct connections shall fit securely to necks or collars behind face area. Provide all necessary transition pieces and duct collars to make connections from ductwork to neck sizes. Where ducts connect directly to necks or collars provide a minimum straight duct section of two times the duct diameter to the last elbow. Where minimum straight duct sections are not physically possible provide sheet metal plenum sized for approximately 500 fpm air velocity with duct tapped directly to side of plenum. Where building walls, floors and ceilings form portions of duct or plenum, provide gasketed angles or channels at junction points, securely bolted and sealed to building structure.

5. Install turning vanes in all mitered elbows in all ducts, so that tips are parallel with the sides of the ducts. Vanes shall be single thickness type. Tips of acoustical turning vanes on outside radius shall be flush with acoustical lining.

6. Provide flexible connections to completely isolate fans from direct contact with all sheet metal work.

7. Provide access panels or doors, as required, for access to valves, controllers, fire dampers and humidifier dispersion tubes. Access doors required in Product Conveying Vapor/Moisture Ductwork (see applicable paragraph above) shall not be installed in the bottom of the duct or in a manner to allow leaks.

8. Volume Dampers: Provide manual volume dampers in all low pressure supply, return and exhaust branch ductwork to grilles, diffusers, inlet and outlet openings to facilitate balancing of systems. These are to be provided as part of contract whether shown on plans or not. Where ceilings are not accessible, provide access door or remote damper operator.

9. Splitters and splitter dampers shall not be installed in medium or low pressure supply ductwork to VAV systems.

B. Hangers and Supports: Securely fasten all ductwork to the building construction by means of hangers, supports, guides, anchors, and sway braces to maintain duct alignment, to prevent sagging, and to prevent noise and excessive strain on ductwork due to movement under operating conditions.

1. Maximum spacing between hangers shall not exceed eight (8) feet.

2. Adequately mount and anchor all material and equipment as required. Include lateral bracing as required to prevent horizontal, seismic movement. Refer to IBC and architectural Drawings for seismic requirements.

3. Do not support ductwork from fans or any other pieces of equipment.

4. Powder driver fasteners shall not be used to support rectangular ducts of 40" maximum dimension. Powder driven fasteners shall not be allowed in existing facilities where electronic equipment is located.

5. Support round duct, 30" and larger, with two hangers at each support point.

6. Hangers and supports shall conform to SMACNA section "Hangers and Supports". Nail inserts, hangers and supports to formwork before slabs are poured. Cut off or remove nails, strap-ends and other projections, flush with concrete after forms are removed.
7. Support vertical ducts, passing through floors with two continuous angles screwed to the duct and bearing to the floor and conforming to SMACNA section "Riser Support-From Floor". Blocking or shimming ducts will not be permitted.

C. Other:
1. Fans: Align fans, motors, and drives. Install fans to render bearings accessible for lubrication without dismantling fans or ducts. Provide extended bearing oilers as required. Mount all fans on vibration isolators as specified.
2. Insulation: Properly and neatly apply insulation on all material and equipment and apparatus, as specified, including all fittings. Apply insulation over clean, dry surfaces, with adjoining sections firmly butted together and canvas smoothly pasted over. When vapor barriers are specified, install continuous overall external surfaces of the entire system.
3. Duct Sizing: Where duct sizes are not specifically shown on the plans or must be modified due to physical limitations, supply ducts may be sized at a maximum velocity of 1,500 fpm or 0.08" sp friction per 100 feet, whichever provides the larger duct, and return/exhaust/intake ducts may be sized at a maximum velocity of 1,000 fpm or 0.06" sp friction per 100 feet, whichever provides the larger duct.
4. Humidifiers: Humidifier installation shall be approved by manufacturer and coordinated with all other systems. Condensate piping shall include p-traps as recommended by the humidifier manufacturer. Insulate exposed piping as required by the code.
5. Access Floor Diffusers: The mounting ring for floor mounted diffusers are to be affixed to the floor tiles using a clamp insert or other method approved for use with the floor diffuser.

3.3 STAINLESS STEEL DUCTWORK
A. For installations serving moisture, vapor, or fume exhaust.
1. For connections to hoods or equipment provide minimum 12" length flanged and bolted stainless steel spool piece connection.
2. All fittings shall be long radius. Round elbows shall be minimum 5 gore.
3. Slope horizontal ductwork back toward source connected equipment minimum 1% slope so that moisture and liquids may drain back toward equipment.
4. Low point “traps” in the ductwork shall be fitted with a low point drain valve, ½” welded connection, stainless steel piping and valve.
5. All welding to be completed by certified welders experienced in 316 grade stainless.

3.4 CONSTRUCTION AND SEALING CRITERIA
A. Unless called out otherwise on drawings the pressure classification of ductwork shall be as follows:

<table>
<thead>
<tr>
<th>Duct system:</th>
<th>Location</th>
<th>Working Pressure</th>
<th>Build to SMACNA Pressure Class</th>
<th>Build to SMACNA Seal Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outdoor air intake</td>
<td>From ambient intake to AHU</td>
<td>-1” wc</td>
<td>-2” wc</td>
<td>B</td>
</tr>
<tr>
<td>Med press Supply Air</td>
<td>From AHU to air terminal units</td>
<td>+6” wc</td>
<td>+10” wc</td>
<td>A</td>
</tr>
<tr>
<td>Med press Supply Air</td>
<td>From AHU to air terminal units</td>
<td>+4” wc</td>
<td>+6” wc</td>
<td>A</td>
</tr>
<tr>
<td>Med press Supply Air</td>
<td>From AHU to air terminal units</td>
<td>+2” wc</td>
<td>+3” wc</td>
<td>A</td>
</tr>
<tr>
<td>Low press Supply Air</td>
<td>Downstream of air terminal units to Low pressure</td>
<td>+1” wc</td>
<td>B</td>
<td></td>
</tr>
</tbody>
</table>
### AIR DISTRIBUTION

<table>
<thead>
<tr>
<th>Duct system:</th>
<th>Location</th>
<th>Working Pressure</th>
<th>Build to SMACNA Pressure Class</th>
<th>Seal Class:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low press Supply Air</td>
<td>From AHU to grilles, registers or diffusers.</td>
<td>Low pressure</td>
<td>+1” wc</td>
<td>B</td>
</tr>
<tr>
<td>Med. Press Return air</td>
<td>From air terminal units to AHU</td>
<td>-3” wc</td>
<td>-4” wc</td>
<td>A</td>
</tr>
<tr>
<td>Med. Press Return air</td>
<td>From air terminal units to AHU</td>
<td>-2” wc</td>
<td>-3” wc</td>
<td>B</td>
</tr>
<tr>
<td>Med. Press Return air</td>
<td>From air terminal units to AHU</td>
<td>-1” wc</td>
<td>-2” wc</td>
<td>B</td>
</tr>
<tr>
<td>Low press Return air</td>
<td>From return grilles to AHU</td>
<td>Low pressure</td>
<td>-1” wc</td>
<td>B</td>
</tr>
<tr>
<td>Transfer air</td>
<td>From grille to grille, or acoustic boots or “z” bends</td>
<td>Low pressure</td>
<td>+0.5” wc</td>
<td>C</td>
</tr>
<tr>
<td>Relief air</td>
<td>From AHU to discharge at ambient</td>
<td>+1” wc</td>
<td>+2” wc</td>
<td>B</td>
</tr>
<tr>
<td>General exhaust</td>
<td>From grille to exhaust fan</td>
<td>-1” wc</td>
<td>-2” wc</td>
<td>B</td>
</tr>
<tr>
<td>General exhaust</td>
<td>From exhaust fan to discharge at ambient</td>
<td>+1” wc</td>
<td>+2” wc</td>
<td>B</td>
</tr>
<tr>
<td>Washroom exhaust</td>
<td>From grille to exhaust fan</td>
<td>-1” wc</td>
<td>-2” wc</td>
<td>B</td>
</tr>
<tr>
<td>Type II Kitchen Hood</td>
<td>From Hood or equipment to exhaust fan</td>
<td>-2” wc</td>
<td>-3” wc</td>
<td>A, or welded. Refer to specification</td>
</tr>
<tr>
<td>Type I Kitchen Hood</td>
<td>From Hood to exhaust fan</td>
<td>-3” wc</td>
<td>-4” wc</td>
<td>A, or welded. Refer to specification</td>
</tr>
<tr>
<td>General Lab exhaust</td>
<td>Branches from grilles to air valve and mains to exhaust fan</td>
<td>-2” wc</td>
<td>-3” wc</td>
<td>A, or welded. Refer to specification</td>
</tr>
<tr>
<td>General Lab exhaust</td>
<td>From exhaust fan to discharge at ambient</td>
<td>+1” wc</td>
<td>+2” wc</td>
<td>A, or welded. Refer to specification</td>
</tr>
<tr>
<td>Chemical fume hood</td>
<td>From Hood to exhaust fan</td>
<td>-2” wc</td>
<td>-3” wc</td>
<td>A, or welded. Refer to specification</td>
</tr>
</tbody>
</table>
AIR DISTRIBUTION

<table>
<thead>
<tr>
<th>Duct system</th>
<th>Location</th>
<th>Working Pressure</th>
<th>Build to SMACNA Pressure Class</th>
<th>Build to SMACNA Seal Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>and biosafety cabinet exhaust</td>
<td>fan</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chemical fume hood and biosafety cabinet exhaust</td>
<td>From exhaust fan to ambient discharge</td>
<td>+2” wc</td>
<td>+3” wc</td>
<td>A, or welded. Refer to specification</td>
</tr>
<tr>
<td>Boiler direct connection air intake</td>
<td>From ambient to boiler connection</td>
<td>Low pressure</td>
<td>-1” wc</td>
<td>B, or per boiler mfg. installation recommendations.</td>
</tr>
<tr>
<td>Gravity type boiler vent</td>
<td>From boiler connection to ambient discharge</td>
<td>Low pressure</td>
<td>+1”</td>
<td>Seal per boiler vent mfg. installation recommendations</td>
</tr>
<tr>
<td>Pressure type boiler vent</td>
<td>From boiler connection to ambient discharge</td>
<td>N/A</td>
<td>N/A</td>
<td>Seal per boiler vent mfg. installation recommendations</td>
</tr>
<tr>
<td>Dust collection exhaust</td>
<td>From floor machine tool to dust collector</td>
<td>-4” wc</td>
<td>-6” wc</td>
<td>A, or welded. Refer to specification</td>
</tr>
</tbody>
</table>

B. The default leakage classification of ductwork is as follows:

<table>
<thead>
<tr>
<th>Duct working pressure class:</th>
<th>Low pressure less than +/-0.5”wc</th>
<th>+/-0.5” to +/-2.99”</th>
<th>+/-3” to +/-10” wc</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMACNA Seal Class</td>
<td>C</td>
<td>B</td>
<td>A</td>
</tr>
<tr>
<td>Sealing Applicable</td>
<td>Transverse joints only</td>
<td>Transverse and longitudinal Joints</td>
<td>Joints, seams, and all wall penetrations</td>
</tr>
<tr>
<td>Rectangular sheet metal SMACNA Leakage Class</td>
<td>24</td>
<td>12</td>
<td>6</td>
</tr>
<tr>
<td>Round sheet metal SMACNA Leakage Class</td>
<td>12</td>
<td>6</td>
<td>3</td>
</tr>
</tbody>
</table>

3.5 MANDATORY DUCTWORK TESTING

A. Ductwork leakage testing may be required to meet local energy code requirements. Refer to local codes for applicability.

3.6 COMBINATION FIRE, SMOKE DAMPER INSTALLATION

A. Install per manufacturer’s and UL installation requirements.

B. Interlock operation of all fire smoke dampers to close dampers when the fans associated with the dampers are shut down. This also includes dampers in transfer ducts associated with system fans.
C. For buildings with no fire alarm system, all fire smoke dampers shall be interconnected with the HVAC units controls and duct smoke detectors. The detection of smoke at any fire smoke damper shall stop for HVAC unit fans and close all fire smoke dampers. A single test/reset station shall be capable or resetting all devices back to normal operation.

3.7 CONTROL DAMPER INSTALLATION

A. Note that installation of control dampers is a part of the mechanical contractor’s work regardless of whether they are specified in this section or as part of products to be selected by the Control Contractor.

B. When electric actuators are provided, dampers shall be installed to allow direct over the shaft mounting of actuators. No connecting rods and stand off brackets shall be necessary.

C. Dampers shall be installed straight and true, level in all planes, and square in all dimensions. Dampers shall move freely without undue stress due to twisting, racking (parallelogramming), bowing, or other installation error.

D. Blades shall close completely. Leakage shall not exceed manufacturer’s specifications at rated static.

E. Structural support shall be provided as necessary for all multi-section dampers.

F. Where blankoffs or structural supports obstruct duct or air passages, the decrease in free area shall not exceed 15% of the damper face area unless otherwise specified here or on plans.

G. No individual damper section may exceed 20 sq. ft.

H. Dampers shall be parallel blades style for outside air economizer to facilitate improved mixing of outside air and return air. Airflows shall be directed towards each other.

3.8 SEISMIC REQUIREMENTS

A. See Section 230548 for specific requirements.

B. All HVAC equipment and machinery shall be anchored to withstand forces generated by earthquake motions. As a minimum, equipment and equipment frames shall be designed to withstand a force of 100% of the weight of the equipment and frame acting at its center of gravity. Anchorage of the equipment and/or frame to the structure shall be for a force of four times gravity also acting at the center of gravity.

C. The seismic calculations shall be the responsibility of contractor.

3.9 EQUIPMENT

A. Install equipment as shown on plans and in accordance with manufacturer’s installation recommendations.

3.10 SUPPLY DIFFUSER AND REGISTER LOCATIONS

A. Coordinate location of supply outlets with ceiling mounted smoke detectors. Locate outlets or outlet distribution so as to prevent airflow from inhibiting the operation of smoke detectors. Locate ceiling outlets a minimum of 3'-0" from smoke detectors.

3.11 PAINTING

A. Where the interior surfaces of ductwork are visible through the blades of supply outlets, return inlets, and exhaust inlets - paint the interior visible surfaces with one coat of flat black paint.
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3.12 FIELD QUALITY CONTROL

A. Do not insulate or conceal ductwork before inspection by Owner's Representative, Architect or Engineer. If ductwork is insulated and concealed prior to this inspection the Contractor shall remove insulation and ceiling to permit inspection at no additional cost to the Owner. The Contractor shall replace the insulation and ceiling after final inspection at no additional cost to the Owner.

B. Ductwork Deflection Criteria:
   1. Maximum inward and/or outward deflection at sheet metal panels shall be 3/4" under maximum static pressure operating conditions. Additional intermediate stiffening angles shall be installed where deflections exceed 3/4".
   2. Maximum inward and/or outward deflection at sheet metal elbows and joints shall be 1/4" under maximum static pressure operating conditions. Additional stiffening angles shall be installed where deflections exceed 1/4".

C. Acceptance of duct systems shall be contingent upon conformance with the requirements specified in Section 230593 "Testing, Adjusting and Balancing".

3.13 ADJUSTING AND CLEANING

A. Clean the inside of plenums, casings, enclosures, fans, and accessible ductwork before starting fans. Blowout coils and condensate piping with compressed air. Install a clean set of filters in each system prior to testing and balancing. Proceed with testing and balancing. All dampers shall be locked in place.

END OF SECTION
PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS
A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 230500 - Basic Materials and Methods, and other Sections in Division 23 specified herein.

1.2 SCOPE
A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 1, and shall include, but not necessarily be limited to, the following:
   1. Spun Aluminum and Steel Housed Centrifugal Exhaust Fans
      a. Upblast Spun Aluminum Exhaust Fan for roof or sidewall mount
   2. Housed Centrifugal Fans
      a. Utility Set

1.3 RELATED WORK SPECIFIED ELSEWHERE
A. Section 230500: Basic Materials and Methods
B. Section 230593: Testing, Adjusting and Balancing
C. Section 230700: Mechanical Insulation
D. Section 230900: Controls and Instrumentation
E. Section 233113: Air Distribution
F. Division 26: Electrical

1.4 QUALITY ASSURANCE
A. Manufacturer's Qualifications: Provide air handling units that are the standard product of an equipment manufacturer regularly engaged in the production of such units who issues complete catalog information on such products. Units shall not be fabricated by the Contractor.
B. Certifications: Provide certified ratings of units based on tests performed in accordance with ARI 430, "Central-Station Air Handling Units."
C. Codes and Standards: Provide air handling units conforming to the requirements of the latest addition of the following:
   1. Air Movement and Control Association (AMCA):
      a. 99 standards Handbook
      b. 210 Laboratory Methods of Testing Fans for Rating [Unit shall bear AMCA Certified Rating Seal]
      c. 300 Reverberant Room Method for Sound Testing of Fans [Unit shall bear AMCA Certified Rating Seal]
      d. 301 Methods for Calculating Fan Sound Ratings from Laboratory Test Data
      e. 500 Test Method for Louvers, Dampers, and Shutters
      a. 9 Load Ratings and Fatigue Life for Ball Bearings
      b. 11 Load Ratings and Fatigue Life for Roller Bearings
      c. 900 Test Performance of Air Filter Units
   3. Air-Conditioning and Refrigeration Institute (ARI):
      a. 350 Sound Rating of Non-Ducted Indoor Air-Conditioning Equipment
      b. 410 Forced-Circulation Air-Cooling and Air-Heating Coils
      c. 430 Central-Station Air-Handling Units
      d. 440 Room Fan-Coil Air-Conditioners

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4. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
   a. 15 Safety Code for Mechanical Refrigeration

5. National Electrical Manufacturers Association (NEMA): Except for motors, provide electrical components required as part of air handling units, which comply with NEMA Standards.

6. National Fire Protection Association (NFPA): Provide air handling unit internal insulation having flame spread rating not higher than 25 and smoke developed rating not higher than 50:
   a. 70 National electrical Code
   b. 90A Standard for the Installation of Air Conditioning and Ventilating Systems
   c. 90B Standard for the Installation of Warm Air Heating and Air Conditioning Systems

7. Sheet Metal and Air Conditioning Contractors’ National Association, Inc. (SMACNA): Comply with applicable SMACNA standards including "HVAC Duct Construction Standards - Metal and Flexible."

8. Underwriters Laboratories, Inc. (UL): Except for motors, provide electrical components required as part of air handling units, which have been listed and labeled by UL.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data for air handling units showing dimensions, weights, capacities, ratings, fan performance with operating point clearly indicated, motor electrical characteristics, and finishes of materials, installation instructions, sound and vibration test report, and bearing life calculations.

B. Shop Drawings: Submit shop drawings showing unit dimensions, weight loadings, required clearances, field connection details and methods of support. Draw to a scale of 1/4” per one foot. Include field fabricated mixing boxes, dampers and duct connections.

C. Maintenance Data: Submit maintenance instructions, including instructions for lubrication, filter replacement, motor and drive replacement, and spare parts lists. Include this data, product data, shop drawings, and wiring diagrams in operating and maintenance manuals.

1.6 ENVIRONMENTAL REQUIREMENTS

A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver unit to the site in containers with manufacturer's stamp or label affixed.

B. Store and protect equipment and products against dirt, water, chemical, and mechanical damage. Do not install damaged unit - remove from project site.

1.8 WARRANTY

A. Provide one-year (12 months) warranty. The warranty shall include parts, labor, travel costs, and living expenses incurred by the manufacturer to provide factory authorized service.

1.9 SAFETY PROVISIONS

A. Provide all open drives and fan wheels subject to maintenance and potential entanglement with protective guards or screens meeting OSHA requirements.
PART 2 - PRODUCTS

2.1 GENERAL FAN REQUIREMENTS

A. Construction, Rating and Testing: Provide fans constructed and factory tested in accordance with the Air Moving and Conditioning Association (AMCA). All fan wheels shall be statically and dynamically balanced. Size and capacity as indicated on the Drawings. Provide extended bearing lubrication fittings where necessary to assure accessibility of all lubrication points.

B. Motors and Drives: Provide premium efficiency drip-proof motors with temperature rise not greater than 40 degrees C above ambient temperature. Provide belt drive assembly capable of 150% of the motor rated horsepower on one less than the total number of belts, for belt drives with two or more belts. All drives shall have adjustable sheaves to allow adjustment of ±20%. Provide two speed, two winding motors where indicated on schedules.

C. Accessories: Provide, as indicated on the Drawings and specified in other paragraphs of this Section, all related accessories to match the fan section, including access sections, diffusion sections, transition sections, flexible connections, vibration eliminators, and belt guards.

D. Submissions: For shop drawings include complete dimensional and physical data, CFM, SP, HP, discharge arrangement, rotation, class, base details, and fan curves.

2.2 SPUN ALUMINUM AND STEEL HOUSED CENTRIFUGAL EXHAUST FANS

A. Manufacturer: Models as scheduled manufactured by Greenheck, Carnes, Cook, Penn, Twin City or approved equal.

B. Upblast Spun Aluminum Exhaust Fan for Roof or Sidewall Mount

1. Belt-drive: Spun aluminum exhaust fans shall be belt driven type.
   a. Fan wheel shall be centrifugal backward inclined, constructed of aluminum and shall include a wheel cone carefully matched to the inlet cone for precise running tolerances. Wheels shall be statically and dynamically balanced. The fan housing shall be constructed of heavy gauge aluminum with a rigid internal support structure. The windband shall be welded to the one-piece curb cap and on all sizes with UL/CUL-762.
   b. Motors shall be heavy duty ball bearing type, carefully matched to the fan load, and furnished at the specified voltage, phase and enclosure. Drive frame assembly shall be constructed of heavy gauge steel. Motors and drives shall be mounted on vibration isolators, out of the airstream. Fresh air for motor cooling shall be drawn into the motor compartment through a tube sized for sufficient fresh air to provide motor cooling. Motors and drives shall be readily accessible for maintenance.
   c. Precision ground and polished fan shafts shall be mounted in permanently sealed, lubricated pillow block ball bearings. Bearings shall be selected for a minimum L10 life in excess of 100,000 hours (L50 life of 500,000 hours) at maximum cataloged operating speed. Drives shall be sized for a minimum of 150% of driven horsepower. Pulleys shall be of the cast type, keyed and securely attached to the wheel and motor shafts. Motor pulleys shall be adjustable for final system balancing. Third pulley to be included for ease of adjusting drive belt tension and to enhance belt life.
   d. A NEMA 3R disconnect switch shall be factory installed and wired from the fan motor to a junction box installed within the motor compartment. A conduit chase shall be provided through the base to the motor compartment for ease of electrical wiring.
   e. All fans shall bear the AMCA Certified Ratings Seal for sound and air performance.
   f. Each fan shall bear a permanently affixed manufacturer's engraved metal nameplate containing the model number and individual serial number for future identification.
FANS AND VENTS

g. Fan Arrangement:
   1) Roof Mounted Upblast Exhaust Fans A leakproof fan housing shall be constructed with a one piece windband with an integral rolled bead for added strength.
   2) Sidewall Mounted Exhaust Fans A leakproof fan housing shall be constructed with a one piece windband with an integral rolled bead for added strength. Fan shall be provided with a mounting plate, which is attached and sealed to the wall prior to locating the entire unit.

h. Options:
   1) Fans shall be Listed by Underwriters Laboratory for UL/cUL 762 Listed for all electrical components and grease removal
   2) Easy Clean Options: Provide a curb hinge kit constructed of heavy gauge hinges and including hold open cables or chain for field installation. Non Stick wheel shall be constructed of aluminum with a non stick coating simular to Teflon® as manufactured by Dupont. Clean out port shall have a hole on the outside of the windband and a grease repellent compression rubber fit, allowing access to entire wheel for cleaning.
   3) Vented Curb Extensions: Shall be mounted between roof curb and roof mounted fans to meet NFPA requirements of 40 in. minimum discharge above the roof when mounted on a minimum 8 in. high roof curb.

2.3 WINDBAND EXTENSION SHALL BE CONSTRUCTED FROM HEAVY GAUGE ALUMINUM TUBE THAT RAISES THE DISCHARGE AN ADDITIONAL 36 INCHES

A. Utility Set
   1. Manufacturer: Trane, Loren Cook, Carnes, Industrial Air, Peerless-Winsmith, Aerovent, Twin City, or approved equal.
   2. Belt Drive Utility Fans:
      a. Supply, exhaust and return air fans shall be of the belt driven utility fan type in AMCA Arrangement 10 with a single width, single inlet housing, in CW or CCW rotation as specified. The housing shall be constructed of heavy gauge steel with air tightlock formed seams. The housing shall be easily rotated in the field to any of the eight standard discharge positions. Housing andbearing supports shall be constructed of welded steel members to prevent vibration and to rigidly support the shaft and bearings.
      b. Fan wheels shall be of the forward curved type, constructed of heavy gauge steel with uniform stamped steel blades. Wheels shall be statically and dynamically balanced. The wheel cone and fan inlet cone shall be carefully matched for maximum performance and operating efficiency.
      c. Motors shall be heavy duty, ball bearing type, matched to the fan load and furnished at the specified voltage, phase and enclosure. The fan shaft shall be ground and polished solid steel mounted in heavy duty, permanently sealed, pillow block ball bearings. Bearings shall be selected for a minimum L50 life in excess of 200,000 hours of maximum cataloged operating speed. Drives shall be sized for a minimum of 150% of driven horsepower. Pulleys shall be of the fully machined cast iron type, keyed and securely attached to the wheel and motor shafts. The motor pulley shall be adjustable for final system balancing.
   3. All fans shall bear the AMCA Certified Ratings Seal for air performance.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Coordinate motor starters with Div. 26 and control contractor.
B. Install in accordance with manufacturer’s instructions.
C. Examine site to verify if site is ready to receive work. Provide layout drawings of air handlers and fan locations to electrical installer.
D. Install unit on vibration isolators.
E. Install 3" flexible duct connection at inlets and outlets of units.
F. Control installers shall install all wiring associated with control signals into the fan starters.
G. Electrical installer shall install all line voltage power wiring and conduit. Coordinate with Division 26 work.

3.2 MANUFACTURER’S START-UP SERVICES

A. The manufacturer shall provide start-up service in the form of a factory trained service technician. The service technician shall verify correct installation, verify unit mounting, verify fan rotation, verify spring isolator adjustments, verify control wiring, verify power wiring, start-up the fans, and check for proper operation. The service technician shall provide final adjustments to meet the specified performance requirements. Fully staffed parts and service personnel shall be within four hours travel from the job site.

END OF SECTION
PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS
A. All work to be furnished and installed under this section shall comply with all the requirements of General conditions, Supplemental Conditions, Division 01 - General Requirements, Section 230500 - Basic Materials and Methods, and other Sections in Division 23 specified herein.

1.2 SCOPE
A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to, the following:
   1. Air filters and Associated Hardware
   2. Activated Carbon and Odoroxidant Media
   3. Air Filter Gauges

1.3 RELATED WORK SPECIFIED ELSEWHERE
A. Section 230500: Basic Materials and Methods
B. Section 233113: Air Distribution

1.4 QUALITY ASSURANCE
A. Codes and Standards: Provide products conforming to the requirements of the following:
   1. ASHRAE Standard 52.1
   3. NFPA Standard 90A
B. Design Criteria
   1. Air flow not to exceed rated capacity
   2. Initial and final resistance not to exceed scheduled values.
C. Filters for Schools and State Funded Buildings
   1. Air filters shall be of an approved type tested in accordance with State Fire Marshal test method SFM-31.6. Pre-formed filters having combustible framing shall be tested as a complete assembly.
   2. Air filters in all occupancies shall be U.L. Class 2 or better, as defined in the test method above.
   3. Air filters shall be accessible for cleaning or replacement.

1.5 SUBMITTALS
A. Prior to construction, submit for approval on all materials and equipment.
   1. Manufacturer's name and catalog data
   2. Installation Data
   3. Capacities and Resistances
   4. Materials of Construction

1.6 DELIVERY, STORAGE, AND HANDLING
A. Deliver products to the site in containers with manufacturer's stamp or label affixed.
B. Store and protect all products against dirt, water, chemical, and mechanical damage. Do not install damaged products. Remove damaged materials from project site.
PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Filters: Model numbers given throughout are listed for Eco-Air products.
   1. Eco-Air Products, Inc.
   2. American Air Filter
   3. Westates Carbon
   4. Farr
   5. Flanders
   6. Camfil-Farr

B. Accessories
   1. Framing Modules - Eco-Air K-Trac
   2. Air Filter Gages - Dwyer
   3. Metal Filters - Eco-Air Metal Masters

2.2 FILTER CARTRIDGES

A. Panel Filters - Construction grade
   1. Disposable Filters
   2. Fiberglass or polyester media and cardboard frames, completely disposable, thickness as scheduled.
   3. Permanent washable types not acceptable.
   5. Basis of design: Eco-Air Products, SFM #3175-394:003, U.L. #R6908 (N) (fiberglass disposable)

B. Pleated Media Filters (ASHRAE Dust-spot Efficiency 25-30%)
   1. Filter media of a high-loft, reinforced, non-woven cotton/synthetic blend.
   2. Media support is continuously laminated to an expanded metal grid on the air leaving side.
   3. Radial wedge pleat design.
   4. Media frame is constructed from two pieces of die-cut high wet-strength carrier board. The frame is designed with diagonal and horizontal support members bonded to the media on the air entering and leaving sides.
   5. U.L. Class 2 listed.

C. Pleated Media Filters (ASHRAE Dust-Spot Efficiency 50%)
   1. Filter media of high efficiency micro-fine glass fiber reinforced with a synthetic backing.
   2. Media support is continuously laminated to an expanded metal grid on the air leaving side.
   3. Pleat design shall be a radial wedge pleat.
   4. The enclosing frame is constructed from moisture-resistant chipboard. Perforated steel support grilles are placed on the upstream and downstream sides. The entire unit is then sealed to insure a positive media-to-frame bond.
   5. U.L. Class 2 listed.

D. Medium and High Efficiency Bag Filters
   1. Filter Construction
      a. Replaceable factory-assembled cartridges incorporating a fine-fibered all-glass medium encased in a non-woven backer mat material. Filters up to 22” in depth shall be designed to operate in Variable Air Volume Systems.
      b. Provide cartridge frame with a gasket on the vertical sides to prevent leakage between the cartridges if installed in framing modules or side access housings.
AIR FILTRATION

c. Open area on the cartridge face available for air passage: not less than 90 percent of the total face area.
d. Flexible internal supports maintain individual pleats in a tapered form under rated airflow conditions. At any point, the size of the upstream and downstream air-passage are in exact proportion to the volume of unfiltered and filtered air being handled at that point.
e. Each pocket shall be individually sewn with stringently regulated stitching to create a uniformly shaped channel. Each stitch line to be sealed with a thin thermoplastic bead to prevent air bypass. All pocket edges shall be finished with a 4-thread stitch to maintain maximum airflow and durability.
f. U.L. Class 2 construction and so listed.

2. Performance
   a. Initial and final resistance not to exceed the scheduled values.
   b. Media area must equal or exceed that of the specified products.
   c. Determine the average efficiency using the ASHRAE Standard 52.1 Test Method using atmospheric dust.

3. Test Report
   a. Submit an independent test laboratory report showing the pressure drop of the clean filter cartridge elements at flow rates from 75% to 125% of the manufacturer's published rated capacity for the filter cartridge elements.
   b. Perform this test in an ASHRAE test duct system in accordance with the applicable portion of ASHRAE Standard 52.1.


E. Medium and High Efficiency Rigid Filters (Separator Type U.L. Class 1)
1. Filter Construction
   a. Totally rigid type, constructed by pleating a continuous sheet of moisture-resistant all-glass media into closely-spaced pleats with hemmed edge aluminum separators.
   b. Filter pack shall be sealed in a 24 gauge galvanized steel frame with fire-retardant urethane resin potting compound.
   c. Media area per 24x24x12 size filter shall be 91 square feet per 65% and 85% efficient filters and 116 square feet per 95% efficient filters.
   d. U.L. Class 1 construction and so listed.
   e. Basis of design: Eco-Air Ecopac, SFM #3175-394:106, U.L. #R6908 (N)

F. Medium and High Efficiency Rigid Filters (Lofted Media Type U.L. Class 2)
1. Filter Construction
   a. Totally rigid type with a lofted high-density microfine glass filter media laminated to a non-woven backing. The media shall be supported by an expanded metal support grid bonded to the media to eliminate media oscillation. Media finger supports shall be manufactured of an industrial strength board and be permanently installed on both air leaving sides, (4) per side.

2. Enclosing Frame
   a. The enclosing frame shall be manufactured of 26 gauge galvanized steel and furnished with horizontal and diagonal support members to stabilize and protect the media pack.


G. Panel Air Filters
   1. Refer to the schedule and air filter specification for details.
   2. The side access filter cabinet shall match the air handler cabinet with similar construction and finish. Hinged access doors with positive-latching fasteners shall be provided at both ends of the housing. Sheet metal screws shall not be used.

SERA Architects, Inc. Package 1 – PERMIT / CONSTRUCTION

NOTICE OF ALTERNATE BILLING CYCLE: The Contract will allow the Owner to require the submission of billings or estimates in billing cycles other than 30-day cycles. Billing or statements shall be submitted monthly ending on the last day of the month.

NOTICE OF EXTENDED CERTIFICATION PROVISION: The Contract will allow the Owner to certify billings and estimate within 20 days after the billings and estimates are received from the original contractor.

NOTICE OF EXTENDED PAYMENT PROVISION: The Contract will allow the Owner to make payment within 30 days after the date a billing or estimate is received.
H. Extended Area Air Filters
   1. Refer to the schedule and air filter specification for details.
   2. Holding frames and side access housings shall be provided under Section 233113 by the filter manufacturer.
   3. The rooftop unit manufacturer shall install the holding frames or framing modules in the unit at the factory in strict accordance with Section 233113.
   4. Side access filter housings may be supplied by the central station air handler manufacturer if:
      a. The housing construction meets or exceeds that of the specified housing; and
      b. Such housings are offered as a standard product by the air handler manufacturer; and
      c. The housings provide equal or greater filter face area.

2.3 MODULAR FRAMING SYSTEM (UPSTREAM OR DOWNSTREAM ACCESS)
   A. Medium and high efficient extended surface ASHRAE-rated filters shall be installed in extruded (mill finish) (anodized) aluminum framing modules factory-cut, pre-punched and packaged with all necessary stiffening members and thread cutting screws for field assembly into modules up to 12’ high and 14’ wide using only a screwdriver or socket wrench.
   B. The framing members shall be permanently gasketed with a reinforced nylon pile seal to prevent the bypass of unfiltered air. Each horizontal row of filters shall have a positive spring-loaded sealing device which will allow easy installation and removal of cartridges from either upstream or downstream access as specified and shall secure the seal between cartridges while the bank is in operation.
   C. A separate track shall be incorporated for 2” panel pre-filters (if desired or specified) which can be serviced from upstream without disturbing the final filters.
   D. Basis of design: Eco-Air K-Trac

2.4 INDIVIDUAL HOLDING FRAMES FOR BUILT-UP BANKS
   A. Frames for panel filters
      1. 16 gauge (galvanized) (304 stainless) steel with filter sealing gaskets and fasteners.
      2. Basis of design: Eco-Air Type 9 Holding Frame
      *** Use for 1”, 2” or 4” panel filters in a built-up bank.***
   B. Frames for ASHRAE-rated Extended Area Filters
      1. 3 inches deep, 16 gauge (galvanized) (304 stainless) steel with gaskets and filter retaining clips to maintain a positive pressure seal between the frame and the replaceable filter element and matching rivet holes to facilitate installation.
      2. Provide frames with clips or other means to hold a 2” panel pre-filter if desired, removable without disturbing the final filter element.
      3. Basis of design: Eco-Air Type 9 Frame
   C. Frames for DOP-rated and HEPA Filters.
      1. 16 gauge (galvanized) (304 stainless) steel with filter retaining fasteners and matching rivet holes with depth to match the filter cartridges.
      2. Provide bolt type fasteners and flat-edge sealing surfaces.
      3. Basis of design: Eco-Air Model Alpha Frame

2.5 AIR FILTER GAGES
   A. Dial type, diaphragm-actuated with external zero adjustment and 3-7/8 inch diameter dial.
   B. With two (2) static pressure tips, 2-way valves, tubing and mounting plate (and adjustable signal flag).

SERA Architects, Inc. Package 1 – PERMIT / CONSTRUCTION
PART 3 - EXECUTION

3.1 INSTALLATION

A. Filter Bank Construction
   1. Filter banks of individual holding frames: install leak tight and structurally sound to eliminate air bypass.
   2. Filter banks three filters high or higher: provide 3’ wide 16 gauge (galvanized) (stainless) steel stiffeners between each vertical row of filters. Caulk frames before installing. After installation caulk any gaps appearing at the leading edge of the holding frames. Use DAP "Butyl Gutter and Lap Sealer." After erection of the filter bank and careful caulking, tape the joints between filter frames on the downstream side with 1” duct tape.
   3. HEPA filter frames over 6” deep do not require stiffeners, only taping and caulking. HEPA filter frames must be bolted together; welding will not be acceptable.
   4. Framing modules require sealant and stiffening only between modules and around the periphery.

B. Filter gages are to be installed across each filter bank, mounted where directed. One gage may serve immediately adjacent pre-filter/final filter banks.

C. Temporary Pre-filters for Construction
   1. Protect all 40% or higher efficient filters upstream of air handling units during construction with temporary blankets of 2” polyester or fiberglass filter media or 2” disposable panel filters, U.L. Class 2 listed.
   2. Remove after air balancing and prior to acceptance.
   3. Provide a spare set of these temporary pre-filters or media and install them during construction if required per 3.04B.

3.2 SPARE FILTERS

A. Furnish one new complete spare set of cartridges for each filter bank listed below on completion and acceptance of the work:
   1. Medium and high efficient bag filters.
   2. Medium and high efficient rigid filters.
   3. DOP-rated 95% and HEPA filters.

B. Install spare set in A. above only if and when directed. If not installed, deliver to owner in sealed carton.

C. Replace all panel filters which are not temporary pre-filters with a new set at job completion and furnish owner with an additional set in sealed cartons.

D. Furnish owner with one set of spare trays loaded with carbon, if carbon housings or adsorbers are specified on this project.

3.3 FIELD QUALITY CONTROL

A. Filter cartridges shall be capable of easily being loaded and unloaded through access doors in the housings or access sections.

3.4 START-UP PROCEDURE

A. No fan shall be operated unless all particulate filters as specified (except gas phase filters) are installed, along with temporary pre-filter media as outlined in 3.01.C.
AIR FILTRATION

B. When the pressure drop of the temporary media reaches 0.5" W.G. during construction, replace it with the spare set. If not used, deliver the spare set to the owner at job completion.

C. Gas phase carbon trays shall not be installed until just prior to beneficial occupancy and all paint is dry and cleaning solvents are completely evaporated. Test and balance contractor shall allow for resistance of carbon trays in his work by simulating their resistance on the system.

3.5 SCHEDULE

A. See air filter schedule on Drawings for filter model numbers, CFM and sizing data.

END OF SECTION
PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS

A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 230500 - Basic Materials and Methods, and other Sections in Division 23 specified herein.

1.2 SCOPE

A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to, the following:
   1. Dedicated Outside Air System (DOAS) Air Handling Unit
   2. Direct Expansion Heat Pump Condensing unit matched to DOAS.
   3. Unit curbs.

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Section 230500: Basic Materials and Methods
B. Section 230593: Testing, Adjusting and Balancing
C. Section 230902: Variable Frequency Drives (VFD)
D. Section 233113: Air Distribution
E. Division 26: Electrical

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Provide air handling units that are the standard product of an equipment manufacturer regularly engaged in the production of such units who issues complete catalog information on such products. Units shall not be fabricated by the Contractor.
B. Certifications: Provide certified ratings of units based on tests performed in accordance with ARI 430, "Central-Station Air Handling Units."
C. Codes and Standards: Provide air handling units conforming to the requirements of the latest addition of the following:
   1. Air Movement and Control Association (AMCA):
      a. 99 Standards Handbook
      b. 210 Laboratory Methods of Testing Fans for Rating [Unit shall bear AMCA Certified Rating Seal]
      c. 300 Reverberant Room Method for Sound Testing of Fans [Unit shall bear AMCA Certified Rating Seal]
      d. 301 Methods for Calculating Fan Sound Ratings from Laboratory Test Data
      e. 500 Test Method for Louvers, Dampers, and Shutters
      a. 9 Load Ratings and Fatigue Life for Ball Bearings
      b. 11 Load Ratings and Fatigue Life for Roller Bearings
      c. 900 Test Performance of Air Filter Units
   3. Air-Conditioning and Refrigeration Institute (ARI):
      a. 410 Forced-Circulation Air-Cooling and Air-Heating Coils
      b. 430 Central-Station Air-Handling Units
DEDICATED OUTSIDE AIR HANDLING UNITS

4. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
   a. 15 Safety Code for Mechanical Refrigeration

5. National Electrical Manufacturers Association (NEMA): Except for motors, provide electrical components required as part of air handling units, which comply with NEMA Standards.

6. National Fire Protection Association (NFPA): Provide air handling unit internal insulation having flame spread rating not higher than 25 and smoke developed rating not higher than 50:
   a. 70 National electrical Code
   b. 90A Standard for the Installation of Air Conditioning and Ventilating Systems
   c. 90B Standard for the Installation of Warm Air Heating and Air Conditioning Systems

7. Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA): Comply with applicable SMACNA standards including "HVAC Duct Construction Standards - Metal and Flexible."

8. Underwriters Laboratories, Inc. (UL): Except for motors, provide electrical components required as part of air handling units, which have been listed and labeled by UL.

9. Units shall be listed and labeled by either UP or ETL for air handler construction.

1.5 PRODUCT SUBSTITUTIONS

A. The Contractor shall certify the following items are correct when using substituted products other than those scheduled or shown on the drawings as a basis of design:
   1. The proposed substitution does not affect dimensions shown on drawings.
   2. The Contractor shall pay for changes to building design, including engineering design, detailing, structural supports, and construction costs caused by proposed substitution.
   3. The proposed substitution has no adverse effect on other trades, construction schedule, or specified warranty requirements.
   4. Maintenance and service parts available locally are readily obtainable for the proposed substitute.

B. The Contractor further certifies function, appearance, and quality of proposed substitution are equivalent or superior to specified item.

C. The Contractor agrees that the terms and conditions for the substituted product that are found in the contract documents apply to this proposed substitution.

1.6 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data for air handling units showing dimensions, weights, capacities, ratings, fan performance with operating point clearly indicated, motor electrical characteristics, and finishes of materials, installation instructions, sound and vibration test report, and bearing life calculations.

1. Direct drive fan wheels shall be factory dynamically balanced and shall meet or exceed guidelines in AMCA 204-96 for Balance Quality and Vibration Levels for Fan Application Category BV-3. Following fan assembly, the complete spring isolated fan assembly shall be tested using an electronic balance analyzer with tunable filter and stroboscope.

   Vibration measurements shall be taken on each motor bearing housing in the vertical, horizontal, and axial planes (5 total measurements, 2 each motor bearing and 1 Axial).

   The maximum allowable velocity shall not exceed 0.125 inches per second peak amplitude (filter on) on any of 5 readings and shall not exceed .5 mils @ 1170 rpm. A copy of the Vibration test report (Vibration Nomograph) shall be provided with the Operation and Maintenance Manual upon request. The fan assembly shall also be vibration tested at design RPM with the spring isolators at the specified deflection, with the tunable filter utilized and frequencies from 500 cpm to 50,000 cpm shall be scanned to detect misalignment, bearing defects, mechanical looseness or foundation weakness.
DEDICATED OUTSIDE AIR HANDLING UNITS

A copy of the balance test data for this project showing calculations for deflection and critical speed of the shaft and wheel assembly shall be submitted to the engineer review.

B. Shop Drawings: Submit shop drawings showing unit dimensions, weight loadings, required clearances, field connection details and methods of support. Draw to a scale of one half inch to one foot. Include field fabricated mixing boxes, dampers and duct connections.

C. Maintenance Data: Submit maintenance instructions, including instructions for lubrication, filter replacement, motor and drive replacement, and spare parts lists. Include this data, product data, shop drawings, and wiring diagrams in operating and maintenance manuals.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver unit to the site in containers with manufacturer’s stamp or label affixed.

B. Store and protect unit against dirt, water, chemical, and mechanical damage. Do not install damaged unit - remove from project site.

1.9 WARRANTY

A. Provide one-year (12 months) warranty. The warranty shall include parts, labor, travel costs, and living expenses incurred by the manufacturer to provide factory authorized service.

PART 2 - PRODUCTS

2.1 CUSTOM MAKE UP AIR SYSTEM AIR HANDLER

A. Manufacturer: Products shall be provided by the following manufacturers:
   1. Energy Labs, HuntAir, Haakon, Scott Springfield
   2. Substitute equipment may be considered for approval that includes at a minimum:
      a. Direct drive supply fans
      b. Double wall cabinet construction
      c. Insulation with a minimum R-value of 8
      d. Stainless steel drain pans
      e. Hinged access doors with lockable handles
      f. All other provisions of the specifications must be satisfactorily addressed

B. General Description of Rooftop Unit
   1. Custom make up air handling unit shall include filters, supply fans, dampers, hydronic coils, exhaust fans, energy recovery heat pipe, and variable frequency drives.
   2. Unit shall be factory assembled and tested including leak testing of the coils, pressure testing of the refrigeration circuit, and run testing of the completed unit. Run test report shall be supplied with the unit in the controls compartment’s literature pocket.
   3. Unit shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel.
   4. Unit components shall be labeled, including pipe stub outs, refrigeration system components and electrical and controls components.
   5. Estimated sound power levels (dB) shall be shown on the unit ratings sheet.
   6. Installation, Operation and Maintenance manual shall be supplied within the unit.
   7. Laminated color-coded wiring diagram shall match factory installed wiring and shall be affixed to the interior of the control compartment’s access door.
   8. Unit nameplate shall be provided in two locations on the unit, affixed to the exterior of the unit and affixed to the interior of the control compartment’s access door.

SERA Architects, Inc.

NOTICE OF ALTERNATE BILLING CYCLE: The Contract will allow the Owner to require the submission of billings or estimates in billing cycles other than 30-day cycles. Billing or statements shall be submitted monthly ending on the last day of the month.

NOTICE OF EXTENDED CERTIFICATION PROVISION: The Contract will allow the Owner to certify billings and estimates within 20 days after the billings and estimates are received from the original contractor.

NOTICE OF EXTENDED PAYMENT PROVISION: The Contract will allow the Owner to make payment within 30 days after the date a billing or estimate is received.
DEDICATED OUTSIDE AIR HANDLING UNITS

C. Construction
1. All cabinet walls, access doors, and roof shall be fabricated of double wall steel panels.
2. Unit insulation shall have a minimum thermal resistance R-value of 8. Foam insulation shall have a minimum density of 2 pounds/cubic foot and shall be tested in accordance with ASTM D-1929 for a minimum flash ignition temperature of 610°F.
3. Unit construction shall be double wall with G90 galvanized steel on both sides, with minimum 18 ga exterior and 22 ga interior walls.
4. Unit shall be designed to reduce air leakage and infiltration through the cabinet. Cabinet leakage shall not exceed 1% of total airflow when tested at 3 times the minimum external static pressure provided in AHRI Standard 340/360. Panel deflection shall not exceed L/240 ratio at 125% of design static pressure, at a maximum 8 inches of positive or negative static pressure, to reduce air leakage. Deflection shall be measured at the midpoint of the panel height and width. Continuous sealing shall be included between panels and between access doors and openings to reduce air leakage.
5. Roof of the air tunnel shall be sloped to provide complete drainage. Cabinet shall have rain break overhangs above access doors.
6. Access to filters, dampers, cooling coils, reheat coil, heaters, exhaust fans, energy recovery devices, and electrical and controls components shall be through hinged access doors with quarter turn, zinc cast, lockable handles. Full length stainless steel piano hinges shall be included on the doors.
7. Exterior paint finish shall be capable of withstanding at least 1000 hours with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.
8. Units with cooling coils shall include double sloped 304 stainless steel drain pans.
9. Unit shall be provided with base discharge and return air openings. All openings through the base pan of the unit shall have upturned flanges of at least 1/2 inch in height around the opening.
10. Unit shall include lifting lugs on the top of the unit.

D. Electrical
1. Unit shall be provided with standard power block for connecting power to the unit.
2. Required Electrical Options:
   a. Unit fans shall be provided with factory installed and factory wired variable frequency drives.
   b. Unit shall be provided with factory installed and field wired 115V, 20 amp GFI outlet in the unit control panel.
   c. Provide a main control panel with access door(s) for direct access to the controls. The panel shall be NEMA type 3R (rainproof) and shall contain a single externally operated, non-fused disconnect. The panel shall carry a UL 508 listing and be constructed in accordance with NEC regulations.
   d. Provide vapor tight marine lights in each access section, factory wired to a single weatherproof switch located on exterior of cabinet. Provide weatherproof, 15 amps, GFIC receptacle near the light switch wired to the lighting circuit. The Electrical Contractor shall bring separate 120/1/60 power to the light switch.
   e. All wiring shall be run in EMT conduit, raceways are not acceptable.
   f. If the unit requires splits, junction boxes shall be furnished on each section to allow the electrical contractor to make final connections in the field. Wiring shall be clearly labeled to allow ease in final interconnections.
   g. Unit fans shall be provided with factory installed and factory wired variable frequency drives for the supply and exhaust/return fans. Variable frequency drives shall be installed in a ventilated NEMA 3R enclosure where shown on plans. Refer to VFD specification for additional requirements.
E. Fans
1. Fan performance shall be based on tests run in an AMCA certified laboratory and administered in accordance with AMCA Standard 210. Fan performance tests shall be taken with fans running inside the cabinet to include any affects from the unit cabinet and other internal components. Fans shall bear AMCA seal for air and sound.
2. Plenum fans shall be configured so that both fan bearings are on the drive side of the wheel with the wheel over hung (Arrangement #1). There shall be no obstructions (i.e., bearings or bearing supports, etc.) at the inlet of the fan. Fan wheel shall be aluminum with aluminum extruded airfoil blades. Fan bearings shall have a minimum L10-200,000 Hr. operating life and be mounted on a structural steel channel or machined surface. The fan discharge shall be isolated from the cabinet by means of a neoprene-coated flexible connection. Plenum fans shall be provided with spring-style thrust restraints.
3. Each fan shall be sized to perform as indicated on the equipment schedule. The wheel diameter shall not be less than that shown on the equipment schedule. The fan shall be constructed to AMCA Standards for the Class Rating as indicated on the Equipment Schedule.
4. Blowers and motors shall be dynamically balanced and mounted on restrained spring isolators.
5. Motors shall be standard (premium) efficiency TEFC with ball bearings rated for 200,000 hours service with external lubrication points.
6. Variable frequency drives shall be factory wired and mounted in the unit.
7. All motors shall be equipped with shaft grounding.

F. Hydronic Coils
1. Coils shall be constructed of copper tubes with aluminum fins mechanically bonded to the tubes and 304 stainless steel end casings. Fin design shall be sine wave rippled.
2. All coil assemblies shall be tested under water at 300 psi and rated for 150-psi working pressure.
3. Intermediate condensate pans are to be furnished on multiple coil units and single coils greater than 48” high. The pans shall be 16Ga. 304 stainless steel and drain to the main drainpan through copper downspouts.
4. All water coils shall be rated in accordance with ARI Standard 410.
5. The air handling unit manufacturer, for the purpose of sole source responsibility, shall manufacture all coils supplied for the air handlers.

G. Filters
1. Unit Supply Side shall include 2 inch thick MERV 8 and 4 inch thick, pleated panel filters with an ASHRAE efficiency of 85% and a MERV 13 rating upstream of the heat recovery device and cooling coil.
2. Unit Exhaust Side: Unit shall include 2 inch thick, pleated panel outside air filters with an ASHRAE efficiency of 30% and MERV rating of 8, upstream of the wheels.
3. Unit shall include a Magnehelic gauge mounted in the controls compartment for each filter bank.

H. Energy Recovery Heat Pipe
1. Integral fins will be fabricated from 1050 Aluminum Alloy.
2. Tubes will be made from Aluminum Alloy.
3. Heat pipes will have a capillary wick structure integral to the heat pipe container wall.
4. Heat pipe working fluids will be R-134a
5. Heat pipes will be individually processed, charged, hermetically sealed and factory tested.
6. Heat pipe coil structural casing will be fabricated from a minimum of C90 Galvanized Steel. The heat pipe coil will be supplied with 4 flanges on the top and bottom along the front and back edges. Intermediate supports shall be furnished as required.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer’s instructions.

B. Examine site to verify if site is ready to receive work. Provide a layout drawing of air handler and fan locations to electrical installer.

C. Install minimum 30% efficiency air filters in unit during installation phase. Do not operate the unit without filters in place.

D. Assemble units by bolting sections together.

E. Install unit on vibration isolators.

F. Install 3” flexible duct connection at inlets and outlets of units.

G. Install condensate drain piping and traps in accordance with manufacturer’s instructions and as shown on the drawings.

H. Install all refrigerant piping and valves in accordance with manufacturer’s instructions and as shown on drawings.

I. Install a new set of pre-filters and final filters prior to final air balance and substantial completion.

J. Control installers shall install all wiring associated with control signals into the air handlers.

K. Electrical installer shall install all line voltage power wiring and conduit. Coordinate with Division 26 work.

L. If return fans are configured to drawing inlet air from a raised curb, curb access must be provided for field installation and service of measuring devices and smoke detectors.

M. Airflow measuring arrays installed in fan inlet volutes must be designed to withstand velocities encountered in this location. Mounting system is to be warranted against failure and consequent fan damage.

3.2 MANUFACTURER’S START-UP SERVICES

A. The manufacturer shall provide start-up service in the form of a factory trained service technician. The service technician shall verify correct installation, verify unit mounting, verify fan rotation, verify spring isolator adjustments, verify control wiring, verify power wiring, start-up the fans, and check for proper operation. The service technician shall provide final adjustments to meet the specified performance requirements. Fully staffed parts and service personnel shall be within four hours travel from the job site.

3.3 AIR HANDLING UNIT CONFORMANCE

A. Manufacturer representative shall complete the following table and provide a copy with each submittal package to assure conformance to specifications:

B. AIR HANDLER COMPLIANCE CHECKLIST:

<table>
<thead>
<tr>
<th>AIR HANDLER PERFORMANCE</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer</td>
<td></td>
</tr>
<tr>
<td>Dimensions (LxWxH inches)</td>
<td></td>
</tr>
<tr>
<td>Operating Weight (LBS)</td>
<td></td>
</tr>
<tr>
<td>-----------------------</td>
<td>--</td>
</tr>
<tr>
<td>Total Air Flow (CFM)</td>
<td></td>
</tr>
<tr>
<td>System Supply Air Static Pressures (in. wg.)</td>
<td></td>
</tr>
<tr>
<td>External Supply Ductwork</td>
<td></td>
</tr>
<tr>
<td>Discharge Loss</td>
<td></td>
</tr>
<tr>
<td>Cooling Coil</td>
<td></td>
</tr>
<tr>
<td>Clean Filters</td>
<td></td>
</tr>
<tr>
<td>Dirty Filter Allowance</td>
<td></td>
</tr>
<tr>
<td>Damper/Louver/Fitting Loss</td>
<td></td>
</tr>
<tr>
<td>Total Supply Fan Static</td>
<td></td>
</tr>
<tr>
<td>Systems Return Air Static Pressures (in. wg.)</td>
<td></td>
</tr>
<tr>
<td>External Return Air Static Pressure</td>
<td></td>
</tr>
<tr>
<td>Entrance Loss</td>
<td></td>
</tr>
<tr>
<td>Internal Louver/Damper/Fitting Loss</td>
<td></td>
</tr>
<tr>
<td>Total Return Fan Static</td>
<td></td>
</tr>
</tbody>
</table>

### SUPPLY FAN PERFORMANCE
- Supply Fan BHP
- Supply Fan HP
- Supply Fan RPM
- Supply Fan Efficiency
- Direct Drive Plenum Fans: Yes or No
- Fan Arrangement
- Pressure Class
- Aluminum Construction: Yes or No
- Bearings (L 10/200000 hours): Yes or No
- Fans selected at rated motor RPM: Yes

### RETURN FAN PERFORMANCE
- Return Fan BHP
- Return Fan HP
- Return Fan RPM
- Return Fan Efficiency
- Direct Drive Plenum Fans: Yes or No
- Fan Arrangement
- Pressure Class
- Aluminum Construction: Yes or No
- Bearings (L 10/200000 hours): Yes or No
- Fans selected at rated motor RPM: Yes

### EXHAUST AIR EVAPORATIVE COOLING PERFORMANCE
- Total Capacity (MBH)
- Sensible Capacity (MBH)
- Face Velocity (FPM)
- GPM
- Water Pressure Drop (ft. H2O)
- Coils/Fins per Inch/Rows

---

SERA Architects, Inc.  Package 1 – PERMIT / CONSTRUCTION

NOTICE OF ALTERNATE BILLING CYCLE: The Contract will allow the Owner to require the submission of billings or estimates in billing cycles other than 30-day cycles. Billing or statements shall be submitted monthly ending on the last day of the month.

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NOTICE OF EXTENDED PAYMENT PROVISION: The Contract will allow the Owner to make payment within 30 days after the date a billing or estimate is received.
### DEDICATED OUTSIDE AIR HANDLING UNITS

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tube Size (inches)</td>
<td></td>
</tr>
<tr>
<td>Tube thickness (inches)</td>
<td></td>
</tr>
<tr>
<td>Tube return bend thickness (inches)</td>
<td></td>
</tr>
<tr>
<td>Coils have 16 ga 304 SS</td>
<td>Yes/No</td>
</tr>
<tr>
<td>Drain pans are 304 SS</td>
<td>Yes/No</td>
</tr>
<tr>
<td>Coil blank offs are 304 SS</td>
<td>Yes/No</td>
</tr>
</tbody>
</table>

### FURNACE PERFORMANCE

### CABINET CONSTRUCTION

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural Steel Channel base</td>
<td>Yes/No</td>
</tr>
<tr>
<td>Tubular steel base</td>
<td>Yes/No</td>
</tr>
<tr>
<td>Can vary base height</td>
<td>Yes/No</td>
</tr>
<tr>
<td>Structural steel channel cross support</td>
<td>Yes/No</td>
</tr>
<tr>
<td>Formed channel cross support</td>
<td>Yes/No</td>
</tr>
<tr>
<td>Cross support max spacing</td>
<td></td>
</tr>
<tr>
<td>Thermal break at joints</td>
<td>Yes/No</td>
</tr>
<tr>
<td>Outer steel (gauge)</td>
<td></td>
</tr>
<tr>
<td>Solid inner steel (gauge)</td>
<td></td>
</tr>
<tr>
<td>Insulation (wall/floor thickness) (inches)</td>
<td></td>
</tr>
<tr>
<td>Standing seam construction</td>
<td>Yes/No</td>
</tr>
<tr>
<td>Welded frame construction</td>
<td>Yes/No</td>
</tr>
<tr>
<td>Bolted construction</td>
<td>Yes/No</td>
</tr>
<tr>
<td>Sheet metal screw construction</td>
<td>Yes/No</td>
</tr>
<tr>
<td>Standing seam roof with seam cleats</td>
<td>Yes/No</td>
</tr>
<tr>
<td>Roof attachment external to unit casing</td>
<td>Yes/No</td>
</tr>
<tr>
<td>Outdoor-pitched roof</td>
<td>Yes/No</td>
</tr>
<tr>
<td>Access door locations as required</td>
<td>Yes/No</td>
</tr>
<tr>
<td>Double seals on doors</td>
<td>Yes/No</td>
</tr>
<tr>
<td>Latches per door (number)</td>
<td></td>
</tr>
<tr>
<td>Adjustable door hinges</td>
<td>Yes/No</td>
</tr>
<tr>
<td>Adjustable door latches</td>
<td>Yes/No</td>
</tr>
<tr>
<td>Access doors open against static pressure</td>
<td>Yes/No</td>
</tr>
<tr>
<td>Door safety &quot;Kill&quot; switches</td>
<td>Yes/No</td>
</tr>
<tr>
<td>Polyurethane paint</td>
<td>Yes/No</td>
</tr>
<tr>
<td>Vents and drains extended to outside cabinet</td>
<td>Yes/No</td>
</tr>
<tr>
<td>Cabinet Sounds data for inlet &amp; outlet</td>
<td></td>
</tr>
<tr>
<td>Supply connection at 125 &amp; 1000 hz (db)</td>
<td></td>
</tr>
<tr>
<td>Return connection at 125 &amp; 1000 hz (db)</td>
<td></td>
</tr>
<tr>
<td>Economizer has min/max dampers</td>
<td>Yes/No</td>
</tr>
<tr>
<td>Dampers sizing (maximum fpm)</td>
<td></td>
</tr>
<tr>
<td>Outside air louver sizing (maximum fpm)</td>
<td></td>
</tr>
<tr>
<td>Exhaust air louver sizing (maximum fpm)</td>
<td></td>
</tr>
<tr>
<td>Exterior hoods</td>
<td>Yes/No</td>
</tr>
</tbody>
</table>

### ADDITIONAL UNIT FEATURES

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marine lights with GFI</td>
<td>Yes/No</td>
</tr>
<tr>
<td>Fan screen enclosures</td>
<td>Yes/No</td>
</tr>
<tr>
<td>Min OSA air flow station</td>
<td>Yes/No</td>
</tr>
<tr>
<td>Airflow stations on each fan</td>
<td>Yes/No</td>
</tr>
<tr>
<td>Motor removal rails</td>
<td>Yes/No</td>
</tr>
<tr>
<td>Bellmouth outlet</td>
<td>Yes/No</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Requirement</th>
<th>Yes or No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof curb</td>
<td></td>
</tr>
<tr>
<td>TEFC premium efficiency motors</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Shaft grounding factory mounted on motors</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Variable Frequency Drive (VFD) manufacturer</td>
<td></td>
</tr>
<tr>
<td>VFD’s are factory mounted &amp; wired (UL508)</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Data sheets for VFD’s</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Filters are size and type specified</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Filter frames are face load type 8</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Two filter gages (one per filter bank)</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Weather covers for filter gages</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Data sheets for filters</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Data sheets for air flow stations</td>
<td>Yes or No</td>
</tr>
<tr>
<td>PROVIDE DETAILS</td>
<td></td>
</tr>
<tr>
<td>Base/floor construction</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Casing/cabinet construction</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Access doors</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Door hinges and latches</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Fan curves</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Pressure losses (including internal/external loss)</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Sound data for inlet/outlet</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Electrical wiring diagram</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Vibration isolation detail</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Coil construction</td>
<td>Yes or No</td>
</tr>
<tr>
<td>VFD mounting details</td>
<td>Yes or No</td>
</tr>
<tr>
<td>MANUFACTURER CAPABILITIES</td>
<td></td>
</tr>
<tr>
<td>Fan Wheel Manufacturer</td>
<td></td>
</tr>
<tr>
<td>Coil Manufacturer</td>
<td></td>
</tr>
<tr>
<td>Dampers Manufacturer</td>
<td></td>
</tr>
<tr>
<td>Louver Manufacturer</td>
<td></td>
</tr>
<tr>
<td>Isolator Manufacturer</td>
<td></td>
</tr>
<tr>
<td>Have a certified UL508 electrical shop</td>
<td>Yes or No</td>
</tr>
<tr>
<td>ARI certified for coils</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Coil Testing Capabilities</td>
<td>Yes or No</td>
</tr>
<tr>
<td>AMCA certified for blowers</td>
<td>Yes or No</td>
</tr>
<tr>
<td>UL-508</td>
<td>Yes or No</td>
</tr>
<tr>
<td>AMCA 210 accredited lab</td>
<td>Yes or No</td>
</tr>
<tr>
<td>AMCA 300 accredited lab</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Ability to perform leak tests</td>
<td>Yes or No</td>
</tr>
<tr>
<td>UL-508 compliance</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Unit ETL or UL listing</td>
<td>Yes or No</td>
</tr>
</tbody>
</table>

END OF SECTION
PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS

A. All work under this Section shall comply with the requirements of General Conditions, Supplemental Conditions, Special Conditions and Division 01 - General Requirements, and shall include all Mechanical Sections specified herein.

1.2 SCOPE OF THIS SECTION

A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to, the following:
   1. Compliance with all codes and standards applicable to this jurisdiction
   2. Shop Drawings for Equipment
   3. Coordination Documents
   4. Record Drawings
   5. Start-up Service and Building Commissioning
   6. Instruction, Maintenance, and O & M Manuals
   7. Work associated with Delivery, Storage, and Handling of products
   8. Work associated with provision of Temporary Facilities
   9. Preparation of Posted Operating Instructions
   10. Meeting Project Safety and Indemnity requirements
   11. Proper Cleaning and Closing
   12. Supplying proper Warranty information
   13. Supply specified Guarantee documentation
   14. Design and provision of Supports and Anchors
   15. Access Panels and Doors
   16. Identification Markers
   17. Demolition/Remodel Work

1.3 DESCRIPTION OF WORK

A. The Contract Documents, including Specifications and Construction Drawings, are intended to provide all material and labor to install complete power distribution, auxiliary power production, lighting systems for the building and shall interface with all existing building systems affected by new construction.

B. The Contractor shall refer to the architectural interior details, floor plans, elevations, and the structural and other Contract Drawings and he shall coordinate his work with that of the other trades to avoid interference. The plans are diagrammatic and show generally the locations of the fixtures, equipment, and raceways and are not to be scaled; all dimensions and existing conditions shall be checked at the building.

C. The Contractor shall comply with the project closeout requirements as detailed in General Requirements of Division 01.

1.4 DESCRIPTION OF BID DOCUMENTS

A. Specifications:
   1. Specifications, in general, describe quality and character of materials and equipment.
   2. Specifications are of simplified form and include incomplete sentences.

B. Drawings:
   1. Drawings in general are diagrammatic and indicate sizes, locations, connections to equipment and methods of installation.
   2. Before proceeding with work check and verify all dimensions.
COMMON WORK RESULTS FOR ELECTRICAL

3. Assume all responsibility for fitting of materials and equipment to other parts of equipment and structure.
4. Make adjustments that may be necessary or requested, in order to resolve space problems, preserve headroom, and avoid architectural openings, structural members and work of other trades.
5. If any part of Specifications or Drawings appears unclear or contradictory, apply to Architect or Engineer for his interpretation and decision as early as possible, including during bidding period.

1.5 RELATED WORK SPECIFIED ELSEWHERE

A. All Division 26 Electrical sections included herein.
B. Division 33: Utility Site Work.
1. Coordination of excavation of trenches and the installation of mechanical systems and piping on site.
C. Division 03: Concrete.
1. All concrete work for Mechanical Division shall be included in Division 23 under the appropriate Sections and shall include:
   a. Concrete curbs and housekeeping pads for the mechanical equipment.
   b. Thrust blocks, pads, and boxes for mechanical equipment.
   c. Coordination of floor drain and floor sink installations in sloped floors.

D. Division 07: Thermal and Moisture Protection.
1. Flashing and sheet metal
2. Sealants and caulking
3. Firestopping
E. Division 09: Painting:
1. Division 09 installer shall perform all painting, except where specifically stated otherwise in Division 09.
F. Division 21: Plumbing is related to work of:
1. Power connections to all plumbing equipment
2. Installation of controllers and disconnect furnished by Division 21 contractor.
G. Division 23: HVAC is related to work of:
1. Power connections to all mechanical equipment
2. Installation of controllers and disconnect furnished by Division 23 contractor.
H. Division 28: Electronic Safety and Security is related to work of:
1. Power connections to equipment

1.6 CODES AND STANDARDS

A. The Contractor is cautioned that code requirements not explicitly detailed in these specifications or drawings, but which may be reasonably inferred or implied from the nature of the project, must be provided as part of the contract.
B. Perform all tests required by governing authorities and required under all Division 26 Sections. Provide written reports on all tests.
C. Electrical devices and wiring shall conform to the latest standards of NEC; all devices shall be UL listed and labeled.
D. All electrical work shall comply with the Americans with Disabilities Act (ADA).
E. All excavation work must comply with all provisions of state laws including notification to all owners of underground utilities at least 48 business day hours, but not more than 10 business days, before commencing an excavation.

F. Provide in accordance with rules and regulations of the following:
1. Building Codes enforced by the Authority Having Jurisdiction in Oregon:
   a. 2010 Oregon Structural Specialty Code (OSSC) with amendments based on 2009 International Building Code (IBC)
   b. 2007 Oregon Fire Code (Based on the 2006 International Fire Code)
   c. 2011 National Electric Code (NEC) with 2011 (OESC) State Amendments
2. Local, city, county and state codes and ordinances
3. Local Bureau of Buildings
4. Local Health Department
5. Local and State Fire Prevention Districts
6. State Administrative Codes

1.7 GENERAL REQUIREMENTS

A. Examine all existing conditions at building site.
B. Review contract documents and technical specifications for extent of new work to be provided.
C. Provide and pay for all permits, licenses, fees and inspections.
D. Install equipment and materials to provide required access for servicing and maintenance. Coordinate the final location of concealed equipment and devices requiring access with final location of required access panels and doors. Allow ample space for removal of all parts that require replacement or servicing. This work shall include furnishing and installing all access doors required for access.
E. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected. Refer to Equipment Specifications in Divisions 02 through 26 for rough-in requirements.
F. Coordinate electrical equipment and materials installation with other building components.
G. Verify all dimensions by field measurements.
H. Arrange for chases, slots, and openings in other building components to allow for mechanical installations.
I. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
J. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing-in the building.
K. Coordinate the cutting and patching of building components to accommodate the installation of electrical equipment and materials. Contractor to provide for all cutting and patching required for installation of his work unless otherwise noted.
L. Where mounting heights are not detailed or dimensioned, install electrical services and overhead equipment to provide the maximum headroom possible.
M. Install electrical equipment to facilitate maintenance and repair or replacement of equipment components.
COMMON WORK RESULTS FOR ELECTRICAL

N. Coordinate the installation of electrical materials and equipment above ceilings with ductwork, piping, conduits, suspension system, light fixtures, cable trays, sprinkler piping and heads, and other installations.

O. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

P. All materials located within air plenum spaces, air shafts, and occupied spaces shall have a flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E84 (NFPA 255) Method. In addition, the products, when tested, shall not drip flame particles, and flame shall not be progressive. Provide Underwriters Laboratories, Inc., label or listing, or satisfactory certified test report from an approved testing laboratory to prove the fire hazard ratings for materials proposed for use do not exceed those specified.

Q. Products made of or containing lead, asbestos, mercury or other known toxic or hazardous materials are not acceptable for installation under this Division. Any such products installed as part of the work of the Division shall be removed and replaced and all costs for removal and replacement shall be borne solely by the installing Contractor.

1.8 MINOR DEVIATIONS

A. The Drawings are diagrammatic and show the general arrangements of all mechanical work and requirements to be performed. It is not intended to show or indicate all offsets, fittings, and accessories which will be required as a part of the work of this Section.

B. The Contractor shall review the structural and architectural conditions affecting his work. It is the specific intention of this section that the contractor’s scope of work shall include

1. Proper code complying support systems for all equipment whether or not scheduled or detailed on drawings or in these specifications
2. Minor deviations from the electrical plans required by architectural and structural coordination.

C. The Contractor shall study the operational requirements of each system, and shall arrange his work accordingly, and shall furnish such fittings, offsets, supports, accessories, as are required for the proper and efficient installation of all systems from the physical space available for use by this section. This requirement extends to the Contractor’s coordination of this section’s work with the “Mechanical Work.” Should conflicts occur due to lack of coordination, the time delay, cost of rectification, demolition, labor and materials, shall be borne by the Contractor and shall not be at a cost to the Owner.

D. Minor deviations in order to avoid conflict shall be permitted where the design intent is not altered.

E. Advise the Architect, in writing, in the event a conflict occurs in the location or connection of equipment. Bear all costs for relocation of equipment, resulting from failure to properly coordinate the installation or failure to advise the Architect of conflict.

1.9 PRODUCT SUBSTITUTIONS

A. The Contractor shall certify the following items are correct when using substituted products other than those scheduled or shown on the drawings as a basis of design:

1. The proposed substitution does not affect dimensions shown on drawings.
2. The proposed substitution does not affect the electrical characteristics shown on the drawings.
3. The Contractor shall pay for changes to building design, including engineering design, detailing, structural supports, and construction costs caused by proposed substitution.

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Package 1 – PERMIT / CONSTRUCTION

NOTICE OF ALTERNATE BILLING CYCLE: The Contract will allow the Owner to require the submission of billings or estimates in billing cycles other than 30-day cycles. Billing or statements shall be submitted monthly ending on the last day of the month.

NOTICE OF EXTENDED CERTIFICATION PROVISION: The Contract will allow the Owner to certify billings and estimate within 20 days after the billings and estimates are received from the original contractor.

NOTICE OF EXTENDED PAYMENT PROVISION: The Contract will allow the Owner to make payment within 30 days after the date a billing or estimate is received.
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4. The proposed substitution has no adverse effect on other trades, construction schedule, or specified warranty requirements.
5. Maintenance and service parts available locally are readily obtainable for the proposed substitute.

B. The Contractor further certifies function, appearance, and quality of proposed substitution are equivalent or superior to specified item.

C. The Contractor agrees that the terms and conditions for the substituted product that are found in the contract documents apply to this proposed substitution.

1.10 SHOP DRAWINGS AND EQUIPMENT SUBMITTALS

A. Prior to construction submit for review all materials and equipment in accordance with Division 01 requirements.

B. After approval of preliminary list of materials, the Contractor shall submit Shop Drawings and manufacturer's Certified Drawings to the Architect for approval.

C. Submittals and Shop Drawings shall be submitted as a complete package bound in a 3-ring binder with tabs for each specification section. The approved submittals shall be converted into Operations & Maintenance Manuals at the completion of the project. Submit six (6) typed copies of submittals. Refer to Division 01 for additional requirements.

1.11 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical 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 raceways, 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 electrical 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 of firestopping specified in Division 07 "Through – Penetration firestop systems."

1.12 COORDINATION DOCUMENTS

A. The Contractors shall prepare coordinated Shop Drawings to coordinate the installation and location of all HVAC equipment, ductwork, grilles, diffusers, piping, fire sprinklers, lights, audio/video systems, electrical services and all system appurtenances. The Drawings shall include all mechanical rooms and floor plans. The Drawings shall be Overlay Drawings showing each discipline on a single sheet. The Drawings shall be keyed to the structural column identification system, and shall be progressively numbered. Prior to completion of the Drawings, the Contractor shall coordinate the proposed installation with the Architect and the structural requirements, and all other trades (including HVAC, Plumbing, Fire Protection, Electrical, Ceiling Suspension, and Tile Systems), and provide reasonable maintenance access requirements. When conflicts are identified, modify system layout as necessary to resolve. Do not fabricate, order or install any equipment or materials until coordination documents are approved by the General Contractor, Architect, and Owner. Within thirty (30) days after award of Contract, sub-
COMMON WORK RESULTS FOR ELECTRICAL
mit proposed coordination document Shop Drawing schedule, allowing adequate time for review and approval by parties mentioned above. Drawings should be prepared and submitted for approval on a floor-by-floor basis to phase with building construction.

B. Plans are to incorporate all addenda items and change orders.

C. Advise the Architect in the event a conflict occurs in the location or connection of equipment. Bear all costs for relocation of equipment, resulting from failure to properly coordinate the installation or failure to advise the Architect of conflict.

D. Provide means of access to all junction boxes, disconnect switches, controllers, operable devices, and other apparatus that may require adjustment or servicing.

E. Final Coordination Drawings with all appropriate information added are to be submitted as Record Drawings at completion of project.

F. Provide copy of Record Drawings to Commissioning Agent for their use when doing their work.

1.13 RECORD DRAWINGS
A. Before commencing installation, obtain an extra set of prints from Architect, marked "Record." Keep this set of Drawings at the job site at all times, and use it for no other purpose but to mark on it all the changes and revisions to the Contract Drawings resulting from coordination with other trades. At the completion of the project,

1. Edit project AutoCAD files to incorporate all site markups, changes, and revisions to the Contract Drawings. Submit plots of Record Drawings and six copies CD Roms labeled with all record AutoCAD drawing files.

B. Provide copy of Record Drawings to Testing and Balancing Contractor for use when doing his work.

C. Mark Drawings to indicate revisions to raceways; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground raceways; concealed equipment, dimensioned to column lines; Change Orders.

D. Mark Specifications to indicate approved substitutions; Change Orders; actual equipment and materials used.

E. Refer also to Special Conditions in Division 01 for full scope of requirements.

1.14 DEMOLITION/REMODEL WORK
A. Refer to Division 01 section on Summary of Work for requirements on working in Owner-occupied areas of the existing building and Division 02 section on selective demolition. The following expand the requirements specified in Division 01 and 02.

B. Existing equipment that is removed and not scheduled to be reused shall remain the property of the Owner unless specifically indicated otherwise and shall be stored in a location designated by the Owner. Miscellaneous materials that are removed shall become the property of the Contractor.

C. Existing equipment that is removed and is to be reused shall be cleaned, serviced and operable before being energized.

D. Revise panelboard schedules to reflect removal or relocation of equipment. Circuit integrity of equipment shall be left intact.

E. Where remodeling interferes with existing circuits and equipment which is not to be removed, such circuits and equipment shall be reworked and relocated as required to complete the project.
F. The project involves renovation and remodel of the existing building. On the drawings, certain renovation symbols are used. These symbols are amplified as follows:

**R** = Existing items to be removed. Contractor shall remove the existing item and turn over to the Owner. The existing wiring shall be removed. Where the raceway serving the equipment is accessible (via removal of suspended ceiling, crawl space, etc.) the raceway shall also be removed. Where the removal of a raceway leaves visible evidence on an existing surface which is not being repaired or replace as part of the Work, this Contractor shall repair the surface. Where the existing raceway is concealed, the outlet box shall be cleaned, and a blank cover plate installed. Where the concealed raceway is uncovered by demolition performed as part of the Work, the raceway shall be removed (or extended to new location if appropriate).

**E** = Existing item to remain in place. Contractor shall perform the following function based upon the item to remain:
- Luminaries - Clean and relamp.
- Switches - Leave as existing.
- Receptacles - Leave as existing.

**RL** = Existing item to be relocated. Contractor shall remove the existing item, and store in a safe place. The existing item shall be relocated to the new position as called for on the drawings. At contractors option, the existing wiring may be extended, or new wiring may be run from the source. Based upon the item to be relocated, the Contractor shall perform the following function:
- Luminaires - Clean and relamp.
- Switches - Replace.
- Receptacles - Replace.

G. The Contractor shall remove all distribution equipment, conductors, etc. which are indicated to be removed or which must be removed to accommodate demolition. Equipment to be removed may require reworking conduit and wiring in order to maintain service to other equipment.

H. Where remodeling interferes with circuits serving areas outside of the project or phase limits or which are remodeled in later phases of the project, circuits shall be reworked or temporary circuits provided as required.

I. Existing equipment and circuiting shown are based upon field surveys and/or Owner furnished drawings. The Contractor shall verify conditions as they exist with necessary adjustments being made to the drawing information.

J. Reuse of existing luminaires, devices, conduits, boxes, or equipment will be permitted only where specifically indicated within the Contract Documents.

K. Electrical Outages:
   1. Contractor shall submit a Method of Procedure (MOP) for each outage to the Owner detailing the reasons for the outage, areas affected, sequence of procedures to accomplish work, estimated maximum duration, the date and time of day outage will occur. The Contractor shall meet with the Owner to set a schedule and date for the outage based upon the MOP. Due to the critical implications of power outage, the Owner may direct the Contractor as to the time of day or night and date an outage may take place. A 7 day notice is required.
1.15 DELIVERY, STORAGE AND HANDLING

A. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage, and handling.

B. Store equipment and materials in an environmentally controlled area at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage. Piping shall be stored in bundles covered with visqueen. Piping showing signs of rust shall be removed from site and replaced.

C. Coordinate deliveries of mechanical materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.

1.16 SAFETY AND INDEMNITY

A. The Contractor shall be solely and completely responsible for conditions of the job site including safety of all persons and property during performance of the work. This requirement will apply continuously and not be limited to normal hours of work.

B. No act, service, drawing, review, or Construction Review by the Owner, Architect, the Engineers or their consultants, is intended to include the review of the adequacy of the Contractor's safety measures, in, on, or near the construction site.

C. The Contractor performing work under this Division of the Specifications shall hold harmless, indemnify and defend the Owner, the Architect, the Engineers and their consultants, and each of their officers, employees and agents from any and all liability claim, losses or damage arising, or alleged to arise from bodily injury, sickness, or death of a person or persons, and for all damages arising out of injury to or destruction of property arising directly or indirectly out of, or in connection with, the performance of the work under the Division of the Specifications, and from the Contractor's negligence in the performance of the work described in the Construction Contract Documents; but not including the sole negligence of the Owner, the Architect, the Engineers, and their consultants or their officers, employees and agents.

1.17 CLEANING AND CLOSING

A. All work shall be inspected, tested, and approved before being concealed or placed in operation.

B. Upon completion of the work, all equipment installed as specified in this section, and all areas where work was performed, shall be cleaned to provide operating conditions satisfactory to the Architect.

1.18 WARRANTIES

A. All equipment shall be provided with a minimum one-year warranty to include parts and labor. Refer to individual Equipment Specifications for extended or longer-term warranty requirements.

B. Provide complete warranty information for each item, to include product or equipment, date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, telephone numbers and procedures for filing a claim and obtaining warranty services.

C. Service during warranty period: Contractor shall provide maintenance as specified elsewhere during the 12-month warranty period.
1.19 GUARANTEE
A. The Contractor shall guarantee and service all workmanship and materials to be as represented by him and shall repair or replace, at no additional cost to the Owner, any part thereof which may become defective within the period of one (1) year after the Date of Final Acceptance, ordinary wear and tear excepted.
B. Contractor shall be responsible for and pay for any damages caused by or resulting from defects in his work.

PART 2 - PRODUCTS
2.1 GENERAL
A. Furnish and install all new material, equipment, and apparatus hereinafter specified unless specifically noted otherwise. All material, equipment, and apparatus shall be identified by the manufacturer's name, nameplate, and pertinent data.
B. All materials, equipment, and apparatus are mentioned as standards unless noted otherwise. The words "or approved equal" shall be considered to be subsequent to all manufacturers' names used herein, unless specifically noted that substitutes are not allowed.

2.2 ACCESS PANELS AND ACCESS DOORS
A. Provide all access doors and panels to serve equipment under this work, including those which must be installed, in finished architectural surfaces. Frame of 16-gauge steel, door of 20 gauge steel. 1" flange width, continuous piano hinge, key operated, prime coated. Refer to Architectural Specifications for the required product Specification for each surface. Contractor is to submit schedule of access panels for approval. Exact size, number and location of access panels is not shown on Plans. Access doors shall be of a size to permit removal of equipment for servicing. Access door shall have same rating as the wall or ceiling in which it is mounted. Provide access panel for each trap primer or concealed valve, for fire and combination fire/smoke dampers, and for volume dampers. Use no panel smaller than 12" x 12" for simple manual access, or smaller than 24" x 24" where personnel must pass through. Provide cylinder lock for access door serving mixing or critical valves in public areas.
B. Included under this work is the responsibility for verifying the exact location and type of each access panel or door required to serve equipment under this work and in the proper sequence to keep in tune with construction and with prior approval of the Architect. Access doors in fire rated partitions and ceilings shall carry all label ratings as required to maintain the rating of the rated assembly.
C. Acceptable Manufacturers: Milcor, Karp, Nystrom, or Elmdor/Stoneman.
D. Submit markup of architectural plans showing size and location of access panels required for equipment access for approval by Architect.

2.3 SLEEVES FOR RACEWAYS AND CABLES
A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
B. Sleeves for Rectangular Openings: Galvanized sheet steel.
   1. Minimum Metal Thickness:
      a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches, thickness shall be 0.052 inch.
      b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches and 1 or more sides equal to, or more than, 16 inches, thickness shall be 0.138 inch.
2.4 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL 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 electrical 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 way to piping systems installed at a required slope.

F. Equipment Dimensions: Provide equipment that fits the available space. Do not exceed dimensions indicated or shown without prior approval.

G. Field verify exact locations, dimensions, and routing of existing equipment.

H. Workmanship shall be performed by licensed journeymen or master mechanics and shall result in an installation consistent with the best practices of trades.

I. Install work uniform, level and plumb, in relationship to lines of building. Do not install any diagonal, or otherwise irregular work unless so indicated on Drawings or approved by Architect.

3.2 MANUFACTURER'S DIRECTIONS

A. Follow manufacturers’ directions and recommendations in all cases where the manufacturers of articles used on this Contract furnish directions covering points not shown on the Drawings or covered in these Specifications.

B. If the contractor must deviate from the manufacturer’s recommendations provide a letter from the manufacturer indicating the clearance to be provided is acceptable for scheduled performance and maintenance.

3.3 INSTALLATION

A. Coordinate the work between the various Electrical Sections and with the work specified under other Divisions. If any cooperative work must be altered due to lack of proper supervision or failure to make proper and timely provisions, the alternations shall be made to the satisfaction of the Engineer and at the Contractor’s cost. Coordinate wall and ceiling work with the General Contractor, and his subcontractors in locating lighting fixtures, wiring devices, disconnects, controllers, etc.

B. Inspect all material, equipment, and apparatus upon delivery and do not install any damaged or defected materials.
3.4 ELECTRICAL REQUIREMENTS

A. Electrical Contractor shall coordinate with Division 23 work to provide electrical service as required to operate all mechanical devices under this Division of work.

B. Installation of Electrical Connections: Furnish, install, and wire (except as may be otherwise indicated) all heating, ventilating, air conditioning, etc., motors and controls in accordance with the following schedule and in accordance with equipment manufacturer’s written instructions and with recognized industry practices, and complying with applicable requirements of UL, NEC, and NECA’s “Standard of Installation” to ensure that products fulfill requirements. Carefully coordinate with work performed under the Mechanical Division of these Specifications.

C. Division 23 has responsibilities for electrically powered or controlled mechanical equipment which is specified in Division 23 Specifications or scheduled on Division 23 Drawings. The specific division of responsibilities between Division 23 and 26 for furnishing or wiring this equipment is as follows:

1. Division 23 Mechanical Responsibilities:
   a. MOTORS: Furnish and install all motors necessary for mechanical equipment.
   b. MAGNETIC STARTERS: Furnish all magnetic starters whether manually or automatically controlled which are necessary for mechanical equipment. Furnish these starters with all control relays or transformers necessary to interface with mechanical controls. If the starter is factory installed on a piece of Division 23 equipment, also furnish and install the power wiring between starter and motor.
   c. VARIABLE FREQUENCY DRIVES: Provide all VFD’s associated with mechanical equipment. If the drive is installed on a piece of factory assembled equipment the wiring between motor and drive is to be provided as part of the factory equipment.
   d. DISCONNECTS: Provide the disconnects which are part of factory wired Division 23 equipment. Factory wiring to include wiring between motor and disconnect or combination starter/disconnect.
   e. CONTROLS: Division 23 Contractor (including the temperature controls subcontractor) is responsible for the following equipment in its entirety. This equipment includes but is not limited to the following:
      1) Control relays necessary for controlling Division 23 equipment
      2) Control transformers necessary for providing power to controls for Division 23 equipment
      3) Line voltage thermostats
      4) Low or non-load voltage control components
      5) Remote bulb thermostats
      6) Non-life safety related valve or damper actuators
      7) Float switches
      8) Solenoid valves, EP and PE switches
      9) Refrigeration controls. (Division 26 provides power to refrigeration panels.)
   f. FIRE AND LIFE SAFETY EQUIPMENT:
      1) Fire/Smoke Dampers: Division 23 is responsible for providing and physically installing the damper and for installing any required control interface wiring to Division 23 controls.
      a) Where fire/smoke dampers are part of an integrated smoke control system, Division 23 is responsible for providing dampers with necessary end switches for proof of closure (see Section 233113.)
      b) Where these dampers are not part of an integrated area wide smoke detection system, Division 23 is responsible for providing each fire/smoke damper with a dedicated duct detector installed per the requirements of the building code (see Section 233113). If not integral with the damper assembly, the detector is to be installed by Div. 23 but wired for damper control by Div. 26.
COMMON WORK RESULTS FOR ELECTRICAL

2) Fire Sprinkler System: Division 23 is responsible for providing necessary controls including flow switches and alarm bells.
3) Specialized fire suppression systems: Division 23 is responsible for providing necessary system controls and any required control interface wiring to these controls. Division 26 is responsible for bringing power to point of connection with the system.

g. Division 26 has responsibilities for electrically powered or controlled mechanical equipment, which is specified in Division 23 Specifications or scheduled on Division 23 Drawings. The specific division of responsibilities between Division 23 and 26 for furnishing or wiring this equipment is as follows:

2. Division 26 Electrical Responsibilities:
   a. MOTORS: Provide the power wiring for the motors.
   b. MAGNETIC STARTERS: Except where magnetic starters are factory installed on Division 23 factory assembled equipment, Division 26 is to install magnetic starters furnished by Division 23 and install the necessary power wiring to the starter and from the starter to the motor. In the case of factory installed starters, Division 26 is to install the necessary power wiring to the starter.
   c. VARIABLE FREQUENCY DRIVES: Physically mount all VFD’s, which are not specified to be installed on Division 23 factory assembled equipment. Provide the necessary power wiring to the VFD and from the VFD to the motor except in the case of factory installed VFD’s where wiring between the motor and VFD is to be by Division 23. Where disconnects are installed between a VFD and a motor provide the interlocking wiring between the disconnect and VFD to insure that the drive is shutdown simultaneously with motor.
   d. DISCONNECTS: Provide all disconnects necessary for Division 23 mechanical equipment which are not provided as part of factory wired Division 23 equipment. Provide power wiring to all disconnects. In addition provide power wiring between motor and disconnect when the disconnect is not factory installed. See also Variable Frequency Drive above for special wiring requirements.
   e. CONTROLS: Division 26 Contractor is responsible for providing power to control panels and control circuit outlets.
   f. FIRE AND LIFE SAFETY EQUIPMENT:
      1) Fire/Smoke Dampers: Division 26 is responsible for power wiring to the damper and as follows:
         c) Where these dampers are part of an integrated smoke control system Division 26 is responsible for providing the detectors and for all fire detection system wiring necessary to integrate dampers and related end switches into the system.
         d) Where these dampers are not part of an integrated area wide smoke detection system, Division 23 is responsible for providing each fire/smoke damper with a dedicated duct detector installed per the requirements of the building code (see Section 233113). If not integral with the damper assembly, the detector is to be installed by Div. 23 but wired for damper control by Div. 26.
      2) Fire Sprinkler System: Division 26 is responsible for providing power wiring to fire protection controls including flow switches and alarm bells.
      3) Specialized fire suppression systems: Division 26 is responsible for providing power wiring to suppression system and power for controls.
   
3. Coordinate with other work, including wires/cables, raceway and equipment installation, as necessary to properly interface installation of electrical connections for equipment with other work.
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4. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer’s written instructions and wiring diagrams. Mate and match conductors of electrical connections for proper interface between electrical power supplies and installed equipment.

5. Maintain existing electrical service and feeders to occupied areas and operational facilities, unless otherwise indicated, or when authorized otherwise in writing by Owner, or Architect/Engineer. Provide temporary service during interruptions to existing facilities. When necessary, schedule momentary outages for replacing existing wiring systems with new wiring systems. When that “cutting-over” has been successfully accomplished, remove, re-locate, or abandon existing wiring as indicated.

6. Cover splices with electrical insulating material equivalent to, or of greater insulation resistivity rating, than electrical insulation rating of those conductors being spliced.

7. Prepare cables and wires, by cutting and stripping covering armor, jacket, and insulation properly to ensure uniform and neat appearance where cables and wires are terminated. Exercise care to avoid cutting through tapes which will remain on conductors. Also avoid "ringing" copper conductors while skinning wire.

3.5 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways 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. Extend sleeves installed in floors 2 inches above finished floor level.

G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry

I. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section “Joint Sealants.”

K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section “Penetration Firestopping.”

L. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

M. 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.
M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway 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 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.

3.7 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical 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
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. 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.
      3. Sleeves and sleeve seals for cables.

1.3 DEFINITIONS
   A. EPDM: Ethylene-propylene-dieneterpolymer rubber.
   B. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS
   A. Product Data: For each type of product indicated.
   B. Qualification Data: For testing agency.
   C. Field quality-control test reports.

1.5 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.

1.6 COORDINATION
   A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1. General Cable Corporation.
      2. Southwire Company.
      3. Rome
      4. Anaconda-Erickson
      5. Okonite
      6. General electric
      7. Excell
   B. Conductor Material:
      1. Copper complying with NEMA WC 5 or 7.
      2. Aluminum material not allowed.
   C. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN and XHHW.
D. Multiconductor Cable: Armored cable, Type AC; Metal-clad cable, Type MC; Type SO. All multiconductor cables shall have full sized green insulated copper ground wire. Wiring methods without green ground wire are not approved as equal, special permission and approval by engineer is required. MC cable is not allowed for general use and is only allowed as approved by owner.

2.2 CONNECTORS AND SPLICES
A. 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:
1. 3M; Electrical Products Division.
2. Buchanan
B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.
C. Molded connectors with metal thread-on core shall be used for splicing 14, 12 and 10 wire.

2.3 WIRE PULLING LUBRICANT
A. 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:
1. Polywater
2. Aqua Gel (clear)
3. NO Ideal 77 Yellow

2.4 SLEEVES FOR CABLES
A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
B. Sleeves for Rectangular Openings:
1. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
2. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.
C. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATION
A. Feeders: Copper, stranded for No.14 AWG and larger.
1. Solid copper conductors are not allowed.
B. Branch Circuit: Copper No.14 AWG and larger.
1. Solid copper conductors are not allowed.
C. Aluminum conductors are not allowed.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS
A. Service Entrance: Type THHN-THWN, single conductors in raceway.
B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.
C. Feeders and Homers Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN-THWN, single conductors in raceway.
D. Feeders and Homersuns Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.

E. Exposed Branch Circuits: Type THHN-THWN, single conductors in raceway.

F. Branch Circuits Concealed in Ceilings, Walls, Crawlspace and Partitions: Type THHN-THWN, single conductors in raceway. Type MC and AC cables are not allowed in walls and not approved for homersuns to power panels.

G. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.

H. Branch circuits to lighting and vibrating equipment: Type MC and AC.

I. Cord Drops and Portable Appliance Connections: Type SO, hard service cord.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conductors pulled shall not exceed 40% of conduit area.

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. Oil and grease shall not be used to lubricate wires. Do not exceed manufacturer's recommended sidewall pressure values.

D. Do not exceed cable pulling tensions and bending radius as specified by the cable manufacturer.

E. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway. Avoid kinking or abrasion to the insulation.

F. Couplings and conduit connectors shall have pre-insulated bushings in place before pulling wires.

G. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

H. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."

I. Identify and color-code conductors and cables according to Division 26 Section "Identification 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 (150 mm) of slack.

END OF SECTION
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. This Section includes methods and materials for grounding systems and equipment. Grounding requirements specified in this section may be supplemented by special requirements of systems described in other sections.

1.3 SUBMITTALS
A. Product Data: For each type of product indicated.
B. Qualification Data: For testing agency and testing agency's field supervisor.
C. Field quality-control test reports.

1.4 QUALITY ASSURANCE
A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association to supervise on-site testing specified in Part 3.
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.
C. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS
A. Insulated Conductors: Comply with Division 26 “Low Voltage Electrical Power Conductors and Cables” unless otherwise required by applicable Code or authorities having jurisdiction.
B. Material: Copper.
C. Color: See specification section 26 0553 – Identification for electrical systems.
D. Equipment Grounding Conductors: Insulated with green-colored insulation.
E. Isolated Ground Conductors: Insulated with green-colored insulation with yellow stripe. On feeders with isolated ground, use colored tape, alternating bands of green and yellow tape to provide a minimum of three bands of green and two bands of yellow.
F. Grounding Electrode Conductors: Stranded cable.
G. Bare Copper Conductors:
2. Tinned Conductors: ASTM B 33.
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

H. Copper Bonding Conductors: As follows:
1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch in diameter.
2. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.
3. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
4. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

I. Grounding Bus: Rectangular bars of annealed copper, 1/4 by 2 inches in cross section, unless otherwise indicated on drawings; with insulators.

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. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.3 GROUNDING ELECTRODES
A. Ground Rods: Copper-clad steel, sectional type; 3/4 inch in diameter by 10 feet long.

PART 3 - EXECUTION

3.1 APPLICATIONS
A. Conductors: Install stranded conductors for No. 14 AWG and larger, unless otherwise indicated.
B. In raceways, use insulated equipment grounding conductors.
C. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections, except those at test wells.
D. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 3/0 AWG minimum.
   1. Bury at least 24 inches (600 mm) below grade.
E. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated on drawings.
   1. Install bus on insulated spacers 1 inch, minimum, from wall 6 inches above finished floor, unless otherwise indicated. Bus to be 12 inches minimum in length unless noted otherwise on drawings.
F. Equipment Grounding Conductor Terminations use Bolted Pressure Clamps.

1.01 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS
A. Comply with IEEE C2 grounding requirements.
B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.
C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.

D. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 3/0 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches from the foundation.

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. Metal-clad cable runs.

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 and Heat-Tracing: 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. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 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.

E. Metal Poles Supporting Outdoor Lighting Fixtures: Install grounding conductor with branch-circuit conductors.

3.3 INSTALLATION

A. Equipment and Device Grounding
   1. Equipment: Terminate ground conductor to equipment enclosure.
   2. Receptacle: Terminate ground conductor to box and receptacle.

B. Grounding Conductors:
   1. Route along shortest and straightest paths possible unless otherwise indicated or required by code. Avoid obstructing access or placing conductors where they may be subject to strain, impact or damage.
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

C. Ground Rods:
1. Install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor. Drive rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.
2. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.

D. 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.

E. 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.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

F. 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.

G. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.

H. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each indicated item, extending around the perimeter of building basement as indicated.
1. Install tinned-copper conductor not less than No. 2/0 AWG for ground ring.
2. Bury ground ring not less than 24 inches from building's foundation.

G. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70, using a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG.
1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
2. Bond grounding conductor to reinforcing steel in at least four locations. Extend grounding conductor below grade and connect to building grounding grid or to grounding electrode external to concrete.
3.4 CONNECTIONS

A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
   1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
   2. Make connections with clean, bare metal at points of contact.
   3. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

C. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

D. Tighten screws and bolts for grounding and bonding 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.

E. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

F. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

G. All connections and terminations are to be cad welded, crimped or compression type. Connections shall not be mechanically reversible.

3.5 FIELD QUALITY CONTROL

A. 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.

END OF SECTION
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. This Section includes the following:
      1. Hangers and supports for electrical equipment and systems.
      2. Construction requirements for concrete bases.
   B. Related Sections include the following:
      1. Division 26 Section "Vibration and Seismic Controls For Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

1.3 DEFINITIONS
   A. EMT: Electrical metallic tubing.
   B. IMC: Intermediate metal conduit.
   C. RMC: Rigid metal conduit.

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.

1.5 COORDINATION
   A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
   B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

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. Allied Tube & Conduit.
         b. Cooper B-Line, Inc.; a division of Cooper Industries.
         c. ERICO International Corporation.
         d. GS Metals Corp.
         e. Thomas & Betts Corporation.
         f. Unistrut; Tyco International, Ltd.
         g. Wesanco, Inc.
      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.
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

5. Channel Dimensions: Selected for applicable load criteria.

B. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch-diameter holes at a maximum of 8 inches o.c., in at least 1 surface.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Allied Tube & Conduit.
      b. Cooper B-Line, Inc.; a division of Cooper Industries.
      c. Fabco Plastics Wholesale Limited.
      d. Seasafe, Inc.
   2. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
   3. Fitting and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.
   4. Rated Strength: Selected to suit applicable load criteria.

C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

D. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Appleton
      b. Raco
      c. Thomas & Betts
      d. Kindorf
      e. Steel City
      f. Pline

E. 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.

F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
   1. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used. All anchors shall have provisions for removal.
      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.
         4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
         5) MKT Fastening, LLC.
   2. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
   3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
   4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
5. **Toggle Bolts:** All-steel springhead type.
6. **Hanger Rods:** Threaded steel.

**H. Trapeze or wall surface supports:** shall be Kindorf “bolt-hole” base galvanized steel channels with C105 and C106 single bolt pipe straps.

### 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 05 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 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 support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with 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, 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. **To Steel:** Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
6. **To Light Steel:** Sheet metal screws.
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

7. 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.

F. Hanger spacing
   1. Do not exceed 8’ on center.
   2. Provide a hanger adjacent to each outlet box.
   3. Provide one hanger within 12’ on each side of a change in direction.

G. Conduits are not permitted to be supported from ductwork, pipes, t-bar ceiling supports or other systems foreign to electrical installation.

H. Support conduits as close to ceiling structure as practical.

I. Coordinate conduit locations with other trades.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 05 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.
   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.

END OF SECTION
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. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
B. Related Sections include the following:
   1. Division 07 Section "Through-Penetration Firestop Systems" for firestopping materials and installation at penetrations through walls, ceilings, and other fire-rated elements.
   2. Division 26 Section "Hangers and Supports for Electrical Systems" and "Vibration and Seismic Controls for Electrical Systems" for seismic restraints and bracing of raceways, boxes, enclosures, and cabinets.
   3. Division 26 Section "Wiring Devices" for devices installed in boxes and for floor-box service fittings.

1.3 DEFINITIONS
A. EMT: Electrical metallic tubing.
B. ENT: Electrical nonmetallic tubing.
C. FMC: Flexible metal conduit.
D. LFMC: Liquidtight flexible metal conduit.
E. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS
A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
B. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.
   1. Custom enclosures and cabinets.
C. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
   1. Structural members in the paths of conduit groups with common supports.
   2. HVAC and plumbing items and architectural features in the paths of conduit groups with common supports.
D. Manufacturer Seismic Qualification Certification: Submit certification that enclosures and cabinets and their mounting provisions, including those for internal components, will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
      a. The term "withstand" means "the cabinet or enclosure will remain in place without separation of any parts when subjected to the seismic forces specified."
   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.

1.5 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.
C. Facilities maintenance electrician is to walkthrough the project with the electrical contractor to view pathways prior to encasement or enclosure.

PART 2 - PRODUCTS
2.1 METAL CONDUIT AND TUBING
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Allied Tube & Conduit; a Tyco International Ltd. Co.
   2. O-Z Gedney; a unit of General Signal.
   3. Triangle PWC Inc.
   4. Western Tube and Conduit
B. Rigid Steel Conduit: ANSI C80.1.
   1. Zinc coated by hot dip galvanizing or sherardizing.
   2. 3/4" size minimum.
C. EMT: ANSI C80.3.
D. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
   1. Comply with NEMA RN 1.
   2. Coating Thickness: 0.040 inch, minimum.
E. 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: set-screw or compression type.
   3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch, with overlapping sleeves protecting threaded joints.
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.
   1. Fittings for EMT: Steel or set-screw or compression type.

2.2 NONMETALLIC CONDUIT AND TUBING
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AFC Cable Systems, Inc.
   2. Anamet Electrical, Inc.; Anaconda Metal Hose.
   3. Arnco Corporation.
   4. CANTEX Inc.
7. ElecSYS, Inc.
8. Electri-Flex Co.
9. Lamson & Sessions; Carlon Electrical Products.
10. Manhattan/CDT/Cole-Flex.
11. RACO; a Hubbell Company.
12. Thomas & Betts Corporation.

B. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.
C. Fittings for RNC: NEMA TC 3; match to conduit or tubing type and material.

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 1, 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: Screw cover type.
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: Fiberglass polyester, extruded and fabricated to size and shape indicated, with no holes or knockouts. Cover is gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections are flanged, with stainless-steel screws and oil-resistant gaskets.
C. Description: PVC plastic, extruded and fabricated to size and shape indicated, with snap-on cover and mechanically coupled connections with plastic fasteners.
D. Fittings and Accessories: Include couplings, offsets, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
   1. PVC sweeps and elbows are not allowed.

2.5 SURFACE RACEWAYS
A. Surface Metal Raceways: not allowed.
B. Surface Nonmetallic Raceways: not allowed.
2.6 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Hoffman.
   2. Circle AW.
   3. Rittal.
   4. Bell
   5. T&B
   6. Bowers
   7. Raco
   8. Steel City
   9. Or approved.

B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

C. Pressed steel Outlet and Device Boxes: NEMA OS 1.

D. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover.

E. Nonmetallic Outlet and Device Boxes: NEMA OS 2.

F. Metal Floor Boxes: Cast or sheet metal, fully adjustable, rectangular. Refer to Section 26 2726 Wiring Devices.

G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

H. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.

I. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous hinge cover and latch capable of being keyed to cat 15. Door in door panel doors.
   1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

J. Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage and include accessory feet where required for freestanding equipment.

2.7 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. Description: Comply with SCTE 77.
   2. Configuration: Units shall be designed for flush burial and have closed bottom, unless otherwise indicated.
   3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
   4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
   5. Cover Legend: Molded lettering, as indicated for each service.
   6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
   7. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.
RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel or fiberglass or a combination of the two.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
      a. Armocast Products Company.
      b. Carson Industries LLC.
      c. CDR Systems Corporation.
      d. Hubbell Quazite

C. Fiberglass Handholes and Boxes with Polymer-Concrete Frame and Cover: Sheet-molded, fiberglass-reinforced, polyester-resin enclosure joined to polymer-concrete top ring or frame.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
      a. Armocast Products Company.
      b. Carson Industries LLC.
      c. Christy Concrete Products.
      d. Synertech Moulded Products, Inc.; a division of Oldcastle Precast.
      e. Hubbell Quazite

2.8 FACTORY FINISHES

A. Finish: For raceway, enclosure, or cabinet components, provide manufacturer's standard grey paint applied to factory-assembled surface raceways, enclosures, and cabinets before shipping.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:
   1. Exposed Conduit: Rigid steel conduit in areas where subject to damage; EMT in areas where not subject to damage.
   2. Concealed Conduit, Aboveground: Rigid steel conduit, EMT.
   4. Service Entrance: Rigid, Intermediate metallic or PVC.
   5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
   6. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
   7. No surface exposed PVC.
   8. Application of Handholes and Boxes for Underground Wiring:
      a. Handholes and Pull Boxes in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Polymer concrete or Fiberglass enclosures with polymer-concrete frame and cover, SCTE 77, Tier 15 structural load rating.
      b. Handholes and Pull Boxes in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Polymer-concrete units or Heavy-duty fiberglass units with polymer-concrete frame and cover, SCTE 77, Tier 8 structural load rating.
      c. Handholes and Pull Boxes Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf vertical loading.
9. Utility Tunnels and Electrical Vault Conduit  
   a. Conduit bodies shall not be used.  
   b. Maintain a minimum of 6" clearance between conduit and mechanical piping.  
   c. Maintain a minimum of 12" clearance between conduit and any heat source.  
   d. Seal tunnel and vault penetrations with non-shrinking, vinyl reinforced, concrete sealant.  

B. Comply with the following indoor applications, unless otherwise indicated:  
   1. Exposed, Not Subject to a corrosive environment: EMT.  
   2. Exposed and Subject to Severe Physical Damage: IMC. Includes raceways in the following locations:  
      a. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.  
      b. Mechanical rooms.  
   3. Concealed in Ceilings and Interior Walls and Partitions: EMT.  
   4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.  
   5. Damp or Wet Locations: Galvanized rigid steel conduit or PVC 40  
   6. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, nonmetallic in damp or wet locations.  

C. Minimum Raceway Size: 3/4-inch trade size.  

D. Raceway Fittings: Compatible with raceways and suitable for use and location.  

E. Do not install aluminum conduits in contact with concrete.  

F. Flexible metal conduit is limited to the following applications:  
   1. Vibrating or moveable equipment connections.  
   2. Finished into existing stud walls.  
   3. Distance from the luminaire connection to structure to the powering junction box, not to exceed 6'.  

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 (150 mm) 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 for Electrical Systems."  
   E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.  
   F. Install no more than the equivalent of four 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 in Slabs:  
      1. Facilities maintenance electrician review and approval is required before any conduits are buried in slab.  
      2. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
3. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
4. Change from ENT to RNC, Type EPC-40-PVC, rigid steel conduit, before rising above the floor.

I. 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.

J. Set floor boxes level and flush with finished floor surface.

K. Outlet boxes are to be sealed at exterior walls and as needed in other locations.

L. Outlet boxes are to be supported independent from the raceway system.

M. Electrical Boxes and Devices:
   1. Provide electrical boxes for electrical and low voltage devices. Mud rings only at TV, communication, data devices, etc., not allowed.
   2. Back-to-back electrical boxes are not allowed.
      a. Separate by at least one (1) stud cavity.
      b. Electrical boxes 24 inches apart: Apply mastic/putty pads on both outlets, seal airtight with non-hardening sealant.

N. Electrical boxes less than 24 inches apart: Apply mastic/putty pads on both outlets, plus both outlets boxed in. The box must be sealed airtight with non-hardening sealant and must use one layer 5/8 inch gypsum wall board.

O. Electrical Floor Boxes 24 inches apart: Apply mastic/putty pads on both outlets, seal airtight with non-hardening sealant.

P. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.

Q. Terminations:
   1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.
   2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.

R. 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.

S. Telephone and Signal System Raceways, 2-Inch Trade Size (DN 53) and Smaller: In addition to above requirements, install raceways in maximum lengths of 150 feet and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements.

T. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with UL-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.
U. Flexible Connections: Use maximum of 72 inches of flexible conduit for recessed and semi-recessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use LFMC in damp or wet locations. Install separate ground conductor across flexible connections.

V. Surface Raceways: not to be installed.

W. Set floor boxes level and flush with finished floor surface.

X. Install hinged-cover enclosures and cabinets plumb. Support at each corner.

Y. Maintain 12” clearance above removable ceiling tiles for all conduits.

Z. All conduit runs beginning at panels shall be no less than 3/4”.

AA. All conduit runs are to run parallel to systems and/or walls, especially when encased in concrete.

BB. At conduit transitions from different temperatures seal the box and/or conduit.

CC. Conduit stub-ups to equipment shall be rigid steel extended a minimum of 12’ outside building foundation and 5’ outside outdoor concrete pads.

DD. All control boxes and panels are to have hinged covers with door-in-door panels.

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 Section "Earth Moving" for pipe less than 6 inches in nominal diameter.
   2. Install backfill as specified in Division 31 Section "Earth Moving."
   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 Section "Earth Moving."
   4. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

3.4 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
   1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

B. At empty/un-used conduits, use suitable conduit caps to protect installed conduit against entrance of dirt and moisture.

3.5 CLEANING

A. After completing installation of exposed, factory-finished raceways and boxes, inspect exposed finishes and repair damaged finishes.

END OF SECTION
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. Wire basket cable trays.
2. Ladder cable trays.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product.
   1. Include data indicating dimensions and finishes for each type of cable tray indicated.
B. Shop Drawings: For each type of cable tray.
   2. Show fabrication and installation details of cable trays, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.
C. Delegated-Design Submittal: For seismic restraints.
   1. Seismic-Restraint Details: Signed and sealed by a qualified professional engineer, licensed in the state where Project is located, who is responsible for their preparation.
   2. Design Calculations: Calculate requirements for selecting seismic restraints.
   3. Detail fabrication, including anchorages and attachments to structure and to supported cable trays.

1.4 INFORMATIONAL SUBMITTALS
A. Coordination Drawings: Floor plans and sections, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Include scaled cable tray layout and relationships between components and adjacent structural, electrical, and mechanical elements.
   2. Vertical and horizontal offsets and transitions.
   3. Clearances for access above and to side of cable trays.
   4. Vertical elevation of cable trays above the floor or below bottom of ceiling structure.
B. Seismic Qualification Certificates: For cable trays, 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.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
C. Field quality-control reports.
PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Division 01 Section "Quality Requirements," to design cable tray supports and seismic bracing.

B. Seismic Performance: Cable trays and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "cable trays will remain in place without separation of any parts when subjected to the seismic forces specified."
   2. Component Importance Factor: 1.0.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes in cable tray installed outdoors.
   1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 GENERAL REQUIREMENTS FOR CABLE TRAYS

A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.
   1. Source Limitations: Obtain cable trays and components from single manufacturer.

B. Sizes and Configurations: See the floor plan drawings for specific requirements for types, materials, sizes, and configurations.

C. Structural Performance: See articles on individual cable tray types for specific values for the following parameters:
   1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.
   2. Concentrated Load: A load applied at midpoint of span and centerline of tray.
   3. Load and Safety Factors: Applicable to both side rails and rung capacities.

2.3 WIRE-BASKET CABLE TRAYS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Chatsworth
   3. Cablofil/Legrande.
   5. Cooper B-Line, Inc.

B. Description:
   1. Configuration: Wires are formed into a standard 2-by-4-inch wire mesh pattern with intersecting wires welded together. Mesh sections must have at least one bottom longitudinal wire along entire length of section.
   4. Sizes:
      a. Straight sections shall be furnished in standard 118-inch lengths.
      b. Wire-Basket Depth: 4-inch usable loading depth by 12 inches, unless otherwise noted on drawings.
   5. Connector Assemblies: Bolt welded to plate shaped to fit around adjoining tray wires and mating plate. Mechanically joins adjacent tray wires to splice sections together or to create horizontal fittings.
CABLE TRAYS FOR ELECTRICAL SYSTEMS

6. Connector Assembly Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

2.4 LADDER CABLE TRAYS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Chatsworth
4. Cooper B-Line, Inc.

B. Description:
1. Configuration: Two I-beam side rails with transverse rungs welded to side rails.
2. Rung Spacing: 6 inches, 9 inches, 12 inches, 18 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.
7. Minimum Usable Load Depth: 3 inches, 4 inches, 5 inches, 6 inches.
8. Straight Section Lengths: 10 feet, 12 feet, 20 feet, 24 feet except where shorter lengths are required to facilitate tray assembly.
9. Width: 6 inches, 12 inches, 18 inches, 24 inches, 36 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.
13. Hardware and Fasteners: ASTM F 593 and ASTM F 594 stainless steel, Type 316 Steel, zinc plated according to ASTM B 633.
14. Splice Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

2.5 MATERIALS AND FINISHES

A. Steel:
1. Straight Section and Fitting Side Rails and Rungs: Steel complies with the minimum mechanical properties of ASTM A 1011/A 1011M, SS, Grade 33, ASTM A 1008/A 1008M, Grade 33, Type 2.
2. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.
3. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.
5. Finish: Electrogalvanized before fabrication.
   b. Hardware: Chromium-zinc plated, ASTM F 1136, Stainless steel, Type 316.
CABLE TRAYS FOR ELECTRICAL SYSTEMS

   a. Powder-Coat Enamel: Cable tray manufacturer's recommended primer and corrosion-inhibiting treatment, with factory-applied powder-coat paint.
   b. Epoxy-Resin Prime Coat: Cold-curing epoxy primer, MPI# 101.
   c. Epoxy-Resin Topcoat: Epoxy, cold-cured, gloss, MPI# 77.

8. Finish: Factory-standard primer, ready for field painting, with chromium-zinc-plated hardware according to ASTM F 1136.

9. Finish: Black oxide finish for support accessories and miscellaneous hardware according to ASTM D 769.

B. Aluminum:
   1. Materials: Alloy 6063-T6 according to ANSI H35.1/H 35.1M for extruded components, and Alloy 5052-H32 or Alloy 6061-T6 according to ANSI H35.1/H 35.1M for fabricated parts.
   3. Hardware for Aluminum Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F 593 and ASTM F 594.

C. Stainless Steel:
   1. Materials: Low-carbon, passivated, stainless steel, Type 304L or Type 316L, ASTM F 593 and ASTM F 594.
   2. Hardware for Stainless-Steel Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F 593 and ASTM F 594.

2.6 CABLE TRAY ACCESSORIES

A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.

B. Covers: Solid, 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.

2.7 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 Division 26 Section "Identification for Electrical Systems."

2.8 SOURCE QUALITY CONTROL

A. Testing: Test and inspect cable trays according to NEMA FG 1, NEMA VE 1.
PART 3 - EXECUTION

3.1 CABLE TRAY INSTALLATION

A. Install cable trays according to NEMA FG 1, 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. Install cable trays so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.

D. Remove burrs and sharp edges from cable trays.

E. Join aluminum cable tray with splice plates; use four square-neck carriage bolts and locknuts.

F. Fasten cable tray supports to building structure and install seismic restraints.

G. Design fasteners and supports to carry cable tray, the cables, and a concentrated load of 200 lb. Comply with requirements in Division 26 Section "Hangers and Supports for Electrical Systems." Comply with seismic-restraint details according to Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

H. Place supports so that spans do not exceed maximum spans on schedules and provide clearances shown on Drawings. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.

I. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.

J. Support bus assembly to prevent twisting from eccentric loading.

K. Install center-hung supports for single-rail trays designed for 60 versus 40 percent eccentric loading condition, with a safety factor of 3.

L. Locate and install supports according to NEMA FG 1, NEMA VE 2. Do not install more than one cable tray splice between supports.

M. 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.

N. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA FG 1, NEMA VE 2. Space connectors and set gaps according to applicable standard.

O. Make changes in direction and elevation using manufacturer's recommended fittings.

P. Make cable tray connections using manufacturer's recommended fittings.

Q. Seal penetrations through fire and smoke barriers. Comply with requirements in Division 07 Section "Penetration Firestopping."

R. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.

S. Install cable trays with enough workspace to permit access for installing cables.

T. 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.
3.2 CABLE TRAY GROUNDING

A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Division 26 Section "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. When using epoxy or powder-coat painted cable trays as a grounding conductor, completely remove coating at all splice contact points or ground connector attachment. After completing splice-to-grounding-bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.

E. 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. Install cable ties with a tool that includes an automatic pressure-limiting device.

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. Remove paint from all connection points before making connections. Repair paint after the connections are completed.

B. 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:
   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.
CABLE TRAYS FOR ELECTRICAL SYSTEMS

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 re-torque in suspect areas.

7. Check for improperly sized or installed bonding jumpers.

8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.

9. 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.

3.6 PROTECTION

A. Protect installed cable trays and cables.

1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.

2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.

3. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION
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. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
5. Silicone sealants.

B. Related Requirements:
1. Division 07 Section "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.3 ACTION 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. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

F. Sleeves for Rectangular Openings:
2. Minimum Metal Thickness:
   a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
   b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 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 one of 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 rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

3. Pressure Plates: Stainless steel.

4. Connecting Bolts and Nuts: 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.

2.4 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.


C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

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 Division 07 Section "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.
   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.
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. This Section includes Seismic Restraints for electrical equipment and systems.
B. Related Sections include the following:
   1. Division 26 Section "Hangers and Supports For Electrical Systems" for commonly used electrical supports and installation requirements.

1.3 DEFINITIONS

1.4 PERFORMANCE REQUIREMENTS
A. Refer to Structural Drawing S1.0 for design criteria.

1.5 SUBMITTALS
A. Product Data: For the following:
   1. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
      a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
      b. Annotate to indicate application of each product submitted and compliance with requirements.
B. Delegated-Design Submittal: For seismic-restraint details 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 static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators and seismic restraints.
      a. Coordinate design calculations with wind-load calculations required for equipment mounted outdoors. Comply with requirements in other Division 26 Sections for equipment mounted outdoors.
   2. Indicate materials and dimensions and identify hardware, including attachment and anchorage devices.
   3. Field-fabricated supports.
   4. Seismic-Restraint Details:
      a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
      b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events.
      c. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).
VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

C. Coordination Drawings: Show coordination of seismic bracing for electrical components with other systems and equipment in the vicinity, including other supports and seismic restraints.

D. Retain paragraph below if procedures for welder certification are retained in "Quality Assurance" Article.

E. Welding certificates.

F. Qualification Data: For professional engineer.

G. Field quality-control test reports.

1.6 QUALITY ASSURANCE

A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

PART 2 - PRODUCTS

2.1 SEISMIC-RESTRAINT DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Amber/Booth Company, Inc.
   2. Loos & Co.; Seismic Earthquake Division.
   3. Mason Industries.

B. General Requirements for Restraint Components: Rated strengths, features, and application requirements shall be as defined in reports by 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: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

D. Restraint Cables: ASTM A 603 galvanized-steel cables with end connections made of steel assemblies with thimbles, brackets, swivels, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.

E. Hanger Rod Stiffener: Reinforcing steel angle clamped to hanger rod. Do not weld stiffeners to rods.

F. Bushings for Floor-Mounted Equipment Anchor: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchors and studs.

G. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices.
VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.2 SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Indicate type and quantity of restrained isolators described in first subparagraph below on Drawings or in the Electrical Vibration-Control and Seismic-Restraint Device Schedule on Drawings.

B. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES providing required submittals for component.

C. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.

D. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.3 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where they terminate with connection to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

END OF SECTION
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
B. Related Sections: The following Sections contain requirements that relate to this Section:
   1. Division 09 Section "Painting and Coatings" for related identification requirements.
   2. Division 26 Section "Basic Electrical Requirements."
C. Refer to other Division 26 sections for additional specific electrical identification associated with specific items.

1.2 SUMMARY
A. This Section includes identification of electrical materials, equipment, and installations. It includes requirements for electrical identification components including but not limited to the following:
   1. Equipment labels and signs
   2. Device labels
   3. Identification labeling for raceways, cables, and conductors
   4. Operational instruction signs
   5. Warning and caution signs
   6. Buried electrical line warnings

1.3 SUBMITTALS
A. None required.

1.4 QUALITY ASSURANCE
A. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."
B. ANSI Compliance: Comply with requirements of ANSI Standard A13.1, "Scheme for the Identification of Piping Systems," with regard to type and size of lettering for raceway and cable labels.
C. All labeling is to be reviewed and approved by the owner.

1.5 GRAPHIC SIGNAGE ALLOWANCE
A. Contractor shall put in their bid an allowance of $500.00 for purchasing additional graphic signage as deemed necessary by the Engineer. The design of the signage will be by the Engineer. The Contractor shall be responsible for obtaining the signs from an engraver and shall submit the purchase order to the contractor for payment. The contractor shall refund to the owner the unused portion of the allowance at the end of the job.
B. Permanent signage will be required, interior and exterior, at all utility boxes, vaults, manholes.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Almetek
   2. American Labelmark Co.
   3. Brother’s Labels
   4. Calpico, Inc.
   5. Cole-Flex Corp.
IDENTIFICATION FOR ELECTRICAL SYSTEMS

6. Emed Co., Inc.
7. George-Ingraham Corp.
8. Ideal Industries, Inc.
9. Kraftbilt
10. LEM Products, Inc.
11. Markal Corp.
13. Panduit Corp.
14. Radar Engineers Div., EPIC Corp.
15. Seton Name Plate Co.
17. W.H. Brady, Co.

2.2 CONDUCTOR AND CABLE IDENTIFICATION

A. Conductor Designation Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound, conductor markers with preprinted numbers and letters. Handwritten graphics are prohibited.

B. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking nylon cable ties, 0.18-inch minimum width, 50-lb minimum tensile strength, and suitable for a temperature range from minus 50 deg F to 350 deg F. Provide ties in specified colors when used for color coding. For outdoor applications provide black UV resistant ties only; white ties are prohibited.

2.3 NAMEPLATES, LABELS, SIGNS, AND INSTRUCTION PLATES

A. Plasticized Card Stock Tags: Vinyl cloth with preprinted and field-printed legends to suit the application. Orange background, except as otherwise indicated, with Eyelet for fastener.

B. Aluminum-Faced Card Stock Tags: Weather-resistant, 18-point minimum card stock faced on both sides with embossable aluminum sheet, 0.002 inches thick, and laminated with moisture-resistant acrylic adhesive. Pre-print legend to suit the application, and punch for tie fastener.

C. Brass or Aluminum Tags: Metal tags with stamped legend, punched for fastener. Dimensions: 2 inches by 2 inches by 19 gage.

D. Engraved, Plastic-Laminated Labels, Signs, and Instruction Plates: Engraving stock melamine plastic laminate, 1/16-inch minimum thick for signs up to 20 square inches, or 8 inches in length; 1/8-inch thick for larger sizes. All exterior plates shall be punched for mechanical fasteners (pop rivets). Refer to details on drawings. Use Rowmark "Matt" for indoor use and Rowmark "Ultra-Matt" for exterior use. Nameplate lettering font shall be Helvetica, with bold or extra-bold strokes where indicated.

E. Baked-Enamel Warning and Caution Signs for Interior Use: Preprinted aluminum signs, punched for fasteners, with colors, legend, and size appropriate to the location.

F. Exterior Metal-Backed Butyrate Warning and Caution Signs: Weather-resistant, nonfading, preprinted cellulose acetate butyrate signs with 20-gage, galvanized steel backing, with colors, legend, and size appropriate to the location. Provide 1/4-inch grommets in corners for mounting.

G. Legend Plates: Die-stamped metal legend plate with mounting hole and positioning key for panel mounted operator devices, i.e. motor control pilot devices, hand-off-auto switches, reset buttons, etc. Stamped characters to be paint-filled.

H. Fasteners for Plastic-Laminated and Metal Signs:
1. Self-tapping stainless steel screws or number 10/32 stainless steel machine screws with nuts and flat and lock washers.
2. Aluminum pop rivets.
IDENTIFICATION FOR ELECTRICAL SYSTEMS

2.4 PANELBOARD, DISTRIBUTION AND MCC IDENTIFICATION

A. Circuit Numbering: Provide factory-supplied permanent self-adhesive labels to identify each pole of all panelboards.

B. Nameplates: Provide nameplates per above section: “Nameplates, Labels, Signs, and Instruction Plates.”

C. Schedule Holder: Provide crystal clear, heavy duty, 5 1/8” x 81/2” vinyl, long side open. Storesmart #STB897 peel and stick 8GA. Vinyl or approved equal.

2.5 DEVICE COVERPLATE LABELS

A. Coverplate material shall be as specified in Section 262726: Coverplates.

B. Embossed metallic or plastic tape (Dymo) is not acceptable for any application.

C. Methods of Inscription: (Unless otherwise noted)
   1. Self-adhesive Tape: For imprinted or thermal transfer characters onto permanent waterproof tape lettering system. (Brother’s or Kroy). Apply Matte finish spray coating (Krylon #1311) as required to make lettering waterproof.

2.6 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.

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

A. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in electrical identification work with corresponding designations specified or indicated. Use numbers, lettering, and colors as approved in submittals and as required by code.

B. Sequence of Work: Where identification is to be applied to surfaces that requires finish, install identification after completion of finish work.

C. Installation:
   1. Install identification devices in accordance with manufacturer’s written instructions and requirements of NEC.
   2. Clean surface of dust, loose material, and oily films before applying identification.
   3. Install identification parallel to equipment lines.
   4. Apply using permanent methods and materials (such as tape and nameplate materials) that is suitable for the environment installed and will not degenerate over time due to UV, sunlight, humidity, temperature swings, etc.
   5. Install labels at locations indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment. Do not cover up other instructions or labels.
3.2 **RACEWAY IDENTIFICATION**

A. Identify Junction, Pull, and Connection Boxes:

1. Identify junction, pull, and connection boxes above accessible ceilings, exposed in mechanical and electrical rooms and other non-finished areas such as tunnels, loading docks, etc., by neatly spray painting the box and cover plate the following colors: The boxes and covers shall be painted prior to installation. It is unacceptable to paint the boxes after installation where the overspray paints the conduits and other surrounding items. It is the Electrician’s responsibility to ensure that the boxes are not painted over by the architectural painting Contractor.
   - Fire alarm system: Red with white label.
   - Emergency power or lighting: Red {1}.

2. **Notes:** {1} Label box covers with identity of contained circuits per the following convention: “Panel/ MCC Name”- “Circuit Numbers.” Example: “HD1A-1,3,5.” Use Brother or Kroy Type labeling or neatly hand letter using block uppercase lettering and permanent type black marker. Engineer has right to require lettering to be redone if not done neatly.

3. In exposed public areas where the ceiling plane, structure, ductwork and conduits are to be painted an architectural color verify with Engineer the required methods for conduit and junction box identification.

3.3 **CONDUCTOR AND CABLE IDENTIFICATION**

A. Conductor Color Coding: Provide color coding for the following:

1. Secondary service, feeder, and branch circuit conductors throughout the project electrical system:

<table>
<thead>
<tr>
<th>208 and 120 Volts Phase</th>
<th>480 and 277 Volts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black</td>
<td>A Brown</td>
</tr>
<tr>
<td>Red</td>
<td>B Orange</td>
</tr>
<tr>
<td>Blue</td>
<td>C Yellow</td>
</tr>
<tr>
<td>White*</td>
<td>Neutral Grey*</td>
</tr>
</tbody>
</table>

   * neutrals in common raceways, provide color band/strip on neutral that corresponds with phase conductor color

- Green
- Green w/ yellow stripe
- Ground
- Isolated
- Green w/ yellow stripe
- Switch leg
- Pink
- Switch leg
- Purple
- Traveler
- Purple

2. Control wiring inside custom electrical equipment and control panels throughout the project electrical system, refer to mechanical specifications.

3. Use conductors with color factory-applied the entire length of the conductors except as follows:

   a. The following field-applied color-coding methods may be used in lieu of factory-colored conductor for sizes larger than No. 10 AWG.
   b. Apply colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply the last two laps of tape with no tension to prevent possible unwinding. Use 1-inch-wide tape in colors as specified. Do not obliterate cable identification markings by taping. Tape locations may be adjusted slightly to prevent such obliteration.
c. In lieu of pressure-sensitive tape, colored cable ties may be used for color identification. Apply three ties of specified color to each conductor or cable at each terminal or splice point starting 3 inches from the terminal and spaced 3 inches apart. Apply with a special tool or pliers, tighten for snug fit, and cut off excess length.

B. Future Connections: Tag or label conductors indicated to be for future connection or connection under another contract with identification indicating source and circuit numbers.

C. Multiple Conductors/Circuits: Where multiple branch circuits or control wiring or communications/signal conductors are present in the same box or enclosure (except for color-coded, three-circuit, four-wire home runs) and wherever there is possible confusion in identifying each conductor, label each conductor or cable. Provide label indicating source, voltage, circuit number, and phase for branch circuit wiring. Phase and voltage of branch circuit wiring may be indicated by means of color-coded conductor insulation. For control and communications/signal wiring, use color coding or conductor/cable marking tape at terminations and at intermediate locations where conductors appear in wiring boxes, troughs, and control cabinets. Use consistent letter/number conductor designations throughout on conductor/cable marking tapes. Conductor numbers shall match the manufacturer's shop drawings.

D. Cable and Feeder Identification Tags: Securely fasten identifying tags around cables, feeders, and power circuits in vaults, pull boxes, junction boxes, manholes, and switchboard rooms with stamped letters and numbers with legend to correspond with designations on Drawings. If metal tags are provided, attach them with approximately 55-lb test monofilament line or one-piece self-locking nylon cable ties.

3.4 NAMEPLATES, LABELS, SIGNS, AND INSTRUCTION PLATES

A. Apply warning, caution, and instruction signs and stencils as follows:
   1. Install warning, caution, or instruction signs where required by NEC, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install butyrate signs with metal backing for outdoor items.
   2. Emergency Operating Signs: Install engraved, laminated signs with white text on red background with minimum 3/8-inch high lettering for emergency instructions on power transfer, load shedding, or other emergency operations.

B. Install equipment/system circuit/device identification as follows:
   1. Apply equipment identification labels of engraved plastic-laminated on each major unit of electrical equipment in building, including central or master unit of each electrical system. This includes communication/signal/alarm systems, unless the factory supplied labeling on the unit is acceptable to the Engineer.
   2. Refer to drawings for details of signs, if details are not included provide the following minimum information:
      a. Equipment or device designation. (Minimum ¼” high)
      b. Amperage, KVA or horsepower rating, where applicable.
      c. Voltage or signal system name.
   3. Text shall match terminology and numbering of the Contract Documents and shop drawings. Apply labels for each unit of the following categories of electrical equipment.
      a. Panelboards, electrical cabinets, disconnects, and enclosures.
      b. Access doors and panels for concealed electrical items.
      c. All junction boxes and enclosures larger than 4” square.
      d. Each circuit breaker or fused switch in distribution boards, switchboards and switchgear.
IDENTIFICATION FOR ELECTRICAL SYSTEMS

e. Electrical switchgear and switchboards.
f. Electrical substations.
g. Motor control centers.
h. Motor starters.
i. Pushbutton stations.
j. Power transfer equipment.
k. Contactors.
l. Dimmers.
m. Control devices.
n. Transformers.
o. Battery racks.
p. Power generating units.
q. Telephone switching equipment.
r. Clock/program master equipment.
s. Call system master station.
t. TV/audio monitoring master station.
u. Fire alarm master station or control panel.
v. Security monitoring master station or control panel.
w. Spare conduits at both ends.

C. Apply circuit/control/item designation labels of engraved plastic laminate for disconnect switches, circuit breakers in distribution, switchboard and switchgear, lights, motor control centers, and similar items for power distribution, except panelboards and alarm/signal components, where labeling is specified elsewhere.

D. Provide legends on panel mounted operators devices such as pilot lights, reset buttons, hand-off-auto switches, pushbuttons and other control components.

3.5 Arc flash hazard labels

A. Arc flash labels shall be orange for PPE levels 0 through 4.

B. Arc flash labels shall be red for a dangerous hazard risk category.

C. The portion of the arc flash hazard label that contains the hazard risk category information shall be color coded as follows:
   1. Hazard risk category 0: Green
   2. Hazard risk category 1: Yellow
   3. Hazard risk category 2: Tan
   4. Hazard risk category 3: Orange
   5. Hazard risk category 4: Pink
   6. Hazard risk category 5: Red

D. Shall meet the requirements of NFPA & 2009 ANSI/NETA Standard for maintenance testing specifications: chapter 6, Power system studies.

E. See spec section 260573 – Over-current protection device coordination study and arc flash hazard analysis, for additional requirements.

3.6 PANELBOARD, DISTRIBUTION AND MCC IDENTIFICATION

A. Circuit Numbering: Starting at the top, odd numbered circuits in sequence down the left hand side and even numbered circuits down the right hand side.

B. Panelboard Nameplates: Mount nameplates with black Bakelite, white letters fastened with sheet metal screws. In finished public areas, such as in lobby or corridor walls, mount the nameplate to the top of the inside of the inner door then also provide an additional 0.75" high, single-line, white
nameplate with black 1/4" high panelboard name. All nameplates that are to be mounted on the outside shall be centered, ½" up from the top on the inner door on the outside of the outer door.

C. Panelboard Schedule Holder: Mount schedule holder, secured to inside face of inner panel door. Contractor shall install construction panel schedules in holders during construction and replace with "as of record" panel schedules in holder at end of project. Final schedules shall include room numbers and explicit description and identification of items controlled by each individual breaker.

3.7 DEVICE COVERPLATE LABELS

A. Provide self-adhesive type labels for all receptacles, switches, outlets, plugmold, etc. per the following:
   1. Lettering Type: Helvetica, 1/4" high.
   2. Text: Label coverplates with identity of source and circuit number serving the device per the following convention: “Panel Name”- “Circuit Numbers” (except UPS circuits, which have word UPS as part of the label). Example: “MTE0032-1”, “UPS MTE0033-3”.
   3. Color of Characters shall be as follows:
      | Text Color | Background Color | System Description |
      | Black      | White           | Normal power devices coverplates |

4. Installation of self-adhesive tape:
   a. Imprinted tape shall be coated with a permanent, non-gloss protective finish. Spray coating shall be applied prior to installation or simultaneously as with Brother’s unit.
   b. Tape shall be applied to coverplate there is no need to wrap label and label should be at bottom of plate. Top of plate for special equipment designations.
   c. Inscription shall be centered and square with coverplate.

B. Provide engraved coverplates for switches, dimmers, etc. as follows: (in addition to panel-circuit number labels)
   1. All multi-ganged (three or more) switches or dimmers.
   2. All special purpose switches or controls, i.e. - fan, projector screen, etc. where it is not obvious what it controls.
   3. Engraving shall indicate fixtures or devices controlled (i.e. "Down Lights", "Cove Lights", etc.)

C. Switch cover plates that control various systems (AV, projection screens, etc.) shall be labeled with 1/8" black lettering indicating the function.

3.8 GROUND CONDUCTOR

1. Label ground conductors at main ground bar.
2. No. 6 and larger are to be identified at accessible points per NEC.

END OF SECTION
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. This section includes computer-based, fault-current and overcurrent protective device coordination studies and arc flash hazard analysis. Protective devices shall be set based on results of the protective device coordination study.

1.3 SUBMITTALS
A. Product Data: For computer software program to be used for studies.
B. Product Certificates: For coordination-study and fault-current-study and arc flash hazard analysis computer software programs, certifying compliance with IEEE 399 and IEEE 1584.
C. Qualification Data: For coordination-study specialist. It is preferred that the gear manufacturer be responsible for coordination study. If this is not possible then written notification from the contractor needs to be provided to the engineer and a qualified engineer will be assigned to do the study.
D. Other Action Submittals: Provide preliminary coordination study for review with shop drawings for electrical gear package. The following submittals shall be made after the approval process for system protective devices has been completed. Submittals shall be in digital form.
   1. Coordination-study input data, including completed computer program input data sheets.
   2. Study and Equipment Evaluation Reports.
   4. Arc-flash hazard analysis.
E. Overcurrent protective device coordination study analysis report shall be provided by the manufacturer supplying the equipment.

1.4 QUALITY ASSURANCE
A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.
B. Coordination-Study Specialist Qualifications:
   1. An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
   2. Professional engineer, licensed in the state where the project is located, shall be responsible for the study.
   3. All elements of the study shall be performed under the direct supervision and control of the engineer.
C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.
D. Comply with IEEE 399 for general study procedures.
E. Comply with IEEE 1584 and NEC 70E for arc flash hazard analysis.
PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS
   A. Computer Software Developers: Subject to compliance with requirements, provide products by
      one of the following:
      1. SKM Systems Analysis, Inc.
   B. The owner requires an electronic copy of the fault current study.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS
   A. Comply with IEEE 399.
   B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
   C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.
      1. Optional Features:
         a. Explicit negative sequence.
         b. Mutual coupling in zero sequence.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.
      1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 POWER SYSTEM DATA
   A. Gather and tabulate the following input data to support coordination study:
      1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
      2. Impedance of utility service entrance.
      3. Available fault current at the primary terminals of the building transformer(s).
      4. Electrical distribution system diagram showing the following:
         a. Load current that is the basis for sizing continuous ratings of circuits for cables and equipment.
         b. Circuit-breaker and fuse-current ratings and types.
         c. Relays and associated power and current transformer ratings and ratios.
         d. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
         e. Generator kilovolt amperes, size, voltage, and source impedance.
         f. Cables. Indicate conduit material, sizes of conductors, conductor insulation, and length.
         g. Busway ampacity and impedance.
         h. Motor horsepower and code letter designation according to NEMA MG 1.
OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY
AND ARC FLASH HAZARD ANALYSIS

5. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram:
   a. Special load considerations, including starting inrush currents and frequent starting and stopping.
   b. Transformer characteristics; primary protective device, magnetic inrush current and overload capability.
   c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
   d. Time-current-characteristic curves of devices indicated to be coordinated.
   e. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
   f. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
   g. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.
   h. Generator thermal-damage curve.
   i. Ratings, types and settings of utility's over-current protective devices.
   j. Special over-current protective device settings or types stipulated by utility.

3.3 FAULT CURRENT STUDY

A. Calculate the maximum available short-circuit in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:
   1. Switchboard buses
   2. Medium-voltage buses
   3. Motor-control centers
   4. Distribution panelboards
   5. Branch circuit panelboards

B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.

C. Calculate momentary and interrupting duties on the basis of maximum available fault current.

D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 424, and/or ANSI.
   1. Transformers:
      a. ANSI C57.12.22.
      b. IEEE C57.12.00.
      c. IEEE C57.96.
   4. Low-Voltage Fuses: IEEE C37.46.

E. Study Report:
   1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.
3.4 COORDINATION STUDY

A. Perform coordination study and prepare a written report using the results of fault-current study and approved computer software program. Comply with IEEE 399.
   1. Identify any deficiencies in the report.
   2. Calculate the maximum and minimum ½-cycle short-circuit currents.
   3. Calculate the maximum and minimum interrupting duty (5-cycles to 2-seconds) short-circuit currents.
   4. Calculate the maximum and minimum ground-fault currents.
   5. Coordinate down to 0.1 sec. (instantaneous) for normal systems
   6. Coordinate down to 0.02 sec. (instantaneous) for standby systems

B. Comply with NFPA 70 for overcurrent protection of circuit elements and devices.

C. Comply with IEEE 242 recommendations for fault currents and time intervals.

D. Transformer Primary Overcurrent Protective Devices:
   1. Device shall not operate in response to the following:
      a. Inrush current when first energized.
      b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
      c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
   2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

E. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

F. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
   1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
      a. Device tag.
      b. Relay-current transformer rations; and tap, time-dial, and instantaneous-pickup values.
      c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
      d. Fuse-current rating and type.
      e. Ground-fault relay-pickup and time-delay settings.
   2. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.
OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY
AND ARC FLASH HAZARD ANALYSIS

3. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Instantaneous shall be shown coordinated down to 0.1 sec. for normal systems and down to 0.02 sec. for standby systems. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
   a. Device tag.
   b. Voltage and current ratio for curves.
   c. Three-phase and single-phase damage points for each transformer.
   d. No damage, melting, and clearing curves for fuses.
   e. Cable damage curves.
   f. Transformer inrush points.
   g. Maximum fault-current cutoff point.

G. Completed data sheets for setting of overcurrent protective devices.

3.5 ARC FLASH HAZARD ANALYSIS

A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in the NFPA70E-2004 annex D.

B. The flash protection boundary and incident energy shall be calculated at all significant locations in the electrical distribution system, (switchboards, switchgear, motor control centers panelboards, busway and splitters) where work could be performed on energized parts.

C. The Arc-Flash Hazard analysis shall include all significant locations in 240 volt and 208 volt systems fed from transformers equal to or greater than 125 kVA where work could be performed on energized parts.

D. Safe working distances shall be based upon the calculated flash boundary considering an incident energy of 1.2 cal/cm².

E. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations.

F. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off). Conversely, the maximum calculation will assume the maximum contribution from the utility and will assume the maximum amount of motors to be operating. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility where applicable.

G. The incident energy calculation must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators should be decremented as follows:
   1. Fault contribution from induction motor should not be considered beyond 3-5 cycles.
   2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g. contributions from permanent magnet generators will typically decay from 10 per unit to 3 per unit after 10 cycles).
H. For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals and the main protective device and the work location), calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.

I. When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.

J. Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute in incident energy for the corresponding location.

K. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section B.1.2 where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

3.6 ARC FLASH WARNING LABELS

A. Coordinate labels with U of O CPS department.

B. The contractor of the Arc Flash Hazard Analysis shall provide a 3.5 in.x 5 in. thermal transfer type label of high adhesion polyester for each work location analyzed. No paper labels.

C. All labels will be based on recommended overcurrent device settings and will be provided after the results of the analysis have been presented to the owner and after any system changes, upgrades or modifications have been incorporated into the system.

D. The label shall include the following information, at a minimum:
   1. Location designation
   2. Nominal voltage
   3. Flash protection boundary
   4. Hazard risk category
   5. Incident energy
   6. Working distance
   7. Engineering report number, revision number and issue date

E. Labels shall be machine printed, with no field markings.

F. Arc flash labels shall be provided in the following manner and all labels shall be based on the recommended overcurrent device settings.
   1. For each 600, 480 and applicable 208 volt panelboard, one arc flash label shall be provided.
   2. For each motor control center, one arc flash label shall be provided.
   3. For each low voltage switchboard, one arc flash label shall be provided.
   4. For each switchgear, one flash label shall be provided.
   5. For medium voltage switches one arc flash label shall be provided.

G. Labels shall be field installed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.

H. The overall color of the arc flash hazard label shall be orange for PPE levels 0 thru 4.

I. The overall color of the arc flash hazard label shall be red for a dangerous hazard risk category.
J. The portion of the arc flash hazard label that contains the hazard risk category information shall be color coded as follows: (Refer to the following sample arc flash hazard labels where the upstream over current protective device has no adjustable settings.)

1. Hazard risk category 0: Green.

![Arc Flash Hazard Label - Category 0](image)

2. Hazard risk category 1: Yellow.

![Arc Flash Hazard Label - Category 1](image)


![Arc Flash Hazard Label - Category 2](image)

5. Hazard risk category 4: Pink.

6. Dangerous: Red.

END OF SECTION
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. This Section includes the following lighting control devices:
      2. Time Switches.
      3. Outdoor and Indoor photoelectric switches.
      4. Standalone daylight-harvesting switching controls.
      5. Indoor occupancy sensors.
      7. Emergency shunt relays.

   B. Related Sections include the following:
      1. Division 26 Section "Wiring Devices" for wall-box dimmers, wall-switch occupancy sensors, and manual light switches.

1.3 DEFINITIONS
   A. LED: Light-emitting diode.
   B. PIR: Passive infrared.

1.4 SUBMITTALS
   A. Product Data: For each type of product indicated.
   B. Shop Drawings: Show installation details for occupancy and light-level sensors.
      1. Interconnection diagrams showing field-installed wiring.
   C. Field quality-control test reports.
   D. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1.5 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.

1.6 COORDINATION
   A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS
2.1 PROGRAMMABLE AUTOMATIC LIGHTING CONTROL SYSTEM
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      2. Lighting Control & Design, Inc.
LIGHTING CONTROL DEVICES

3. Lightolier Controls; a Genlyte Company.
4. Lithonia Lighting; Acuity Lighting Group, Inc.
5. Sensor Switch
6. PCI
7. Watt-Stopper
8. Lutron

B. Expandability: System shall be capable of increasing the number of control functions in the future by 25 percent of current capacity; to include equipment ratings, housing capacities, spare relays, terminals, number of conductors in control cables, and control software.

C. Performance Requirements: Manual switches and an internal timing and control unit send a signal to programmable-system control module that processes the signal according to its programming and routes an open or close command to one or more relays in the power-supply circuits to groups of lighting fixtures or other loads.

D. Control Module Description: Comply with UL 916 (CSA C22.2, No. 205); microprocessor-based, solid-state, 365-day timing and control unit. Output circuits shall be switched on or off by internally programmed time signals or by program-controlled analog or digital signals from external sources. Output circuits shall be pilot-duty relays compatible with power switching devices. An integral keypad shall provide local programming and control capability. A key-locked cover and a programmed security access code shall protect keypad use. An integral alphanumeric LCD or LED shall display menu-assisted programming and control.

1. System Memory: Nonvolatile. System shall reboot program and reset time automatically without errors after power outages up to 90 days’ duration.
2. Software: Lighting control software shall be capable of linking switch inputs to relay outputs, retrieving links, viewing relay output status, controlling relay outputs, simulating switch inputs, setting device addresses, and assigning switch input and relay output modes.
3. Automatic Time Adjustment: System shall automatically adjust for leap year and daylight saving time and shall provide weekly routine and annual holiday scheduling.
4. Astronomic Control: Automatic adjustment of dawn and dusk switching.
5. Local Override Capability: Manual, low-voltage control devices shall override programmed shutdown of lighting and shall override other programmed control for intervals that may be duration programmed.
6. Automatic Control of Local Override: Automatic control shall switch lighting off if lighting has been switched on by local override.
7. Flick Warning: Programmable momentary turnoff of lights shall warn that programmed shutoff will occur after a preset interval. Warning shall be repeated after a second preset interval before end of programmed override period.

E. Modular Relay Panel: Comply with UL 508 (CSA C22.2, No. 14) and UL 916 (CSA C22.2, No. 205); factory assembled with modular single-pole relays, power supplies, and accessory components required for specified performance.

1. Cabinet: Steel with hinged, locking door.
   a. Barriers separate low-voltage and line-voltage components.
   b. Directory: Mounted on back of door. Identifies each relay as to load groups controlled and each programmed pilot device if any.
   c. Control Power Supply: Transformer and full-wave rectifier with filtered dc output.
2. Single-Pole Relays: Mechanically held unless otherwise indicated; split-coil, momentary-pulsed type.
   a. Low-Voltage Leads: Plug connector to the connector strip in cabinet and pilot light power where indicated.
   c. Endurance: 50,000 cycles at rated capacity.

F. Push-Button Switches: Modular, momentary-contact, low-voltage type. Match color specified in Division 26 Section "Wiring Devices."

G. Digital Time Switches:
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Watt Stopper (The) TS-400 or a comparable product by one of the following:
      a. Area Lighting Research, Inc.; Tyco Electronics
      b. Grasslin Controls Corporation; a GE Industrial Systems Company
      c. Intermatic, Inc.
      d. Leviton Mfg. Company Inc.
      e. Lightolier Controls; a Genlyte Company
      f. Lithonia Lighting; Acuity Lighting Group, Inc.
      g. Paragon Electric Co.; Invensys Climate Controls
      h. Square D; Schneider Electric
      i. TORK
      j. Touch-Plate, Inc.

2.2 TIME SWITCHES

A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
   1. Area Lighting Research, Inc.; Tyco Electronics
   2. Grasslin Controls Corporation; a GE Industrial Systems Company
   3. Intermatic, Inc.
   5. Lightolier Controls; a Genlyte Company
   6. Lithonia Lighting; Acuity Lighting Group, Inc.
   7. Paragon Electric Co.; Invensys Climate Controls
   8. Square D; Schneider Electric
   9. TORK
   10. Touch-Plate, Inc.
   11. Watt Stopper (The)
   12. Lutron

B. Electronic Time Switches: Electronic, solid-state programmable units with alphanumeric display; complying with UL 917.
   1. Contact Configuration: SPST.
   2. Contact Rating: 30-A inductive or resistive, 20-A ballast load.
   3. Programs: Channel quantity per schedule; each channel shall be individually programmable with 40 on-off operations per week, plus 4 seasonal schedules that modify the basic program, and an annual holiday schedule that overrides the weekly operation on holidays.
   4. Astronomic Time: Selected channels.
   5. Battery Backup: For schedules and time clock.
2.3 OUTDOOR AND INDOOR PHOTOELECTRIC SWITCHES

A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
1. Intermatic, Inc.
2. Lithonia Lighting; Acuity Lighting Group, Inc.
3. Novitas, Inc.
4. Square D; Schneider Electric
5. Sensor Switch, Inc.
6. Watt Stopper (The)
7. Lutron

B. Outdoor Photocell
1. Description: Solid state, with SPS dry contacts rated for 1800-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.
   a. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lx), 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.
   b. Time Delay: 15-second minimum, to prevent false operation.
   d. 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.

C. Indoor Photocell
1. Application:
   a. Provide closed loop type that measures total light level in the space for classrooms & labs.
   b. Provide open loop type for open 3 story space on eastern side of building.
2. Contact input photosensor.
   c. Input Voltage: 24V
   d. Output Voltage: 24V
   e. Mounting: Twist lock complying with IEEE C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required.
   f. Test mode override with LED status indicator.
   g. User adjustable parameters: on setpoint; off setpoint; and off setpoint time delay.
   h. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).
3. Analog photosensor
   a. Lightlevel monitoring range 0-100FC.
   b. Input Voltage: 24V
   c. Output Voltage: 10V or as required per manufacturer.
   d. Programming is not integral to device but is made via system software.
   e. Mounting: Twist lock complying with IEEE C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required.
   f. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).
4. Combination Occupancy Sensor and Photocell  
   a. As an option, a combination Occupancy Sensor and Photocell in place of the two separate devices where appropriate. Complete coverage and response must be obtained. Device must meet photocell and occupancy sensor device requirements listed in this section.

2.4 DAYLIGHT-HARVESTING SWITCHING CONTROLS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper Industries, Inc.
   2. Eaton Corporation.
   3. Hubbell Building Automation, Inc.
   5. Lithonia Lighting; Acuity Lighting Group, Inc.
   6. Sensor Switch, Inc.
   7. Watt Stopper.
   8. Lutron.

B. Ceiling-Mounted Switching Controls: Solid-state, light-level sensor unit, with separate power pack, to detect changes in indoor lighting levels that are perceived by the eye.

C. Electrical Components, Devices, and Accessories:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).
   3. Sensor Output: Contacts rated to operate the associated power pack, complying with UL 773A. Sensor is powered by the power pack.
   4. Power Pack: 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. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
   5. General Space Sensors Light-Level Monitoring Range: 10 to 200 fc (108 to 2152 lux), with an adjustment for turn-on and turn-off levels within that range.
   6. Atrium Space Sensors Light-Level Monitoring Range: 100 to 1000 fc (1080 to 10800 lux), with an adjustment for turn-on and turn-off levels within that range.
   7. Skylight Sensors Light-Level Monitoring Range: 1000 to 10,000 fc (10800 to 108 000 lux), with an adjustment for turn-on and turn-off levels within that range.
   8. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling.
   9. Set-Point Adjustment: Equip with deadband adjustment of 25, 50, and 75 percent above the "on" set point, or provide with separate adjustable "on" and "off" set points.
   10. Test Mode: User selectable, overriding programmed time delay to allow settings check.
   11. Control Load Status: User selectable to confirm that load wiring is correct.
   12. Indicator: Two digital displays to indicate the beginning of on-off cycles.

2.5 DAYLIGHT-HARVESTING DIMMING CONTROLS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper Industries, Inc.
   2. Hubbell Building Automation, Inc.
   4. Lithonia Lighting; Acuity Lighting Group, Inc.
   5. Sensor Switch, Inc.
   6. Watt Stopper.
   7. Lutron.
B. System Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, the lights are dimmed.
   1. Lighting control set point is based on two lighting conditions:
      a. When no daylight is present (target level).
      b. When significant daylight is present.
   2. System programming is done with two hand-held, remote-control tools.
      a. Initial setup tool.
      b. Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.

C. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with separate controller unit, to detect changes in lighting levels that are perceived by the eye.
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Sensor Output: 0- to 10-V dc to operate electronic dimming ballasts. Sensor is powered by controller unit.
   3. Power Pack: Sensor has 24-V dc, Class 2 power source, as defined by NFPA 70.
   4. Light-Level Sensor Set-Point Adjustment Range: 20 to 60 fc (120 to 640 lux).

2.6 INDOOR OCCUPANCY SENSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Hubbell Lighting
   3. Lithonia Lighting; Acuity Lighting Group, Inc.
   4. Novitas, Inc.
   5. Sensor Switch, Inc.
   6. Watt Stopper (The)
   7. Lutron

B. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensors with a separate power pack.
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Operation: Unless otherwise indicated, these should operate as vacancy sensors. When covered area is occupied, lights must be manually turned on, and will turn off automatically when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes.
   3. Isolated Relay Outputs: Sensor must have a set of contacts to report occupancy to HVAC.
   4. Mounting:
      a. Sensor: Suitable for mounting in any position on a standard outlet box.
      b. Relay: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
      c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
   5. Indicator: Digital display, 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.
C. **PIR Type:** Ceiling mounted; detect occupants in coverage area by their heat and movement.
   1. **Detector Sensitivity:** Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm).
   2. **Detection Coverage (Room):** Detect occupancy anywhere in a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
   3. **Detection Coverage (Corridor):** Detect occupancy within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling.

D. **Ultrasonic Type:** Ceiling mounted; detect occupants in coverage area through pattern changes of reflected ultrasonic energy.
   1. **Detector Sensitivity:** Detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
   2. **Areas listed in detection coverage subparagraphs below are typical.**
   3. **Detection Coverage (Small Room):** Detect occupancy anywhere within a circular area of 600 sq. ft. (56 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
   4. **Detection Coverage (Standard Room):** Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
   5. **Detection Coverage (Large Room):** Detect occupancy anywhere within a circular area of 2000 sq. ft. (186 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
   6. **Detection Coverage (Corridor):** Detect occupancy anywhere within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling in a corridor not wider than 14 feet (4.3 m).

E. **Dual-Technology Type:** Ceiling mounting; detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on-off functions shall be selectable in the field by operating controls on unit.
   1. **Sensitivity Adjustment:** Separate for each sensing technology.
   2. **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., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
   3. **Detection Coverage (Standard Room):** Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch high ceiling.

F. **Combination Occupancy Sensor and Photocell**
   1. As an option, a combination Occupancy Sensor and Photocell in place of the two separate devices where appropriate. Complete coverage and response must be obtained. Device must meet photocell and occupancy sensor device requirements listed in this section.

### 2.7 SWITCHBOX-MOUNTED 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.
   5. Lightolier Controls.
   6. Lithonia Lighting; Acuity Lighting Group, Inc.
   7. Lutron Electronics Co., Inc.
8. Sensor Switch, Inc.
9. Square D; a brand of Schneider Electric.
10. Watt Stopper.

B. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox.
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).
   3. Switch Rating: Not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277 V, and 800-W incandescent.

C. Wall-Switch Sensor:
   1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 900 sq. ft. (84 sq. m).
   2. Sensing Technology: Dual technology - PIR and ultrasonic, unless otherwise indicated on drawings.
   3. Switch Type: SP, field selectable automatic "on," or manual "on" automatic "off."
   4. Voltage: Match the circuit voltage 120 V or 277 V;
   5. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc (108 to 1600 lux). The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
   6. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
   7. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

2.8 LIGHTING CONTACTORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
   1. Hubbell Lighting
   2. Lithonia Lighting; Acuity Lighting Group, Inc.
   3. MicroLite Lighting Control Systems
   4. Sensor Switch
   5. Square D; Schneider Electric
   6. TORK
   7. Watt Stopper (The)
   8. Lutron

B. Description: Electrically operated and electrically held, combination type with fusible switch, 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 scheduled, matching the NEMA type specified for the enclosure.
2.9 EMERGENCY SHUNT RELAY

A. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:
   1. Lighting Control and Design, Inc.
   2. Wattstopper
   3. Sensor Switch

B. Description: Normally closed, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924.
   1. Coil Rating: 277 V.

2.10 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 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power 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. Power packs must be installed in an accessible location near the lighting it serves and not exposed to view from below. Locate over doorway where possible.

C. Occupancy Sensor Application: The following are guidelines for applying occupancy sensors devices for various types of areas unless otherwise specified on drawings or details. Refer to drawings for wall mount or ceiling mount application.
   1. PIR Wall Switch – Initial setting 15 minutes. Wattstopper PW-100 or equal
      a. Storage closets
      b. Small restrooms
      c. Janitor rooms
   2. Dual Technology Wall Switch – Initial setting 10 minutes and set initially as a vacancy sensor. Wattstopper DW-100 or equal.
      a. Small offices
   3. PIR Ceiling Mount – Initial Setting 30 minutes. Wattstopper CI-300/355 or equal.
      a. Common building areas
      b. Lobbies
   4. Dual Technology Vacancy sensor - Initial setting 15 minutes. Wattstopper LMRC-100 with LMDC-100 sensor, LMSW-102 switches and LMRL-100 relay interface. Or equal Sensor Switch Products.
      a. Small offices with fans.
   5. Ultrasonic Ceiling Mount – Initial setting 15 minutes. Wattstopper UT-300/355 or equal.
      a. Stairways
6. Ultrasonic Ceiling Mount – Initial setting 15 minutes. Wattstopper WT-2250 or equal.
   a. Long Hallways
7. Dual Technology Ceiling Mount - Initial setting 10 minutes. Wattstopper DT-300/355 or equal.
   a. Large Restrooms
   b. Small Offices
   c. Large Offices
   d. Open Offices
8. Dual Technology Ceiling Mount - Initial setting 15 minutes. Wattstopper DT-300/355 or equal.
   a. Labs
   b. Large conference rooms
   c. Lunch Rooms/Hearth

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 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 1/2 inch (13 mm).
B. Wiring within Enclosures: Comply with NEC 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 26 Section "Identification for Electrical Systems."
   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.
   3. After programming has been completed, presets shall be locked in to prevent inadvertent programming by staff.
B. Lighting control devices that fail tests and inspections are defective work.
3.6 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION
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. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:
   1. Distribution transformers.

1.3 SUBMITTALS
A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.

B. Shop Drawings:

C. Manufacturer Seismic Qualification Certification: Submit certification that transformers, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
      a. 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."
   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.

D. Arc flash hazard analysis report shall be provided by the manufacturer supplying the equipment.

E. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

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.

B. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

C. Energy-Efficient Transformers Rated 15 kVA and Larger: Certified as meeting NEMA TP 1, Class 1 efficiency levels when tested according to NEMA TP 2.

1.5 DELIVERY, STORAGE, AND HANDLING
A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.
LOW-VOLTAGE TRANSFORMERS

1.6 COORDINATION

A. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   2. General Electric Company.
   4. Federal Pacific
   5. Square D; a brand of Schneider Electric.

2.2 DISTRIBUTION TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service. 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 26 Section "Vibration and Seismic Controls for Electrical Systems."

C. Cores: Grain-oriented, non-aging silicon steel. One leg per phase.

D. Coils: Continuous windings without splices except for taps.
   1. Internal Coil Connections: Brazed or pressure type.
   2. Coil Material: Copper

E. Enclosure: Ventilated, NEMA 250, Type 2.


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. Energy Efficiency for Transformers Rated 15 kVA and Larger:
   1. Complying with NEMA TP 1, Class 1 efficiency levels.
   2. Transformers shall be low loss type with minimum efficiencies per NEMA TP1 when operated at 35% of full load capacity. Efficiency shall be tested in accord with NEMA TP2.

<table>
<thead>
<tr>
<th>Three Phase kVA</th>
<th>Efficiency</th>
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<tbody>
<tr>
<td>15</td>
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<tr>
<td>30</td>
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<td>75</td>
<td>98.0%</td>
</tr>
<tr>
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<td>98.2%</td>
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<tr>
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<tr>
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<tr>
<td>300</td>
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<tr>
<td>500</td>
<td>98.7%</td>
</tr>
<tr>
<td>750</td>
<td>98.8%</td>
</tr>
</tbody>
</table>
LOW-VOLTAGE TRANSFORMERS

K. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.
1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
2. Include special terminal for grounding the shield.
3. Shield Effectiveness:
   a. Capacitance between Primary and Secondary Windings: Not to exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz.
   b. Common-Mode Noise Attenuation: Minimum of minus 120 dBA at 0.5 to 1.5 kHz; minimum of minus 65 dBA at 1.5 to 100 kHz.
   c. Normal-Mode Noise Attenuation: Minimum of minus 52 dBA at 1.5 to 10 kHz.

L. Wall Brackets: Manufacturer's standard brackets.

M. Fungus Proofing: Permanent fungicidal treatment for coil and core.

N. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

2.3 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.
   1. Brace wall-mounting transformers as specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

B. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions, seismic codes applicable to Project, and requirements in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

C. Provide neoprene waffle isolation pads selected for 0.25 inch deflection with neoprene washer/bushings where transformer is anchored to supporting structure or floor.
3.3 FIELD QUALITY CONTROL
A. Perform tests and inspections and prepare test reports.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to in-
      spect 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 com-
      pliance with requirements.
   3. Perform each visual and mechanical inspection and electrical test stated in NETA Ac-
   4. Arc flash hazard analysis shall be performed to identify the shock hazard and appropriate
      personnel protective equipment (PPE) required at each transformer in accordance with
      the following standards:
      b. NFPA 70: National Electric Code
      c. NFPA 70E: Electrical Safety Requirements for Employee Workpalces
B. Report results of tests and inspections in writing. Attach a label or tag to each tested compo-
   nent indicating satisfactory completion of tests.
C. Arc flash hazard analysis report shall be provided by the manufacturer supplying the equipment.
D. Provide arc flash warning labels for all the equipment evaluated. Labels must be UV protected.
E. Studies shall use computer program software. Manual calculations are not acceptable.

3.4 CONNECTIONS
A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Sys-
   tems."
B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and
   Cables."
C. Tighten electrical connectors and terminals according to manufacturer’s published torque –
   tighten valves. If manufacturer’s torque valves are not indicated, use those specified in UL
   486A and 486B.

3.5 ADJUSTING
A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy
   period. 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. Output Settings Report: Prepare a written report recording output voltages and tap settings.

END OF SECTION
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. Service and distribution switchboards rated 600 V and less.
2. Disconnecting and overcurrent protective devices.
3. Instrumentation
4. Control power
5. Accessory components and features
6. Identification

1.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Switchboards 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."

1.4 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, accessories, and finishes.

B. Shop Drawings: For each switchboard and related equipment.
   1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
   2. Detail enclosure types for types other than NEMA 250, Type 1.
   3. Detail bus configuration, current, and voltage ratings.
   5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
   6. Detail utility company's metering provisions with indication of approval by utility company.
   7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
   8. Include schematic and wiring diagrams for power, signal, and control wiring.

C. Seismic Qualification Certificates: Submit certification that switchboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:
   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.

D. Arc flash hazard analysis report shall be provided by the manufacturer supplying the equipment.
SWITCHBOARDS

E. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Routine maintenance requirements for switchboards and all installed components.
   2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
   3. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graph paper; include selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.
B. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
D. 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.
E. Comply with NEMA PB 2.
F. Comply with NFPA 70.
G. Comply with UL 891.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.
B. Handle and prepare switchboards for installation according to NECA 400 and NEMA PB 2.1.

1.7 PROJECT CONDITIONS

A. Environmental Limitations:
   1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
   2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
      a. Ambient Temperature: Not exceeding 104 deg F (40 deg C).

1.8 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
B. Coordinate sizes and locations of concrete bases with actual equipment provided. Concrete, reinforcement, and formwork requirements are specified in Division 03.
1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: One year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Square D; a brand of Schneider Electric.
   2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   4. General Electrical Company; GE Consumer & Industrial.

B. Front-Connected, Front-Accessible Switchboards:
   1. Main Devices: Fixed, individually mounted.
   3. Sections front and rear aligned.

C. Nominal System Voltage: 480Y/277 V.

D. Main-Bus Continuous: As shown on the Drawings.

E. Seismic Requirements: Fabricate and test switchboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

F. Indoor Enclosures: Steel, NEMA 250, Type 1.

G. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

H. Utility Metering Compartment: Not required campus is primary metered by utility.

I. Power monitoring: See single line for power monitoring requirements. Refer to Electricity Metering specification section for additional information.

J. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

K. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

L. Buses and Connections: Three phase, four wire unless otherwise indicated.
   1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity, with tinned aluminum or copper feeder circuit-breaker line connections.
   2. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with compression connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.
   3. Ground Bus: 1/4-by-2-inch hard-drawn copper of 98 percent conductivity, equipped with compression 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.
   4. Main Phase Buses and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections.
SWITCHBOARDS

5. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with compression connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.


M. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

2.2 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents. No series rating.


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 delay 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 Class A ground-fault protection (6-mA trip).

B. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.

2. Lugs: Compression style, suitable for number, size, trip ratings, and conductor material.

3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.


5. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.

6. Power Monitoring: Integrated power monitoring in breakers that are capable of being connected to the Powerlogic Data Collection System.

2.3 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install switchboards and accessories according to NECA 400 and NEMA PB 2.1.

B. Equipment Mounting: Install switchboards on concrete base, 4-inch (100-mm) nominal thickness. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-Place Concrete Miscellaneous Cast-in-Place Concrete."
C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

D. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

E. Install filler plates in unused spaces of panel-mounted sections.

F. Install overcurrent protective devices and transient voltage suppression devices.
   1. Set field-adjustable switches and circuit-breaker trip ranges.

G. Torque logs are required at each service and/or distribution location to ensure good connections.

3.2 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.3 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 installation, including connections, and to assist in testing.
   2. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
   4. Arc flash hazard analysis shall be performed to identify the shock hazard and appropriate personnel protective equipment (PPE) required at each switchboard in accordance with the following standards:
      b. NFPA 70: National Electric Code
      c. NFPA 70E: Electrical Safety Requirements for Employee Workplaces

B. Report results of tests and inspections in writing. Attach a label or tag to each tested component indicating satisfactory completion of tests.

C. Arc flash hazard analysis report shall be provided by the manufacturer supplying the equipment.

D. Provide arc flash warning labels for all the equipment evaluated. Labels must be UV protected.

E. Studies shall use computer program software. Manual calculations are not acceptable.

3.4 DEMONSTRATION

A. Train Owner’s maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories, and to use and reprogram microprocessor-based trip, monitoring, and communication units.
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. Distribution panelboards
2. Lighting and appliance branch-circuit panelboards

1.3 DEFINITIONS
A. TVSS: Transient voltage surge suppressor.

1.4 PERFORMANCE REQUIREMENTS
A. Seismic Performance: Panelboards 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."

1.5 SUBMITTALS
A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression 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. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
   2. Detail enclosure types and details for types other than NEMA 250, Type 1.
   3. Detail bus configuration, current, and voltage ratings.
   4. Short-circuit current rating of panelboards and overcurrent protective devices.
   5. Include wiring diagrams for power, signal, and control wiring.
C. Seismic Qualification Certificates: Submit certification that panelboards, overcurrent protective devices, accessories, and components serving life safety systems and equipment will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:
   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.
D. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.
PANELBOARDS

E. Arc flash hazard analysis report shall be provided by the manufacturer supplying the equipment.
   1. Arc Flash hazard analysis shall be performed to identify the shock hazard and appropriate personnel protective equipment (PPE) required at each switchboard, switchgear, distribution board, motor control center, panelboard, UPS, transformer, etc. in accordance with the following standards:
      c. NFPA 70E: Electrical safety requirements for employee workplaces.
   2. Provide written report and table summarizing the incident energy exposure available at every faulted bus.
   3. Provide arc flash warning labels for all the equipment evaluated.
   4. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides listed in the following. Manual calculations are not acceptable.
   5. Shall meet the requirements of 2009 ANSI/NETA Standard for maintenance testing specifications: Chapter 6, Power system studies.

F. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
   2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

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. Comply with NEMA PB 1.

D. Comply with NFPA 70.

1.7 PROJECT CONDITIONS

A. Environmental Limitations:
   1. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
      a. Ambient Temperature: Not exceeding plus 104 deg F (plus 40 deg C).

1.8 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.9 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Keys: Six spares for each type of panelboard cabinet lock.
PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

B. Enclosures: Flush- and surface-mounted cabinets.
   1. Rated for environmental conditions at installed location.
      a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
      b. Outdoor Locations: NEMA 250, Type 3R.
      c. Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
      d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
      e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

2. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.

3. Finishes:
   a. Panels and Trim: galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.


C. Phase, Neutral, and Ground Buses:
   1. Material: Hard-drawn copper with 98 percent conductivity or aluminum.
   2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.

D. Conductor Connectors: Suitable for use with conductor material and sizes.
   1. Material: Suitable for use copper and aluminum conductors.
   2. Main and Neutral Lugs: Mechanical screw lugs.
   3. Ground Lugs and Bus-Configured Terminators: Mechanical screw lugs.
   4. Feed-Through Lugs: Mechanical screw lugs, suitable for use with conductor material.

E. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices. Provide a minimum of two extra and empty 3/4" conduit stubs at every new panel for future use.

F. Main breaker required at each panelboard.


2.2 DISTRIBUTION PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   2. Siemens Energy & Automation, Inc.
   3. General Electrical Company; GE Consumer & Industrial.
   4. Square D; a brand of Schneider Electric.

B. Panelboards: NEMA PB 1, power and feeder distribution type.
2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   2. Siemens Energy & Automation, Inc.
   3. General Electrical Company; GE Consumer & Industrial.
   4. Square D; a brand of Schneider Electric.
   5. Cooper Bussman

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units. Where fused panelboards are used for selective coordination (emergency and standby branches), provide manufacturer’s integrated fusible switch device.

D. Doors: Door-in-door construction. Concealed hinges; inner door secured with flush latch with tumbler lock; outer door secured with screws, all panels keyed for CAT 60 or CAT 70.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   2. Siemens Energy & Automation, Inc.
   3. General Electrical Company; GE Consumer & Industrial.
   4. Square D; a brand of Schneider Electric.
   5. Cooper-Bussman

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents. No series rating.
   3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replaceable 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.
      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. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
PANELBOARDS

7. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
   a. Standard frame sizes, trip ratings, and number of poles.
   b. Common trip handle for circuits shown as multi-wire branch circuits on the drawings.
   c. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
   d. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
   e. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

C. Fused Switches:
   1. Fused switches are only to be used where there is a coordination issue with using circuit breakers.
   2. Device shall have visible circuit ON/OFF indication with colored and international symbol markings.
   3. Device shall provide open fuse indication via permanently installed neon indicating light.
   4. Device shall be UL and cUL Listed 600Vac, 200kA short-circuit current rating, load-break disconnect with amperage ratings and number of poles as indicated on the panelboard schedule.
   5. Fuse and disconnect assembly shall be a finger-safe component with trim installed.
   6. Fuse and disconnect shall be mechanically interlocked so as not to allow fuse removal while fuse terminals are energized.
   7. No special tools shall be required for fuse removal.
   8. Devices shall have bolt-on style bus connectors.
   9. Device housing shall be clearly marked with device amperage.
   10. Permanently installed lockout means shall be provided on the device for lockout tagout procedures. Permanently installed means for locking device in the ON position shall also be provided.
   11. Device shall provide fuse ampere rating rejection at the following ampacities to ensure continued circuit protection at the specified circuit rating: 15A, 20A, 30A, 40A, 50A, & 60A.
   12. All overcurrent protective devices shall have a minimum interrupting rating of 300kA.
   13. Branch circuit overcurrent protection shall be UL Listed 600Vac, minimum 300kA IR, IP20 finger-safe fuse with Class J performance characteristics.
   14. Main overcurrent protective devices shall be UL Listed 600Vac, minimum 300kA IR, Class J time-delay fuses.
   15. Where panelboard main fuses are installed, fuses in panelboard branch circuits shall selectively coordinate with main fuses for all overcurrents up to 200kA.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panelboards and accessories according to NECA 407 and NEMA PB 1.1.
B. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
C. Mount top of trim 74 inches (2286 mm) above finished floor unless otherwise indicated.
D. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
E. Install overcurrent protective devices and controllers not already factory installed.
   1. Set field-adjustable, circuit-breaker trip ranges.

F. Install filler plates in unused spaces.

G. Comply with NECA 1.

H. Torque logs are required at each service and/or distribution location to ensure good connections.

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 installation, including connections, and to assist in testing.
   2. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
   4. Arc flash hazard analysis shall be performed to identify the shock hazard and appropriate personnel protective equipment (PPE) required at each panelboard in accordance with the following standards:
      b. NFPA 70: National Electric Code
      c. NFPA 70E: Electrical Safety Requirements for Employee Workplaces

B. Report results of tests and inspections in writing. Attach a label or tag to each tested component indicating satisfactory completion of tests.

C. Arc flash hazard analysis report shall be provided by the manufacturer supplying the equipment.

D. Provide arc flash warning labels for all the equipment evaluated. Labels must be UV protected.

E. Studies shall use computer program software. Manual calculations are not acceptable.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.4 ADJUSTING

A. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study."

B. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
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 equipment for electricity metering by Owner.

1.3 DEFINITIONS
   A. PC: Personal computer.

1.4 ACTION SUBMITTALS
   A. Product Data: For each type of product indicated.
   B. Shop Drawings: For electricity-metering equipment.
      1. Dimensioned plans and sections or elevation layouts.
      2. Wiring Diagrams: For power, signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features.

1.5 INFORMATIONAL SUBMITTALS
   A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS
   A. Operation and Maintenance Data. In addition to items specified in Division 01 Section “Operation and Maintenance Data,” include the following:
      1. Application and operating software documentation.
      2. Software licenses.
      3. Software service agreement.
      4. Hard copies of manufacturer’s operating specifications, design user’s guides for software and hardware, and PDF files on CD-ROM of the hard-copy Submittal.

1.7 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.

1.8 DELIVERY, STORAGE, AND HANDLING
   A. Receive, store, and handle modular meter center according to NECA 400.

1.9 PROJECT CONDITIONS
   A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
      1. Notify Architect, Construction Manager & Owner no fewer than two days in advance of proposed interruption of electrical service.
      2. Do not proceed with interruption of electrical service without written permission.
1.10 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 operating system. Upgrade shall include new or revised licenses for use of software. Contractor shall provide a site license for every meter.
1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade his computer equipment if necessary.

PART 2 - PRODUCTS

2.1 EQUIPMENT FOR ELECTRICITY METERING BY OWNER

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Square D – Powerlogic
   a. Schneider Electric ION 7650 for service entrance switchboards.
   b. Square-D PM 870 for main power monitoring meter at MDP.
   c. Square-D PM 850 for metering of standby and emergency loads.
   d. Square-D Advanced Intercept for all other sub-metering.
   e. Square-D Larger breakers with integrated power monitoring built-in and are capable of being connected to Powerlogic Data Collection system.

B. General Requirements for Owner's Meters:
1. Comply with UL 1244.
2. Enclosure: NEMA 250, Type 1 minimum, with hasp for padlocking or sealing.
3. Identification: Comply with requirements in Division 26 Section "Identification for Electrical Systems."
4. Memory Backup: Self-contained to maintain memory throughout power outages of 72 hours, minimum.
5. Sensors: Current-sensing type, with current or voltage output, selected for optimum range and accuracy for meters indicated for this application.
6. Split-core sensor in first subparagraph below is installed in switchboard or panelboard without disturbing feeder connection but is less accurate. Solid-core sensor is usually installed in a separate compartment or in a separate current-transformer cabinet. Coordinate with Drawings.
8. Current-Transformer Cabinet: Listed or recommended by metering equipment manufacturer for use with sensors indicated.
9. Building Automation System (BAS) Interface: One digital KY pulse to a user-definable increment of energy measurement. Match signal to BAS input and arrange to convey the instantaneous, integrated, demand level measured by meter to provide data for processing and possible programmed demand control action by destination system.

C. Kilowatt-hour/Demand Meter: Electronic three-phase meters, measuring electricity use and demand. Demand shall be integrated over a 15-minute interval.
1. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.
2. Display: LCD with characters not less than 0.25 inch high, indicating accumulative kilowatt-hours, current time and date, current demand, and historic peak demand, and time and date of historic peak demand. Retain accumulated kilowatt-hour and historic peak demand in a nonvolatile memory, until reset.
D. Data Transmission Cable: Transmit KY pulse data over Class 1 control-circuit conductors in raceway. Comply with Division 26 Section "Control-Voltage Electrical Power Cables." Contractor to contact metering technician John Ahrends to verify proper installation of RS-45 cable.

E. Software: PC based, a product of meter manufacturer.
   1. Activity Software: Automatically import energy-usage records to automatically compute and prepare activity demand and energy-use statements based on metering of energy use and peak demand. Prepare summary reports in user-defined formats and time intervals. Contractor to provide programming and licenses necessary for complete working system. Contact John Ahrends regarding programming and tying into UO system. All metering to be installed and functioning prior to main services being delivered to the building.

PART 3 - EXECUTION

3.1 INSTALLATION
   A. Comply with equipment installation requirements in NECA 1.
   B. Install modular meter center according to NECA 400 switchboard installation requirements.

3.2 IDENTIFICATION
   A. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
      1. Series Combination Warning Label: Self-adhesive type, with text as required by NFPA 70.
      2. Equipment Identification Labels: Adhesive film labels with clear protective overlay.

3.3 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. Verify that feeder has enough load to process accurate meter readings.
   B. Tests and Inspections:
      1. Connect a load of known kilowatt rating, 1.5 kW minimum, to a circuit supplied by metered feeder.
      2. Turn off circuits supplied by metered feeder and secure them in off condition.
      3. Run test load continuously for eight hours minimum, or longer, to obtain a measurable meter indication. Use test-load placement and setting that ensures continuous, safe operation.
      4. Check and record meter reading at end of test period and compare with actual electricity used, based on test-load rating, duration of test, and sample measurements of supply voltage at test-load connection. Record test results.
   C. Electricity metering will be considered defective if it does not pass tests and inspections.
   D. Prepare test and inspection reports.

END OF SECTION
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. This Section includes the following:
1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Twist-locking receptacles.
3. Floor service outlets.
4. Switches, dimmers, occupancy sensors.

1.3 DEFINITIONS
A. GFCI: Ground-fault circuit interrupter.
B. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
C. AFCI: Arc fault current interrupter.

1.4 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. Field quality-control test reports.
E. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.5 QUALITY ASSURANCE
A. Source Limitations: Obtain each type of wiring device and associated wall plate 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.
C. Comply with NFPA 70.

1.6 COORDINATION
A. Receptacles for Owner-Furnished Equipment: Match plug configurations.

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:
2. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).
4. Wiremold Company (The)
2.2 RECEPTACLES

A. Straight Blade Convenience Receptacles, heavy-duty specification grade, 5362 series, 125 V, 20 A, Plug Tail-Type: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A. Straight blade, non-feed-through to be used in all locations, Plug Tail-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. All receptacles located with weatherproof cover plates shall be classified in this category.

C. Twist-lock Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498 or Nema configuration as indicated on the drawings.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Cooper; L520R.
   b. Hubbell; HBL2310.
   c. Leviton; 2310.
   d. Pass & Seymour; L520-R.

D. Isolated-Ground Receptacles: Straight blade, Heavy-Duty grade, duplex receptacle, with equipment grounding contacts connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap.
1. Devices: Listed and labeled as isolated-ground receptacles.
2. Isolation Method: Integral to receptacle construction and not dependent on removable parts.

E. Hazardous (Classified) Locations: Comply with NEMA FB 11 and UL 1010.

F. Surface mounted outlet boxes shall be utilized only in conjunction with exposed conduits and shall be of the cast metal type with internal hubs and mounting flanges.

2.3 PENDANT CORD/CONNECTOR DEVICES

A. Description: Matching, locking-type plug and receptacle body connector, NEMA WD 6, Configurations L5-20P and L5-20R, Heavy-Duty grade.
2. External Cable Grip: Woven wire-mesh type made of high-strength galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.4 CORD AND PLUG SETS

A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.
1. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.
WIRING DEVICES

2.5 SWITCHES

B. Snap Switches: General-Duty grade, quiet type.
C. Combination Switch and Receptacle: Both devices in a single gang unit with plaster ears and removable tab connector that permit separate or common feed connection.
   2. Receptacle: NEMA WD 6, Configuration 5-15R.
D. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on/off switches and audible frequency and EMI/RFI filters.
   1. Control: Continuously adjustable slider; with single-pole or three-way switching to suit connections.
   2. Incandescent Lamp Dimmers: Modular, 120 V, 60 Hz with continuously adjustable rotary knob, toggle switch, or slider; single pole with soft tap or other quiet switch; EMI/RFI filter to eliminate interference; and 5-inch wire connecting leads.
   3. 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.
E. Wallbox Occupancy Sensor: Dual technology, with both passive-infrared- and ultrasonic-type sensing, 120/277 V, adjustable time delay up to 30 minutes, 110-degree field of view, and a minimum coverage area of 1200 sq. ft., option to choose Auto-ON or Manual-ON. Subject to compliance with requirements, provide one of the following:
   1. Watt Stopper (The); DW-100/DW-200.
   2. Hubbell;
   3. Leviton;

2.6 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. No plastic coverplates.
B. Wet-Locatioin, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant with in-use protection and a lockable cover. All receptacles requiring a weatherproof cover plate shall be GFCI protected. These include but are not limited to the following;
   1. Outdoor areas

2.7 FLOOR SERVICE FITTINGS

A. Floor Box
   1. The floor box shall be manufactured from stamped steel and be approved for use on above grade floors. The box shall be fully adjustable, providing a maximum of 1 3/8" pre-pour adjustment, and a maximum of 3/4" after-pour adjustment. The box shall provide a series of device mounting plates that will accept both duplex power devices, as well as plates that will accommodate workstation connectivity outlets and modular inserts, Wiremold RFB2 or RFB4 or as approved.
B. Activation Covers
   1. Activation covers shall be manufactured of die-cast aluminum or die-cast zinc, and be available in a brushed aluminum finish, plated brass finish, or a powder-coated paint finish. Finish to be verified with Architect for each area of facility. Activation covers shall be available in flanged and flangeless versions. Covers shall be available with options for tile or carpet inserts, flush covers, or covers with one 1" trade size screw plug opening and
NOTICE OF ALTERNATE BILLING CYCLE: The Contract will allow the Owner to require the submission of billings or estimates in billing cycles other than 30-day cycles. Billing or statements shall be submitted monthly ending on the last day of the month.

NOTICE OF EXTENDED CERTIFICATION PROVISION: The Contract will allow the Owner to certify billings and estimates within 20 days after the billings and estimates are received from the original contractor.

NOTICE OF EXTENDED PAYMENT PROVISION: The Contract will allow the Owner to make payment within 30 days after the date a billing or estimate is received.

2.8 POKE-THROUGH ASSEMBLIES

A. Description: Factory-fabricated and -wired assembly of below-floor junction box with multichanneled, through-floor raceway/firestop unit and detachable matching floor service outlet assembly.
   1. Service Outlet Assembly: Flush type with two simplex receptacles and space for two RJ-45 jacks.
   2. Size: Selected to fit nominal 3-inch cored holes in floor and matched to floor thickness.
   3. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
   4. Closure Plug: Arranged to close unused 3-inch (75-mm) cored openings and reestablish fire rating of floor.
   5. Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors; and a minimum of two, 4-pair, Category 5 voice and data communication cables.

2.9 MULTIOUTLET ASSEMBLIES

A. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.
B. Raceway Material: Metal, with manufacturer's standard finish.
C. Wire: No. 12 AWG.

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: As selected by Architect, unless otherwise indicated or required by NFPA 70 or device listing.
   3. Isolated-Ground Receptacles: Orange.

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 pigtales.
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 pigtailes that are not less than 6 inches (152 mm) in length.
5. 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 pigtailes 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.
10. Ground per specification section “Grounding and Bonding for Electrical Systems”

E. Receptacle Orientation:
1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.

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. Outlet boxes are to be sealed at exterior walls and as needed in other locations.

H. Outlet boxes shall be supported independent from the raceway system.

I. 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.

J. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on bottom. Group adjacent switches under single, multigang wall plates.
K. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION

A. Comply with Division 26 Section "Identification for Electrical Systems."
   1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with black-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 ones, and retest as specified above.

END OF SECTION
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. Cartridge fuses rated 600-V ac and less for use in enclosed switches and switchboards.
2. Spare-fuse cabinets.

1.3 SUBMITTALS
A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
   a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
   b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
5. Coordination charts and tables and related data.
6. Fuse sizes for elevator feeders and elevator disconnect switches.
B. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section “Operation and Maintenance Data,” include the following:
1. Ambient temperature adjustment information.
2. Current-limitation curves for fuses with current-limiting characteristics.
3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
4. Coordination charts and tables and related data.

1.4 QUALITY ASSURANCE
A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.
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. Comply with NEMA FU 1 for cartridge fuses.
D. Comply with NFPA 70.

1.5 PROJECT CONDITIONS
A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.
1.6 COORDINATION
   A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

1.7 EXTRA MATERIALS
   A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fuses: Provide three (3) of each size used.

PART 2 - PRODUCTS
2.1 MANUFACTURERS
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1. Cooper Bussmann, Inc.
      2. Ferraz Shawmut, Inc.
      3. Littelfuse, Inc.

2.2 CARTRIDGE FUSES
   A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

2.3 SPARE-FUSE CABINET
   A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.
      1. Size: Adequate for storage of spare fuses specified.
      2. Finish: Gray, baked enamel.
      3. Identification: "SPARE FUSES" in 1-1/2-inch-high letters on exterior of door.
      4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.
      5. Location: Mechanical and Electrical rooms with fused disconnects.

PART 3 - EXECUTION
3.1 EXAMINATION
   A. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
   B. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
   C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS
   A. Cartridge Fuses:
      1. Feeders: Class RK1, time delay.
      2. Motor Branch Circuits: Class RK5, time delay.
      3. Other Branch Circuits: Class RK5, time delay Class J, fast acting.

3.3 INSTALLATION
   A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

NOTICE OF ALTERNATE BILLING CYCLE: The Contract will allow the Owner to require the submission of billings or estimates in billing cycles other than 30-day cycles. Billing or statements shall be submitted monthly ending on the last day of the month.

NOTICE OF EXTENDED CERTIFICATION PROVISION: The Contract will allow the Owner to certify billings and estimate within 20 days after the billings and estimates are received from the original contractor.

NOTICE OF EXTENDED PAYMENT PROVISION: The Contract will allow the Owner to make payment within 30 days after the date a billing or estimate is received.
3.4 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems" and indicating fuse replacement information including fuse type and size on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION
PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
1. Fusible switches
2. Nonfusible switches
3. Shunt trip switches
4. Molded-case circuit breakers (MCCBs)
5. Enclosures

1.3 DEFINITIONS
A. NC: Normally closed
B. NO: Normally open
C. SPDT: Single pole, double throw

1.4 PERFORMANCE REQUIREMENTS
A. Seismic Performance: Enclosed switches and circuit breakers 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."

1.5 SUBMITTALS
A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
   1. Enclosure types and details for types other than NEMA 250, Type 1.
   2. Current and voltage ratings.
   3. Short-circuit current ratings (interrupting and withstand, as appropriate).
   4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
   1. Wiring Diagrams: For power, signal, and control wiring.
C. Qualification Data: For qualified testing agency.
D. Seismic Qualification Certificates: For enclosed switches and circuit breakers, 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.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
E. Field quality-control reports.
   1. Test procedures used.
   2. Test results that comply with requirements.
ENCLOSED SWITCHES AND CIRCUIT BREAKERS

3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

F. Manufacturer's field service report.

G. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
   2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
   1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
   2. Altitude: Not exceeding 6600 feet.

1.7 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, 600A and Smaller: UL 98 and NEMA KS 1, horsepower rated, 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. Limit the use of fused disconnect unless required by code or equipment manufacturer.

2.2 NONFUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, 600 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

C. Provide auxiliary contacts to break contact to motor drives when used with motors.
ENCLOSED SWITCHES AND CIRCUIT BREAKERS

2.3 SHUNT TRIP SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper Bussmann, Inc.
   2. Ferraz Shawmut, Inc.
   3. Littelfuse, Inc.

B. General Requirements: Comply with ASME A17.1, UL 50, and UL 98, with 200-kA interrupting and short-circuit current rating when fitted with Class J fuses.

C. Switches: Three-pole, horsepower rated, with integral shunt trip mechanism and Class J fuse block; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

D. Control Circuit: 120-V ac; obtained from integral control power transformer, with primary and secondary fuses, with a control power transformer of enough capacity to operate shunt trip, connected pilot, and indicating and control devices.

E. Accessories:
   1. Oiltight key switch for key-to-test function.
   2. Oiltight green ON pilot light.
   3. Isolated neutral lug; 200 percent rating.
   4. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.
   5. Form C alarm contacts that change state when switch is tripped.
   6. Three-pole, double-throw, fire-safety and alarm relay; 24-V dc coil voltage.
   7. Three-pole, double-throw, fire-alarm voltage monitoring relay complying with NFPA 72.

2.4 MOLDED-CASE CIRCUIT BREAKERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   4. Square D; a brand of Schneider Electric.

B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.


D. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

E. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
   1. Instantaneous trip.
   2. Long- and short-time pickup levels.
   3. Long- and short-time time adjustments.
   4. Ground-fault pickup level, time delay, and \( I_2t \) response.

F. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
ENCLOSED SWITCHES AND CIRCUIT BREAKERS

G. Features and Accessories:
   1. Standard frame sizes, trip ratings, and number of poles.
   2. Lugs: Compression type, suitable for number, size, trip ratings, and conductor material.
   3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
   4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
   5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
   6. Alarm Switch: One NC contact that operates only when circuit breaker has tripped.

2.5 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
   1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
   2. Outdoor Locations: NEMA 250, Type 3R.
   4. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
   5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
   6. Hazardous Areas if Indicated on Drawings: NEMA 250, Type 7 or Type 9.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
B. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
D. Install fuses in fusible devices and provide spare fuses for each fusible device.
E. Comply with NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."
   1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
   2. Label each enclosure with engraved metal or laminated-plastic nameplate.
PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS
A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, and Section 260500 - Basic Materials and Methods, and other Sections in Division 26 specified herein.

1.2 SCOPE
A. Furnish complete and operational VFD systems as shown on the plans. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to, the following:
   1. Variable frequency drives (VFDs)
   2. Controls and control connections
   3. Electrical power connections

1.3 RELATED WORK IN OTHER SECTIONS
A. Section 230500: Basic Materials and Methods
B. Section 230593: Testing, Adjusting and Balancing
C. Section 230900: Controls and Instrumentation
D. Section 232123: Pumps and Hydronic Specialties
E. Section 237315: Dedicated Outside Air Handling Units
F. Division 26: Coordination of interface items between the Mechanical equipment and controls and the Electrical Work specified in Division 26.

1.4 QUALITY ASSURANCE
A. Supplier of VFD shall be solely responsible for assuring that the VFD shall work properly with the motor(s) being controlled. VFD supplier shall provide all materials and labor required to replace motors, bearing, shafts, etc. that may be incompatible with VFD or become damaged by VFD at no additional cost to the owner. VFD supplier shall reimburse Architect and Engineer at their standard hourly rates for their involvement in resolving failures due to their VFDs.
B. Manufacturer shall have a minimum of 15 years experience building similar equipment for controlling the speed for induction motors and at least one hundred successful installations with a variety of VFD sizes and applications.
C. To insure quality and minimize failures the VFD(s) and connected motor(s) shall be by one manufacturer. To reduce the known problem of bearing failures by “fluting” the VFD switching rates shall be 6-8 Khz wherever possible. Manufactured VFDs at switching rates of 12-15 Khz shall be accompanied by an additional extended warranty to cover bearings and motors to a period of ten (10) years. Should it be impossible to provide matched motor and VFD’s provide a shaft grounding system for the driven motor. Acceptable manufacturer is Shaft Grounding Systems in Albany, Oregon (Representative: DP&A Sales 541-997-4068) or Aegis Shaft Grounding Ring (www.est-aegis.com/cse).
D. To insure quality and minimize infantile failures at the job site, the VFD shall be burned in at the factory at an ambient of 104°F minimum for at least 8 hours. The VFD shall be operating a dynamometer and the load speed shall be cycled during the test. All optional and special features shall be functionally tested at the factory for proper operation.
1.5 Qualifications

A. VFD and options shall be UL listed as a complete assembly. VFD requiring customer supply of external fuses for the VFD to be UL listed is NOT acceptable.

B. The base VFD shall be UL listed for 100 KAIC without the need for input circuit breaker.

C. CE Mark: The VFD shall conform to the European Union Electro Magnetic Compatibility directive, a requirement for CE marking. The VFD shall meet product standard EN 61800-3 for the First Environment restricted level to ensure the VFD does not emit radiated interference.

1.6 SUBMITTALS

A. Concurrent Facilities review and approval of construction submittals required.

B. Product data on variable frequency drives and related components indicating all features specified.

C. Start up log/check list showing successful operation.

D. Operation and Maintenance data

E. Prior to construction submit for approval the following materials:

1. VFD supplier shall provide reference list showing at least ten years of prior manufacturing experience in production of VFDs and a list of at least twenty successful installations with a variety of VFD sizes and applications.

2. Manufacturer's data, installation instructions, and maintenance and operational instructions for variable frequency drives. Indicate electrical service and special requirements. Include manufacturer's descriptive literature, repair data, and parts listing.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver units to the site in containers with manufacturer's stamp or label affixed.

B. Protect units against dirt, water, chemical, and mechanical damage. Do not install damaged units. Remove damaged equipment from site.

1.8 Warranty

A. Warranty shall be 24 months from the date of certified start-up.

B. Warranty shall include all parts, labor, travel time, software, software updates, and access tools at no additional cost to the Owner.

C. 24 hour support line shall be available on a toll-free line.
1.9 **Product Support**

A. Factory trained application engineering and service personnel that are thoroughly familiar with the VFD products offered shall be locally available at both the specifying and installation locations. 24 hour technical support line shall be available on a toll-free line.

**PART 2 - PRODUCTS**

2.1 **MANUFACTURERS**

A. Acceptable Manufacturer: ABB unless reviewed and approved by Facilities Maintenance via Construction Standards Substitution Request.
   1. NO third party VFD.
   2. NO ‘brand labeled’ VFD.
   3. NO packaged VFD.
   4. Any substitution must comply with requirements listed below.
   5. It is required that the drive manufacturer have an existing sales representative exclusively for HVAC products, with expertise in HVAC systems and controls as well as an independent service organization.
   6. The drive manufacturer shall supply the drive and all necessary controls as listed below.
   7. The manufacturer shall have been in the production of this type of equipment for a minimum of 20 years.

2.2 **GENERAL**

A. Furnish a complete VFD as scheduled on the plans. Refer to plans for locations of variable speed controllers. Each fan or pump motor shall have a dedicated VFD unit. All standard and optional features shall be included within the VFD enclosure unless otherwise specified. The VFD enclosure shall be provided to match the environment requirements where the VFD will be mounted and operated. Provide NEMA rated enclosure as required. Provide type 1 NEMA VFD’s wherever possible. NEMA 12 VFD’s must be provided if the VFD is to be run during construction other than testing or the contractor must have the VFD cleaned by a factory tech. Provide type 12 enclosures where located directly below piping or water source.

B. Variable Frequency Drive (VFD) consisting of a pulse width modulated (PWM) inverter designed for use on a standard NEMA Design B induction motor.

C. VFD to be dedicated variable torque design for specific use with centrifugal loads.

D. Provide completely solid state variable frequency power and logic unit.

E. Speed control to be step-less throughout the range under variable torque load on continuous basis.

F. VFD is to be controlled by DDC.

G. Provide adjustable frequency control with diode bridge/capacity input designed to provide high, constant power factor of 0.95 regardless of load or speed and eliminate SCR line noise.

H. Control shall be suitable for operation in ambient temperatures of 0 to 40 degrees C.

I. VFD shall be factory tested with an AC induction motor 100% loaded and temperature cycled within an environmental chamber at 104°F.

J. VFD drives are to be proofed through user adjustable drive auxiliary output.

K. Drives and motors must be compatible.

L. In general set drives to maximum current setting to eliminate over current problems.
2.3 Self Protection and Reliability Features

A. Adjustable current limit on drive to motor maximum amps.
B. Adjustable instantaneous over-current trip.
C. Under voltage trip.
D. Over temperature trip.
E. Short circuit protection phase to phase and phase to ground faults phase rotation insensitive.
F. Momentary power loss, more than 17 milliseconds.
G. Transient protection against all normal transients and surges in incoming power line.
H. Orderly shutdown in event of any of above conditions, drive shall be designed to shut down safely without component failure.
I. Provide visual indication and manual reset.

2.4 Features

A. Drive logic shall be microprocessor based. Control logic shall be isolated from power circuitry.
B. The free standing VFD assembly shall have a circuit breaker disconnect and be UL 508C listed for use on distribution systems with 22,000 AIC.
C. Minimum user adjustable inputs and outputs:
   1. 2 independent analog outputs
   2. 3 digital outputs
   3. 6 digital inputs
   4. ALL are to be independent of the VFD function.
D. Frequency Stability: Output frequency will be held to +0.1% of maximum frequency regardless of load, +10% input voltage change or temperature changes within ambient specification.
E. Built-in digital display on the panel face shall be capable of indicating output frequency, voltage and current and shall provide indication of over current, over voltage, current limit, ground fault, over temperature, input power on, minimum or maximum speed adjustment, power on, fault condition.
F. Start and stop control.
G. If applicable, the control circuit transformer will have primary and secondary fusing.
H. Minimum and maximum speed control.
I. Adjustable acceleration and deceleration; independently adjustable 10-100 second.
J. Hand-Off auto switch(s).
K. Programmable Auto Restart after power outage.
L. The following disconnect switching is required at a minimum:
   1. Safety Disconnect: Does not need to be fused. Shall include an early break auxiliary contact to disable the drive when in the ‘Off’ position.
   2. Service Switch: To be mounted at the ‘Safety Disconnect’ for an orderly shut-down on control. A label shall be included to read ‘NOT and Emergency Shut-Down for VFD’.
M. Remote contacts for fault, and on/off status.
N. Adjustable motor output voltage.
O. Analog output voltage of 0-10 VDC, 4-20 MA proportional to control output frequency.
P. Manual speed control for each motor.
VARIABLE FREQUENCY DRIVES (VFD)

Q. UL listed enclosure is to be completely assembled and tested in an ISO9001 manufacturing facility. The VFD tolerated voltage window shall allow the VFD to operate from a line of +30% nominal, and -35% nominal voltage as a minimum.

R. Provide output filters for all VFD locations more than 25 conductor feet from the motor they serve. Output reactors shall permit VFD to be located up to 350ft from the motors they serve.

S. The VFD shall have an integral 5% impedance line reactor to reduce the harmonics to the power line and to add protection from AC line transients. The 5% impedance may be from dual (positive and negative DC bus) reactors, or 5% AC line reactors. VFD with only one DC reactor shall add AC line reactors. This increased impedance lower harmonic distortion (Vthd) meeting IEEE-519 guidelines.

T. The VFD shall include a coordinated AC transient protection system consisting of 4-120 joule rated MOV (phase to phase and phase to ground), a capacitor clamp and 5% impedance reactors. MOV to protect against transients that would trip a VFD off line or cause serious damage.

U. VFD shall have the following adjustments:
   1. A minimum of 2 PID set point controllers shall be standard in the drive, allowing pressure or flow signals to be connected to the VFD, using the microprocessor in the VFD for the closed loop control.
   2. The VFD shall have 250 ma of 24 VDC (minimum) auxiliary power and be capable of loop powering a transmitter supplied by others.
   3. The PID set point shall be adjustable from the VFD keypad, analog inputs, or over the communications bus.
   4. There shall be at least two parameter sets for the first PID that allow the sets to be switched via a digital input, serial communications or from the keypad for night setback, summer and winter set points, etc.
   5. There shall be an independent, second PID loop that can utilize the second analog input and modulate one of the analog outputs to maintain set point of an independent process (i.e. valve, dampers, etc.).
   6. All set points, process variables, etc. are to be accessible from the serial communications network.
   7. The set points shall be set in engineering units and not require a percentage of the transducer input.
   8. Allows complete control of a system or process

V. The VFD shall include a fireman’s override input. Upon receipt of a contact closure from the fireman’s control station, the VFD shall operate at an adjustable preset speed. The mode shall override all other inputs (analog/digital, serial communication, and all keypad commands) and force the motor to run at the adjustable, preset speed. ‘Override Mode’ shall be displayed on the keypad. Upon removal of the override signal, the VFD shall resume normal operation.

W. All VFD shall have EMI / RFI filters. The onboard filters shall allow the VFD assembly to be CE marked and the VFD shall meet product standard EN 61800-3 for the first environment restricted level, and exceed FCC guidelines with motor cables less than 100 feet.

X. All VFD through 50HP shall be protected from input and output power mis-wiring. The VFD shall sense this condition and display an alarm on the keypad. Prevents damage to the VFD when the electrical contractor wires the input power to motor terminals.

Y. The VFD shall catch a spinning load in forward and reverse direction

Z. Serial Communications:
   1. The VFD shall have an RS-485 port as standard. The standard protocol shall be Modbus, Johnson Controls N2 bus, and Siemens Building Technologies FLN. Optional protocols for LonWorks, BACnet, Profibus, Ethernet, and DeviceNet shall be available. Each individual drive shall have the protocol in the base VFD. The use of third party gateways
VARIABLE FREQUENCY DRIVES (VFD)
and multiplexers is not acceptable. All protocols shall be “certified” by the governing authority. Use of non-certified protocols is not allowed.

2. The VFD shall allow the DDC to control and monitor the drive’s digital and analog outputs via the serial interface. This control shall be independent of any other VFD function.

3. The VFD shall include an independent PID loop for customer use. This independent PID loop may be used for cooling tower bypass valve control, chilled water valve control, etc. Both the VFD control PID loop and the independent PID loop shall continue functioning even if the serial communications connection is lost. The VFD shall keep the last good set point command and last good DO & AO commands in memory in the event the connection is lost.

4. Serial communication:
   a. Capabilities shall include, but not be limited to: run-stop control; speed set adjustment; proportional/integral/derivative PID control adjustments; current limit; acceleration and deceleration time adjustments; and lock and unlock the keypad.

   b. The drive shall have the capability of allowing the DDC to monitor feedback such as: process variable feedback; output speed/frequency; current (in amps); percent torque; power (kW); kilowatt hours, with the ability to reset; operating hours, with the ability to reset; drive temperature.

   c. The DDC shall also be capable of monitoring the VFD relay output status, digital input status, and all analog input and output values.

   d. All diagnostic warning and fault information shall be transmitted over the serial communications bus.

   e. Remote VFD fault reset shall be possible.

   f. The following additional status indications and settings shall be transmitted over the serial communications bus: keypad ‘Hand’ or ‘Auto’ selected; bypass selected; the ability to change the PID set point; the ability to force the unit to bypass, IF bypass is specified.

   g. The DDC system shall also be able to monitor if the motor is running in the VFD mode or bypass mode, IF bypass is specified.

AA. OPTIONAL FEATURES: Optional features to be furnished and mounted by the drive manufacturer. All optional features shall be UL listed by the drive manufacturer as a complete assembly and carry a UL508 label.

1. A complete factory wired and tested bypass system consisting of an output contactor and a bypass contactor. Overload protection and shall be provided in both drive and bypass modes.

2. Door interlocked, and pad-lockable circuit breaker that will disconnect all input power from the drive and all internally mounted options.

3. Fused VFD only disconnect (service switch). Fast acting fuses exclusive to the VFD – fast acting fuses allow the VFD to disconnect from the line prior to clearing upstream branch circuit protection, maintaining bypass capability. Bypass designs, which have no such fuses, or that incorporate fuses common to both the VFD and the bypass will not be accepted. Three contactor bypass schemes are not acceptable.

4. The drive bypass shall provide single-phase motor protection in both the VFD and bypass modes.

5. The following operators shall be provided:
   b. Drive mode selector.
   c. Bypass mode selector.
   d. Bypass fault reset.

6. The following indicating lights (LED type) shall be provided and a test mode or push to test feature shall be provided:
   a. Power-on (Ready).
   b. Run enable (safeties) open.
   c. Drive mode select damper opening.
VARIABLE FREQUENCY DRIVES (VFD)

d. Bypass mode selected.
e. Drive running.
f. Bypass running.
g. Drive fault.
h. Bypass fault.
i. Bypass H-O-A mode.
j. Automatic transfer to bypass selected.
k. Safety open.
l. Damper opening.
m. Damper end-switch made.

7. The following relay (form C) outputs from the bypass shall be provided:
   a. System started.
   b. System running.
   c. Bypass override enabled.
   d. Drive fault.
   e. Bypass fault (motor overload or underload, broken belt).

8. The digital outputs for the system shall accept 24V or 115VAC (selectable). The bypass shall incorporate internally sourced power supply and not require an external control power source.

9. Customer Interlock Terminal strip. Provide a separate terminal strip for connection to freeze, fire, smoke contacts, and external start command. All external safety interlocks shall remain fully functional whether the system is in Hand, Auto, or Bypass modes (not functional in Fireman's Override). The remote start/stop contact shall operate in VFD and bypass modes.

10. Dedicated digital input that will transfer motor from VFD mode to bypass mode upon dry contact closure for fireman's override. Two modes of operation are required:
    a. One mode forces the motor to bypass operation and overrides both the VFD and bypass HO-A switches and forces the motor to operate across the line (test mode). The system will only respond to the digital inputs and motor protections.
    b. The second fireman's override mode remains as above, but will also defeat the overload and single-phase protection for bypass and ignore all keypad and digital inputs to the system (run until destruction).

11. The VFD shall include a 'run permissive circuit' that will provide a normally open contact whenever a run command is provided (local or remote start command in VFD or bypass mode). The VFD system (VFD or bypass) shall not operate the motor until it receives a dry contact closure from a damper or valve and-switch. When the VFD system safety interlock (fire detector, freeze-stat, high static pressure switch, etc.) opens, the motor shall coast to a stop and the run permissive contact shall open, closing the damper or valve.

12. Class 20 or 30 (selectable) electronic motor overload protection shall be included.
13. There shall be an internal switch to select manual or automatic bypass.
14. There shall be an adjustable current sensing circuit for the bypass to provide loss of load indication (broken belt) when in the bypass mode.

PART 3 - EXECUTION

3.1 INSTALLATION

A. VFD shall be installed in accordance with applicable codes and manufacturer’s written installation instructions.
B. Install on a strut support system
C. VFD not to be mounted inside motor control centers or fan units
D. Each VFD will operate only one motor

NOTICE OF ALTERNATE BILLING CYCLE: The Contract will allow the Owner to require the submission of billings or estimates in billing cycles other than 30-day cycles. Billing or statements shall be submitted monthly ending on the last day of the month.
NOTICE OF EXTENDED CERTIFICATION PROVISION: The Contract will allow the Owner to certify billings and estimate within 20 days after the billings and estimates are received from the original contractor.
NOTICE OF EXTENDED PAYMENT PROVISION: The Contract will allow the Owner to make payment within 30 days after the date a billing or estimate is received.
VARIABLE FREQUENCY DRIVES (VFD)

E. Verify that mounting surface is ready to receive work. Mount the VFD(s) on the wall or at supports in locations identified on the drawings. Provide a layout drawing of VFD locations to electrical installer.

F. If the disconnect for the equipment powered by the VFD is in a location where it is probable that it will be placed in an off position prior to shutting down the VFD, the contractor is to provide electrical protection for the VFD. This may be in the form of a conduit and wire interlock between disconnect and drive or internal protection integral to the VFD.

G. Coordinate wiring and control with Control Contractor. Control installers shall install all wiring associated with control signals into the VFD and for interlock control wiring between disconnects and VFDs.

H. Electrical installer shall install all line voltage power wiring and conduit from electrical switchgear and from the VFD to the disconnect at the controlled motor. The only exception to this is when the motor and drive are factory installed on a packaged piece of equipment. In that case the wiring from drive to motor is to be installed in the factory to meet the requirements herein. Coordinate with Division 26 work.

I. Line length between VFD and driven motor shall be as short as possible. Line length shall not exceed twenty (20) feet without prior approval from Engineer.

J. Input and output power wiring shall be installed in separate grounded conduit. In addition, control wiring shall be installed in its own separate grounded conduit.

K. Use symmetric motor cable between the VFD and motor, with low inductance shield or conduit, and with all joints joined with bonding straps. MC metal clad 3 phase type cable per NEC 334-1, UL approved, 3 phase conductors and 3 ground conductors. Sheath to be continuous corrugated aluminum. Manufacturer and type to be BICC 2 kV rated Drives Cable, Anixter series 7V, or approved equal.

L. Use cable connectors with 360 degree connections to the armor conduit at both ends of motor cable. Verify electrical path from inverter cabinet entry plate to armor / conduit to motor terminal box.

M. Install an auxiliary high frequency bonding connection for potential equalization between VFD frame and building steel.

N. Unless absolutely necessary do not install disconnect between VFD and connected motor. VFD is to be furnished with a lockable disconnect.

3.2 Harmonic Measurement:

A. Perform harmonic measurement at the point where the utility feeds multiple loads (PCC) to verify compliance with the latest version of IEEE 519-1992.

B. Provide a report of the voltage THD and current TDD for Engineer and Facilities Maintenance review prior to substantial completion.

C. Provide labor, materials, and protection as needed to access the test points.

D. The readings shall be taken with all drives and other loads at full load, or as close to this as field conditions allow.

3.3 Field Quality Control:

A. Prior to installation, manufacturer’s representative shall coordinate VFD control interface with the control contractor and verify the intended installation (controls, wiring, etc.) complies with the manufacturer’s recommendations.
VARIABLE FREQUENCY DRIVES (VFD)

B. Field Test: Except where initial VFD operation clearly shows the performance meets or exceeds the requirements, test to show compliance. Tests shall be performed by the manufacturer’s representative in the presence of the Facilities PM and/or Maintenance Electrician.

3.4 MANUFACTURER’S START-UP SERVICES

A. Comply with manufacturer’s instructions for startup.

B. Start up shall be provided under the direct supervision of the manufacturer’s representative and factory trained personnel.

C. Certified factory start-up shall be provided for each drive by a factory authorized service center.

D. A certified start-up form shall be filled out for each drive with a copy provided to the Facilities PM, and a copy kept on file at the manufacturer.

E. The manufacturer shall provide start-up service in the form of a factory trained service technician. The service technician shall verify correct installation, verify control wiring, verify power wiring, start-up the drive, and check for proper operation. The service technician shall provide final adjustments to meet the specified performance requirements. Fully staffed parts and service personnel shall be within four hours travel from the jobsite.

F. Carrier Frequency Set-up:
   1. Set initial carrier frequency at 2 kHz.
   2. Manually raise VFD speed output from 10 Hz to 60 Hz by 10 Hz increments, allowing at least 15 seconds between each adjustment. If excessive motor noise is heard at any speed, raise carrier frequency by 2 kHz increments until motor noise is no longer excessive. Do not set carrier frequency higher than 10 kHz.
   3. If excessive motor noise continues to be heard at or below 10 kHz, inform owner. If the motor is provided by the VFD manufacturer, either repair, replace, or provide 5 year extended warranty on the effected motor.

G. Lockout of resonant frequencies:
   1. With carrier frequency set per the above specification, manually and slowly raise VFD speed output from 10 Hz to 60 Hz by 1 Hz increments. If excessive motor, frame, or driven load noise is heard at any speed, lock out that frequency.
   2. Each frequency skip shall be programmed with as narrow a bandwidth as possible, while still avoiding the most objectionable range of resonant frequencies. Each frequency skip bandwidth shall not exceed 5 Hz without approval by Engineer.

H. Training:
   1. Provide 1 hour training session to the owner’s representative.
   2. Training to include
      a. Demonstration of operation of bypass switch and door-mounted disconnect switches. Explain emergency operation.
      b. Demonstrate operation of operator keypads for viewing data and setting parameters.
      c. Demonstrate operation in manual mode, including setting of specific speeds.
      d. Explain the drive parameters that might require operator adjustment.
      e. Describe troubleshooting techniques and warranty procedure.

END OF SECTION
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. Interior lighting fixtures, lamps, and ballasts
2. Exit signs
3. Lighting fixture supports
B. Related Sections:
1. Division 26 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
2. Division 26 Section "Network Lighting Controls" for manual or programmable control systems with low-voltage control wiring or data communication circuits.

1.3 DEFINITIONS
A. BF: Ballast factor.
B. CU: Coefficient of utilization.
C. CRI: Color-rendering index.
D. HID: High-intensity discharge.
E. LER: Luminaire efficacy rating.
F. Lumen: Measured output of lamp and luminaire, or both.
G. Luminaire: Complete lighting fixture, including ballast housing if provided.

1.4 SUBMITTALS
A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
1. Physical description of lighting fixture including dimensions.
2. Emergency lighting units including battery and charger.
3. Ballast, including BF.
5. Life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps.
6. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.
   a. Testing Agency Certified Data: For indicated fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining fixtures shall be certified by manufacturer.
   b. Manufacturer Certified Data: Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
INTERIOR LIGHTING

B. Shop Drawings: For nonstandard or custom lighting fixtures. 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. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Lighting fixtures.
   2. Suspended ceiling components.
   3. Partitions and millwork that penetrate the ceiling or extends to within 12 inches of the plane of the luminaires.
   5. Structural members to which suspension systems for lighting fixtures will be attached.
   6. Other items in finished ceiling including the following:
      a. Air outlets and inlets.
      b. Speakers.
      c. Sprinklers.
      d. Smoke and fire detectors.
      e. Occupancy sensors.
      f. Access panels.
   7. Perimeter moldings.

D. Samples for Verification: Interior lighting fixtures designated for sample submission in Interior Lighting Fixture Schedule. Each sample shall include the following:
   1. Lamps: Specified units installed.
   2. Accessories: Cords and plugs.

E. Qualification Data: For qualified agencies providing photometric data for lighting fixtures.

F. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, from manufacturer.

G. Field quality-control reports.

H. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.
   1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

I. Warranty: Sample of special warranty.

1.5 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910, complying with the IESNA Lighting Measurements Testing & Calculation Guides.

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. Comply with NFPA 70.
INTERIOR LIGHTING

E. FM Global Compliance: Lighting fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

F. Mockups: Provide interior lighting fixtures for room or module mockups, complete with power and control connections.
   1. Obtain Architect's approval of fixtures for mockups before starting installations.
   2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
   3. Approved fixtures in mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

B. Lighting placement must allow access to ballasts and lamps for the purpose of replacement and maintenance without damage to surrounding finishes, equipment, etc.

1.7 WARRANTY

A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
   1. Warranty Period for Emergency Fluorescent Ballast and Batteries: Seven years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining six years.

B. Special Warranty for Ballasts: Manufacturer's standard form in which ballast manufacturer agrees to repair or replace ballasts that fail in materials or workmanship within specified warranty period.
   1. Warranty Period for Electronic Ballasts: Five years from date of Substantial Completion.

C. Special Warranty for T5 and T8 Fluorescent Lamps: Manufacturer's standard form, made out to Owner and signed by lamp manufacturer agreeing to replace lamps that fail in materials or workmanship, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.
   1. Warranty Period: One year(s) from date of Substantial Completion.

1.8 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Lamps: 5% extra lamps are required at the end of projects for all specialty lamps installed.
   2. Plastic Diffusers and Lenses: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
   3. Ballasts: One for every 100 of each type and rating installed. Furnish at least one of each type.
   4. Globes and Guards: 1 for every 20 of each type and rating installed. Furnish at least one of each type.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In Interior Lighting Fixture Schedule where titles below are column or row headings that 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 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

B. Incandescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5A.

C. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.

D. HID Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5B.

E. Metal Parts: Free of burrs and sharp corners and edges.

F. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.

G. 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.

H. 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. Acrylic lenses are not acceptable if lens must be removed to change lamps.
      a. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
      b. UV stabilized.
   2. Glass: Annealed crystal glass unless otherwise indicated.

I. 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.
   4. Laminated Silver Metallized Film: 90 percent.

2.3 BALLASTS FOR LINEAR FLUORESCENT LAMPS

A. Electronic Ballasts: Comply with ANSI C82.11; instant-start type, unless otherwise indicated, and designed for type and quantity of lamps served. Ballasts shall be designed for full light output unless dimmer or bi-level control is indicated.
   1. Sound Rating: A.
   2. Total Harmonic Distortion Rating: Less than 10 percent.
   3. Transient Voltage Protection: IEEE C62.41, Category A or better.
   4. Operating Frequency: 42 kHz or higher.
   5. Lamp Current Crest Factor: 1.7 or less.
   6. BF: 0.85 or higher.
   7. Power Factor: 0.95 or higher.
   8. Parallel Lamp Circuits: Multiple lamp ballasts shall comply with ANSI C 82.11 and shall be connected to maintain full light output on surviving lamps if one or more lamps fail.
B. Electronic Programmed-Start Ballasts for T5 and T5HO Lamps - T5 and T5HO Lamps not acceptable.

C. 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.

D. Ballasts for Low-Temperature Environments:
   1. Temperatures 0 Deg F (Minus 17 Deg C) and Higher: Electronic type rated for 0 deg F (minus 17 deg C) starting and operating temperature with indicated lamp types.
   2. Temperatures Minus 20 Deg F (Minus 29 Deg C) and Higher: Electromagnetic type designed for use with indicated lamp types.

E. Ballasts for Dimmer-Controlled Lighting Fixtures: Electronic type.
   1. Dimming Range: 100 to 1 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.

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 IEEE C62.41.2, 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, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.

2.5 BALLASTS FOR HID LAMPS

A. Electronic Ballast for Ceramic Metal-Halide Lamps: Include the following features unless otherwise indicated:
   1. Minimum Starting Temperature: Minus 20 deg F for single-lamp ballasts.
   2. Rated Ambient Operating Temperature: 130 deg F.
   3. Lamp end-of-life detection and shutdown circuit.
   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. Lamp Current Crest Factor: 1.5 or less.
   8. Power Factor: 0.90 or higher.
   9. Interference: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.
2.6 QUARTZ LAMP LIGHTING CONTROLLER

A. General Requirements for Controllers: Factory installed by lighting fixture manufacturer. Comply with UL 1598.

B. Standby (Quartz Restrike): Automatically switches quartz lamp on when a HID lamp in the fixture is initially energized and during the HID lamp restrike period after brief power outages.

C. Connections: Designed for a single branch -circuit connection.

D. Switching Off: Automatically switches quartz lamp off when HID lamp strikes.

E. Switching Off: Automatically switches quartz lamp off when HID lamp reaches approximately 60 percent light output.

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, 70,000 hours minimum rated lamp life. Green lamps.
   2. Hubbell/Presco Lite – Model PLED1EMGWW; or approved equal.

2.8 FLUORESCENT LAMPS

A. T8 rapid-start lamps, rated 32 W maximum, nominal length of 48 inches, 2800 initial lumens (minimum), CRI 75 (minimum), color temperature 4100 K, and average rated life 20,000 hours unless otherwise indicated.

B. T8 rapid-start lamps, rated 17 W maximum, nominal length of 24 inches, 1300 initial lumens (minimum), CRI 75 (minimum), color temperature 4100 K, and average rated life of 20,000 hours unless otherwise indicated.

C. T5 - not acceptable

D. T5HO - not acceptable.

E. Compact Fluorescent Lamps: 4-Pin, CRI 80 (minimum), color temperature 4100 K, average rated life of 10,000 hours at three hours operation per start, 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).

2.9 HID LAMPS

A. Ceramic, Pulse-Start, Metal-Halide Lamps: Minimum CRI 80, and color temperature 4100 K unless otherwise indicated.

2.10 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with Division 26 Section "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.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Lighting fixtures:
   1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.
   2. Install lamps in each luminaire.

B. Remote Mounting of Ballasts: Distance between the ballast and fixture shall not exceed that recommended by ballast manufacturer. Verify, with ballast manufacturers, maximum distance between ballast and luminaire.

C. Lay-in Ceiling Lighting Fixtures Supports: Use grid as a support element.
   4. Install ceiling support system rods or wires, independent of the ceiling suspension devices, for each fixture. Locate not more than 6 inches from lighting fixture corners.
      1. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
      2. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
      3. Install at least one independent support rod or wire from structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.

D. Suspended Lighting Fixture Support:
   5. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
      2. 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.
      3. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.

E. Adjust aimable lighting fixtures to provide required light intensities.

F. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.2 IDENTIFICATION

A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.3 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.

3.4 STARTUP SERVICE

A. Burn-in all lamps that require specific aging period to operate properly, prior to occupancy by Owner. Burn-in fluorescent and compact fluorescent lamps intended to be dimmed, for at least 100 hours at full voltage.

3.5 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting aimable luminaires to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Some of this work may be required after dark.
   1. Adjust aimable luminaires in the presence of Architect.

PART 4 - LUMINAIRE CUTSHEETS

4.1 INDIVIDUAL LUMINARE SPECIFICATIONS

A. Refer to architectural cutsheets, drawings, and specifications for the basis of design. Manufacturers listed as alternates must meet the requirements of the specification.
PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS

A. Section 27 0000 – Communications (Maintenance; Common Work Results; Schedules)
   1. See Section 09 50 00 – Ceilings.
   2. See Division 23 for Instrumentation & Control for HVAC (DDC) Standards.
   3. See Division 26 for Electrical.
   4. See Division 28 for Electronic Safety & Security
   5. See Division 33 for Utilities and Monitoring & Verification Instrumentation Standards.
   6. NEC and IEEE working clearance required and to be maintained.
   7. NEC and IEEE definitions will apply to all standards that follow.
   8. NO demolition of one item shall occur in order to repair and/or replace another item.
   9. ALL deleted items must be removed and not just abandoned.
   10. Systems and system components in new construction, remodels, and retrofits are to be compatible with existing systems and system components to the extent possible.
   11. Training provided MUST be to a maintenance/technician level for ALL systems.
   12. Voice and data cabling shall not block mechanical access points.
   13. Power supply is to be from a standby feeder or UPS.
   14. Communication conduits are to be a maximum of 40% full for future cabling allowance. Install conduit 100% oversized for future cabling.
   15. Boxes, panels, equipment gutters, etc. are to be cleaned inside and out upon completion and prior to acceptance of work.
   16. Accessibility of Equipment:
      a. Per the Introduction to this document, an AutoCAD layer of ‘Maintenance Access’ is to be incorporated into ALL drawings and system designs. This layer MUST be maintained through all phases of design and construction.
      b. Refer to and abide by all OSHA requirements, as appropriate.
      c. OSHA 1910 Subpart D - Walking-Working Surfaces standards for working platforms must be followed. Provisions to meet these standards must be incorporated into the building design.
      d. All necessary access points for maintenance must be provided and coordinated.
      e. Inaccessible Equipment:
         1) If after meetings, reviews, comments, etc., there are documented and/or discussed changes and the Facilities PM and Maintenance determines that the Contractor has installed or the Designer has located equipment not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled as directed at no additional cost to the UO or the project.
         2) Conveniently accessible’ is defined as being capable of being reached without climbing or crawling under or over obstacles such as motors, pumps, belt guards, transformers, piping and ductwork. Access must not exceed 14ft in height, a typical ladder working height.
   17. Communication Identification requirements:
      a. Horizontal cable IDs shall be assigned to every horizontal category 5e cable.
      b. The cable ID shall be constructed as follows: the three digits building number (in this case, 014), the IDF letter (A, B, or C), followed by a four-digit sequential jack number. For example, if a cable were pulled to IDF C and was the 65th cable pulled to that IDF, the cable ID for that cable shall be 014C0065. All cables in a single faceplate shall have sequential jack numbers.
      c. Cable TV RG6 shall be identified with a sequential, unique number. This number shall be combined with the room number to form the cable ID. For example, if this was the 10th cable TV cable pulled on the project and it was pulled to room 257, the cable ID would be 257-10.
d. Cable tags containing the unique cable ID shall be placed on both ends of all cables, 6 inches from the connector and/or termination blocks. Each label shall be pre-printed with the cable ID as indicated. Hand written cable labels are not acceptable.

e. Individual station outlets shall be labeled with the designator of the cables terminated at that particular outlet. Plates shall be permanently labeled in typewritten ink or professional engraving. Station faceplates shall have the building and IDF letter at the top of the faceplate (for example, 014C). Individual jacks in the station faceplate shall be labeled with the sequential jack numbers (for example, 0065).

f. If at any time during the job the cable tag becomes illegible or removed for whatever reason, the Contractor shall immediately replace it with a duplicate pre-printed cable tag at the Contractor's expense.

g. Patch panels shall be labeled with the permanent room numbers above the jacks and an abbreviated cable ID consisting of the sequential jack number below the individual jacks. For example, if a set of four cable were pulled between IDF C and room 103 and these were the sequentially cables 65, 66, 67, and 68, the patch panel would have a single label 'Room 103' above the set of four jacks, and each of the individual jacks would have the labels 0065, 0066, 0067, and 0068 placed under the jacks.

18. Quality Assurance required:
   a. Do all work in accordance with the guidelines published in TIA standard 568 and 569.
   b. All manufacturer installation instructions shall be followed.
   c. All workers involved in the installation and termination of cable shall have at least one year of experience.
   d. No less than 33% of the workmen on the job shall have attended a vendor sponsored training program covering installation and termination of cable.

19. Construction Submittals required:
   a. Concurrent UO Network & Telecom Services review and approval required.
   b. Drawings and product data requiring the following items:
      1) Backboard layouts for all IDFs. Backboard layout must be coordinated with the UO Network & Telecom Services to avoid coordination conflict.
      2) Relay rack layouts, including panels and wire management for all racks.
      3) Ladder racking layouts in all IDFs.

20. Guarantee(s) required:
   a. Guarantee all work against faulty and improper material and workmanship for a minimum period of one (1) year from the date of final written acceptance by UO Network & Telecom Services, except where guarantees or warranties for longer terms are specified.
   b. Upon notification of a problem, the warranty provider shall furnish within 48 hours and at no cost to the UO project, such labor and materials as are needed to restore the system to proper operation.

B. Structured Cabling (Equipment Room Fittings; Backbone Cabling; Horizontal Cabling; Connecting Cords, Devices, & Adapters)

1. UO Network & Telecom Services Work Includes:
   a. Telephone cabling to provide service to the building or space
   b. Switching to the private Facilities Services network trunk; DDC controls
   c. All wiring harness in the building entrance MDF, patch cords, and network equipment to bring service into all racks.

2. Contractor Work to be Included:
   a. Pathways, hard cabling, and termination.
UO TELECOM STANDARDS

b. Furnishing and installation of all labor and materials required for the installation of a voice and data cable infrastructure.

3. At each main building controller install one (1) spare data jack for Facilities Services trunk communications port so a portable computer with private network, Apogee, can monitor the system.

4. Voice and Data Cable Tray Pathways:
   a. Cable tray in hallways or other common and direct paths through the building.
   b. Conduits from station locations shall stub to the cable tray.
   c. The cable tray or large conduits from the cable tray shall stub into the serving Telecommunication Equipment Room (TER) or Telecommunication Room (TR).

5. General:
   a. Remove all defective cables from pathways system. Do not abandon cables in place.
   b. UO Network & Telecom Services can choose to observe any or all portions of the testing process.
   c. UO Network & Telecom Services can choose to conduct a random re-test of up to five percent (5%) of the cable to confirm documented test results; using Contractor equipment and labor.
   d. All test results and corrective procedures are to be documented and submitted to UO Network & Telecom Services and Facilities PM within fourteen (14) working days of test completion.

6. Acceptable Manufacturers to be used:
   a. Fiber Optic Cable: Corning
   b. Fiber Patch Panels: Corning CCS or CCH with CSH, depending on fiber count.
   c. Multi mode ST Fiber Connector Panels: Coming CCH-CP06-15T
   d. Multi mode ST Fiber Optic Connectors: 3M 6105
   e. Single mode fiber optic modules: Coming CCH-RM12-3C-P03RH
   f. Twisted Pair Backbone Cable: Any ARMM-type
   g. 110 Terminating Hardware for Twisted Pair Backbone Cable: Panduit
   h. Telephone Patch Panels: Panduit VP24382TV25 voice patch panel.
   i. Category 5e Twisted Pair Cable: Belden 1500A/1501A, Commscope Ultra II, BerkTek LANmark 350, or Krone AirES C5eT
   j. Cable TV horizontal cable: any RG6 with at least 66% overall braid.
   k. Cable TV backbone cable: Commscope P3-500
   l. Category 5e Station Jacks: Panduit mini-com TX-5e
   m. Station Device Plates: Panduit classic series faceplates CFP2xx and CFP4xx
   n. Wall phone station jack and device plate: Panduit KWP5E
   o. Category 5e Patch Panels: Panduit mini-com TX-5e modular panels, part number CPP48WBL
   p. Intrabay Wire Management Panels: Panduit NCMHF2
   q. Interbay Wire Management Panels: Chatsworth/CPI 11564-519 large horizontal ring run
   r. Relay Racks: Chatsworth/CPI 55053-503 7ft free standing relay rack
   s. Vertical wire management chase: Chatsworth/CPI 30091-703 vertical wire management chases.
   u. Overhead Ladder Rack: Chatsworth/CPI.

7. Fiber requirements:
   a. All fiber optic cable shall be OFNR or OFNP rated, suitable for duct placement, single or multi-mode shall be indicated on the drawings, and shall meet the requirement of ANSI/EIA/TIA-568 for optical fiber backbone cable. Fiber optic cable routes and strand counts are to be indicated on the drawings.
b. Terminate all multimode fiber strands with ceramic ferrule, epoxy mount or hot-melt ST connectors. Install terminated ST connectors into ST coupler panels mounted in fiber enclosures.

c. Terminate all single mode fiber strands by fusion splicing factory modules onto single mode fiber strands and installing modules into fiber enclosures. Splices shall be protected in splice trays.

d. The UO Network & Telecom Services will provide a Corning CCH rack mount fiber enclosure and CSH splice housing in the MDF for termination of the building entrance fiber cables. The contractor will coordinate placement of fiber panels and modules into MDF rack mount fiber panels with the UO Network & Telecom Services.

8. Twisted Pair Backbone requirements:

a. Twisted pair backbone cabling shall consist of multiple category 5e cable sheaths and ARMM multi-pair cable. Cable and pair counts are to be indicated on the drawings.

b. The category 5e cable shall be terminated in category 5e patch panels in the IDFs. These backbone category 5e cables shall be terminated in patch panels that are separate from the horizontal station category 5e patch panels.

c. ARMM cable shall be terminated compact 110-type terminating blocks complete with mounting hardware, connecting blocks, retainers, wire management, designation strips, etc.

d. The shield of the ARMM cable shall be bonded at the IDF A location with a 6 AWG insulated ground run to the ground bus in IDF A.

e. The ARMM telephone backbone cable shall be brought into the rack system via 25-pair wiring harness that is overlaid on the 110 blocks and routed to the back of the telephone patch panels. 50% of the pair count shall be brought into the rack system.

f. Telephone patch panels shall be installed beneath all the category 5e patch panels.

g. Wire management panels shall be installed between each two telephone patch panels.

9. Horizontal Distribution required:

a. Cable TV cabling shall be rated for use (CL2, CL2P, etc).

b. Cable TV shall be pulled and identified. No terminations are required.

c. All UTP cable shall be rated for the use (CMR or CMP).

d. All category 5e cabling shall be terminated in the IDF location in Panduit mini-com modular category 5e patch panels (maximum of 48 jacks per panel). All station jacks must be Panduit TX-5e category 5e jacks mounted in appropriate faceplates and/or mounting frames. Wiring pattern shall be 568B for all patch panels and jacks. Color of jacks and frames shall match electrical trim. All category 5e termination hardware must meet requirements for Category 5e. All jacks in a single faceplate must be in sequential order and all jacks in the panels must be in sequential order.

e. The category 5e cabling in the racks shall be installed with sufficient and appropriate mounting clips, brackets, and rear cable management to provide a secure and maintainable system. Contractor shall supply and use at least one Chatsworth/CPI 12176-701 patch panel wire management bar and two Chatsworth/CPI 10559-500 standoff tie brackets per category 5e patch panel.

f. Intrabay wire management panels are to be installed below each rack mount category 5e patch panel. Racks without intrabay wire management installed at the top shall have a single intrabay wire management panel installed at the top position in the rack.
g. No rack is to be filled more than 50% full of category 5e and wire management panels. The remainder of the rack is reserved for use by the UO Network & Telecom Services for panels and equipment.

h. All category 5e cabling terminated in panels in the open relay racks shall be routed to the relay racks from the rear. Category 5e bend radius shall be maintained by utilizing the cable runway radius drop behind each vertical wire management chase.

i. Elevator wiring: All outlets to provide service to the elevator emergency phone are to be installed in the elevator mechanical rooms and are to be indicated on the drawings. Locations of these outlets are to be coordinated with the elevator installer. At the IDF end, these cables shall be terminated in category 5e patch panels and carefully labeled as emergency elevator telephones.

j. Wall phone wiring: All outlets for wall phones are to meet height and location requirements for handicapped access. For identified wall phone locations, two 4-pair cables shall be pulled to the wall phone location. One of the cables shall be installed into the wall phone jack voice outlet and the other left coiled for future use. At the IDF end, both cables shall be terminated in category 5e patch panels.

10. Installation requirements:

a. The Contractor shall furnish and install all pathways and cabling

b. Install each cable as an uninterrupted conductor section between the designated termination points.

c. No splices or mechanical coupler installed between the cable points of origin and termination.

d. All cable shall be routed through the building cable tray/conduit system where available.

e. Cable jacket must be suitable for the environment in which it is placed i.e.: CM, CMR, CMP rated.

f. All cable shall be attached to building structure except as noted below, at intervals not to exceed 5 feet.

g. At the same time cable is pulled into a cable pathway, also install a pull string of appropriate size to facilitate future cable pulls along those pathways.

h. The contractor will be responsible for the installation of all J-hooks for horizontal cable support while coordinating locations of support hardware to avoid conflicts with other trades.

i. At no point shall any station cable be tie wrapped or fastened to the cable tray.

j. After cables have exited the cable tray they will must be tie wrapped to the J-hooks and the tie wraps shall be tight enough around the cable bundle to keep them uniform and in the hooks, but not so tight as to damage the construction of the cables themselves.

k. Installation of workstation cables shall be coordinated with the modular furniture systems as applicable. Prior to the furniture system installation, the workstation cables will be pulled near the stub-up or pokethru and left coiled with enough slack to reach the eventual outlet location. After the modular furniture systems are installed and walls are finished, the contractor will pull cable to the outlet locations and complete the cable installation.

l. Provide fire stopping at all locations where cables penetrate fire rated surfaces. Materials and methods used shall be acceptable to the code authority having jurisdiction and shall maintain the fire integrity of the wall, floor, or ceiling.

m. Contractor shall closely coordinate and work with UO Network & Telecom Services on the construction of racking and panels and termination and routing of the cabling in the IDF, overhead ladder racking, and into the open relay racks.
11. Telecommunication Room requirements:
   a. Install all telecommunications termination hardware on plywood backboards.
   b. Backboards are to be 3/4" AC fire rated plywood, 8ft tall, width is to be determined by the project.
   c. Any location using more than one relay rack shall be installed with one intrabay wire horizontal management panel in the top position of each rack.
   d. Each relay rack shall have a vertical wire management chases on each side of the rack. If there is more than one relay rack installed in an IDF, these vertical wire management chases shall be installed between and on each end of the row of racks.
   e. Overhead ladder racking shall be installed in the telecommunications room to provide for routing of cabling as well as earthquake bracing of the relay racks.
   f. All relay racks must have ladder racking installed from the telecommunication backboard to each free relay rack. Ladder rack is to be firmly attached per the manufacturer’s instructions. Coordinate the installation of ladder rack with all other construction within telecommunications room.
   g. Each relay rack shall be firmly anchored to the floor.

12. Termination Hardware requirements:
   a. The Contractor is responsible for providing the correct quantities of termination hardware required to terminate, patch, cross connect, etc. the volume of cable.
   b. During the construction Contractor shall protect the equipment from damage and theft. Equipment shall not be installed until such time as other trades have completed their work in the area.

13. Cable Termination requirements:
   a. Twisted pair cables: After dressing cable to the final location, the sheath shall be removed to a point that allows the conductors to be splayed and terminated in a neat and uniform fashion. Every effort must be made to maintain sheath integrity by removing only as much as is practical to accomplish termination. Cable pair twist shall be maintained up to the point of termination. Under no circumstances shall cable pairs be untwisted or otherwise altered prior to termination.
   b. Fiber optic cables: After dressing the fiber to the final destination, sheath shall be removed to a point that allows the fibers to be splayed and terminated in a neat and uniform fashion. At this point all fiber strands will be terminated in strict compliance with the manufacturer's instructions.
   c. Cable TV: Shall not be terminated. It shall be pulled only, identified, and neatly coiled for future use.

14. Grounding requirements:
   a. A telecommunications grounding system shall be installed and have a 6AWG insulated ground conductor run from the MDF/IDF A to the main ground at the electrical service. A ground bus shall be installed in each IDF. A 6AWG ground conductor shall run from the MDF/IDF A to each IDF. These are minimum sizes allowable.
   b. All metallic cable tray, ladder rack, raceways, cable sheath/armor, enclosures, and equipment racks and other conductive surfaces shall be properly bonded to the grounding system. All paint and other coatings shall be removed at all contact surfaces to ensure proper ground.
   c. All grounding shall be in compliance with the NEC code Article 800, Article 250, well as EIA/TIA standard 607.

15. Copper Cable Testing requirements:
   a. Visually inspect all cables, cable reels, and shipping cartons to detect cable damage incurred during shipping and transport. Return visibly damaged items to the manufacturer.
   b. Conduct cable testing as described below upon completion of installation. Test fully completed systems only; piecemeal testing is not acceptable.
c. All category 5e cables shall be tested in accordance to EIA/TIA 568A, TSB 67 with a test device meeting or exceeding level II accuracy. All installed category 5e cables must pass testing that verifies support of 1000baseT gigabit Ethernet.

16. Fiber Cable Testing requirements:
   a. Visually inspect all fiber, fiber reels, and shipping cartons to detect cable damage incurred during shipping and transport. Return visibly damaged items to the manufacturer.
   b. Conduct fiber testing as described below upon completion of installation. Test fully completed systems only. Piecemeal testing is not acceptable.
   c. After installation of connectors, visually inspect each fiber end-face at 10X magnification. Refinish fibers with visible defects and/or striations in the core area.
   d. Perform end-to-end, bi-directional attenuation (loss) test for each multimode fiber strand at 850nm and 1300nm wave lengths and each single mode fiber strand at 1310nm and 1550nm. Conduct tests in accordance with EIA/TIA-526-14, method B and with test instrument manufacturer printed instructions.
   e. Demonstrate that measured link loss does not exceed the worst case allowable loss which is the sum of: the connectors loss (based on the number of mated connector pairs at the EIA/TIA-568 maximum allowable loss of 1.0 dB per mated pair) and the optical fiber loss (based on the maximum allowable loss of 3.75 dB/km at 850nm, 1.5 dB/km at 1300nm for multimode fiber, 1.5 dB/km at 1310nm, and 1.0 dB/km at 1550nm for single-mode fiber).
   f. Strands whose measured attenuation falls outside the acceptable range shall be subject to further inspection and testing to determine the nature of the fault. At a minimum, an OTDR shall be used to determine the true loss for each connector pair, the exact length of the fiber, and to identify the presence of any core damage.
   g. Faults related to connection shall be corrected, and the fiber re-tested until acceptable attenuation measurements are recorded.
   h. Where defects are found to be inherent in the fiber itself, fiber must be removed and replaced. Also replace any cable having fewer than the manufactures guaranteed number of serviceable fibers.

17. Acceptance requirements: Upon receipt of the Contractor's documentation of cable testing, UO Network & Telecom Services will review the installation and may request a test in Contractor's presence, of up to 1% of the cables/wires installed.

18. As-Built Documentation requirements:
   a. Contractor shall provide CAD prints and disks of the electrical set of prints indicating actual faceplate location and faceplate designations.
   b. Contractor shall provide 3 copies of all test results neatly bound and organized to the Facilities PM. Each test shall clearly indicated jack and/or cable designations.

19. Low Voltage Wiring:
   a. Fire Alarm and monitoring, and data/telecom wiring can share the same cable trays or conduit with UO Network & Telecom Services and Facilities EH&S approval, and with proper and complete coordination.

END OF SECTION
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.
B. The purpose of this Section is to define the scope of work upon which the fire alarm contractor, hereafter known as Contractor, is to base his bid, to establish the design and installation criteria to be used, and to define design submittals which will be required in the preparation and execution of the design.

1.2 SCOPE
A. Contractor Performance Requirements
1. This specification and the drawings provide the requirements for the design, installation, programming and configuration of modifying the existing fire alarm system network. The system shall include, but not limited to: Control Panel programming, automatic and manually activated alarm initiating and indicating peripheral devices and appliances, signage, associated connections, conduit, wire and accessories as indicated in this specification and on associated drawings and as required to furnish a complete and operational fire alarm system. Provide all labor, materials, tools, instructions, data, testing/test results, and reports, spare parts, equipment and design services as required.
2. System shall be designed in accordance with rules, regulations and standards as required by the federal, state and local governing agencies. Even if not particularly specified, all code or county required items or amendments shall be incorporated in the design, furnished, and installed by the Contractor without additional expense to the Owner.
3. Submission to Authority Having Jurisdiction (AHJ): In addition to routine submission of the material, make an identical submission to the authority having jurisdiction. Include copies of annotated Contract Drawings as required to depict component locations to facilitate review. Upon receipt of comments from the Authority, submit them to Architect, Owner and Electrical Engineer for review. Provide written response to the AHJ’s review comments and provide resubmissions with clarifications or revisions as required to obtain approval. Contractor shall meet with appropriate city and county representatives before final construction documents are completed to insure system will pass all city and county plan inspections. Change orders will not be accepted for items that should have been included in the design.
4. The Contractor shall be the Engineer of Record and shall assume total responsibility for their systems, including permits, products, installation, and performance.
5. The Contractor is responsible for design and preparation of shop drawings and shall identify all such work in the process of design and preparation of construction documents.

B. Project Phasing and Coordination
1. Coordinate project phasing with general contractor. Provided additional equipment and labor required to accommodated project phasing.
2. Provide new Notifier fire alarm devices in Crafter Center and connect to existing building Siemens fire alarm system.
3. Coordinated placement and type of detection with Craft Center equipment (Heat and dust issues).
4. Coordinated voice evacuation speaker quantities with expected ambient sound levels by Craft Center room use.

1.3 DEFINITIONS
A. FACP: Fire alarm control panel.
B. LED: Light-emitting diode.
C. NICET: National Institute for Certification in Engineering Technologies.
D. Definitions in NFPA 72 apply to fire alarm terms used in this Section.

1.4 SYSTEM DESCRIPTION
A. Noncoded, addressable system; automatic sensitivity control of certain smoke detectors; and multiplexed signal transmission dedicated to fire alarm service only.

1.5 FIRE ALARM SYSTEM PERFORMANCE REQUIREMENTS
A. Seismic Performance: Fire-alarm control unit and raceways shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
B. Provide speakers adequate for high ambient noise areas in the craft center.
C. Provide heat detectors in areas with high dust issues and hi-temp detectors around equipment with high operating temperatures.

1.6 SUBMITTALS
A. General Submittal Requirements:
   1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
B. Product Data: For each type of product indicated.
C. Shop Drawings:
   1. Shop Drawings shall be prepared by persons with the following qualifications:
      a. Trained and certified by manufacturer in fire alarm system design.
      b. Fire alarm certified by NICET, minimum Level III.
   2. System Operation Description: Detailed description for this Project, including method of operation and supervision of each type of circuit and sequence of operations for manually and automatically initiated system inputs and outputs. Manufacturer's standard descriptions for generic systems are not acceptable.
   3. Device Address List: Coordinate with final system programming. Device address list shall be the architectural room number of device is in or the door number of the nearest the device if located on a hallway or corridor.
   4. System riser diagram with device addresses, conduit sizes, and cable and wire types and sizes.
   5. Wiring Diagrams: Power, signal, and control wiring. Include diagrams for equipment and for system with all terminals and interconnections identified. Show wiring color code.
   7. Duct Smoke Detectors: Performance parameters and installation details for each detector, verifying that each detector is listed for the complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
   8. Ductwork Coordination Drawings: Plans, sections, and elevations of ducts, drawn to scale and coordinating the installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, the detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.
   9. Floor Plans: Indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.
D. Qualification Data: For Installer.
E. Field quality-control test reports.
F. Submittals to Authorities Having Jurisdiction: In addition to distribution requirements for submittals specified in Division 1 Section "Submittals," make an identical submittal to authorities having jurisdiction. To facilitate review, include copies of annotated Contract Drawings as needed.

NOTICE OF ALTERNATE BILLING CYCLE: The Contract will allow the Owner to require the submission of billings or estimates in billing cycles other than 30-day cycles. Billing or statements shall be submitted monthly ending on the last day of the month.
NOTICE OF EXTENDED CERTIFICATION PROVISION: The Contract will allow the Owner to certify billings and estimate within 20 days after the billings and estimates are received from the original contractor.
NOTICE OF EXTENDED PAYMENT PROVISION: The Contract will allow the Owner to make payment within 30 days after the date a billing or estimate is received.
to depict component locations. Resubmit if required to make clarifications or revisions to obtain approval. On receipt of comments from authorities having jurisdiction, submit them to Architect for review.

G. Documentation:
1. Approval and Acceptance: Provide the "Record of Completion" form according to NFPA 72 to Owner, Architect, and authorities having jurisdiction.
2. Record of Completion Documents: Provide the "Permanent Records" according to NFPA 72 to Owner, and Architect. Format of the written sequence of operation shall be the optional input/output matrix.
   a. Hard copies on paper to Owner, and Architect.
   b. Electronic media may be provided to Architect.

1.7 QUALITY ASSURANCE
A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.
B. Source Limitations for Fire-Alarm System and Components: Obtain fire-alarm system from single source from single manufacturer. Components shall be compatible with, and operate as, an extension of existing system.
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. NFPA Certification: Obtain certification according to NFPA 72.

PART 2 - PRODUCTS
2.1 MANUFACTURERS
A. Manufacturers: Subject to compliance with requirements, provide products to interface with existing system:
   1. Notifier, a Honeywell company.
   2. Siemens (Existing fire alarm system)

2.2 SYSTEMS OPERATIONAL DESCRIPTION
A. Fire-alarm system to operate as it presently operates with minimal changes in the Craft Center.

2.3 FIRE-ALARM SYSTEM INTERFACE UNIT
A. Provide interface unit to connect new Notifier devices in the Craft Center to the existing Siemens fire alarm system.

2.4 SYSTEM SMOKE DETECTORS
A. General Requirements for System Smoke Detectors:
   1. Comply with UL 268; operating at 24-V dc, nominal.
   2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
   3. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
   4. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
   5. Integral Visual-Indicating Light: LED type indicating detector has operated.
6. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.
   a. Rate-of-rise temperature characteristic shall be selectable at fire-alarm control unit for 15 or 20 deg F (8 or 11 deg C) per minute.
   b. Fixed-temperature sensing shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 or 155 deg F (57 or 68 deg C).

B. Photoelectric Smoke Detectors:
   1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
   2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
      a. Primary status.
      b. Device type.
      c. Present average value.
      d. Present sensitivity selected.
      e. Sensor range (normal, dirty, etc.).

C. Ionization Smoke Detector:
   1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
   2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
      a. Primary status.
      b. Device type.
      c. Present average value.
      d. Present sensitivity selected.
      e. Sensor range (normal, dirty, etc.).

D. Duct Smoke Detectors: Photoelectric type complying with UL 268A and NFPA 90A.
   1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
   2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
      a. Primary status.
      b. Device type.
      c. Present average value.
      d. Present sensitivity selected.
      e. Sensor range (normal, dirty, etc.).
   3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector.
   4. Each sensor shall have multiple levels of detection sensitivity.
   5. Duct smoke detectors are to be mounted downstream of the supply fan to the exterior housing of the duct and shall be equipped with air sampling tubes. No in duct type detectors will be accepted.
   6. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied. Provide sampling tubes running the full width of the duct in the center of the air stream.
   7. Provide detectors with a visible indicator that shows when the unit is in an alarm condition. Provide a remote visible indicator for detectors located in concealed locations such as above a ceiling, over six feet from the finished floor, etc.
   8. Auxiliary contacts: Rated to provide control, interlock and shutdown function for HVAC equipment.
E. Heat Detectors

2. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F (57 deg C) or a rate of rise that exceeds 15 deg F (8 deg C) per minute unless otherwise indicated.
   b. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
3. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 190 deg F (88 deg C).
   b. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

2.5 NOTIFICATION APPLIANCES

A. General Requirements for Notification Appliances: Individually addressed, connected to a signaling line circuit, equipped for mounting as indicated and with screw terminals for system connections.
   1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated and with screw terminals for system connections.
B. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet (3 m) from the horn, using the coded signal prescribed in UL 464 test protocol.
C. Visible Notification Appliances: Xenon strobe lights comply with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word “FIRE” is engraved in minimum 1-inch- (25-mm-) high letters on the lens.
   1. Rated Light Output:
      a. 15/30/75/110 cd, selectable in the field.
   2. Mounting: Wall mounted unless otherwise indicated.
   3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
   4. Flashing shall be in a temporal pattern, synchronized with other units.
   5. Strobe Leads: Factory connected to screw terminals.

2.6 ADDRESSABLE INTERFACE DEVICE

A. Description: Microelectronic monitor module, NRTL listed for use in providing a system address for alarm-initiating devices for wired applications with normally open contacts.
B. Integral Relay:

2.7 MECHANICAL EQUIPMENT

A. Refer to specification section 23900 for a list of equipment that require a fire alarm interface connection.
PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Comply with NFPA 72 for installation of fire-alarm equipment.

B. Equipment Mounting: Install fire-alarm control unit with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.

C. Smoke- or Heat-Detector Spacing:
   3. Smooth ceiling spacing shall not exceed the rating of the detector.
   4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Appendix A in NFPA 72.
   5. HVAC: Locate detectors not closer than 3 feet (1 m) from air-supply diffuser or return-air opening.
   6. Lighting Fixtures: Locate detectors not closer than 12 inches (300 mm) from any part of a lighting fixture.

D. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct.

E. Heat Detectors in Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location.

F. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.

G. Audible Alarm-Indicating Devices: Install not less than 6 inches (150 mm) below the ceiling. Install horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.

H. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches (150 mm) below the ceiling.

I. Device Location-Indicating Lights: Locate in public space near the device they monitor.

3.2 CONNECTIONS

A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Division 08 Section "Door Hardware." Connect hardware and devices to fire-alarm system.
   1. Verify that hardware and devices are NRTL listed for use with fire-alarm system in this Section before making connections.

3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

B. Install framed instructions in a location visible from fire-alarm control unit.

3.4 GROUNDING

A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.
FIELD QUALITY CONTROL

A. Field tests shall be witnessed by Architect and authorities having jurisdiction.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Tests and Inspections:
   1. Visual Inspection: Conduct visual inspection prior to testing.
      a. Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" Table in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter.
      b. Comply with "Visual Inspection Frequencies" Table in the "Inspection" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
   3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
   4. Test visible appliances for the public operating mode according to manufacturer's written instructions.

D. Fire-alarm system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

F. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

G. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES
A. Clearing and protection of vegetation.
B. Removal of existing debris.

PART 2 PRODUCTS

2.1 NOT USED.

PART 3 EXECUTION

3.1 SITE CLEARING
A. Comply with other requirements specified in Section 01 70 00.
B. Minimize production of dust due to clearing operations; do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.

3.2 EXISTING UTILITIES AND BUILT ELEMENTS
A. Coordinate work with utility companies; notify before starting work and comply with their requirements; obtain required permits.
B. Tunnels and buried utilities must be located prior to jack-hammering, excavation, etc. If tunnel ceiling damage occurs this must be repaired at Contractor's expense in a manner approved by Owner.
C. Protect existing utilities to remain from damage.
D. Do not disrupt public utilities without permit from authority having jurisdiction.
E. Protect existing structures and other elements that are not to be removed.

3.3 VEGETATION
A. Scope: Remove trees, shrubs, brush, and stumps in areas to be covered by building structure, paving, playing fields, lawns, and planting beds.
B. Do not begin clearing until vegetation to be relocated has been removed.
C. Do not remove or damage vegetation beyond the limits indicated on drawings.
D. Install chainlink fences at least 6 feet high to prevent inadvertent damage to vegetation to remain:
   1. At vegetation removal limits.
   2. Around trees to remain within vegetation removal limits; locate no closer to tree than at the drip line.
   3. Around other vegetation to remain within vegetation removal limits.
   4. See Section 01 56 39 for temporary fence construction requirements.
E. Removed Vegetation: Do not burn, bury, landfill, or leave on site, except as indicated.
   1. Chip, grind, crush, or shred vegetation for mulching, composting, or other purposes; preference should be given to on-site uses.
   2. Trees:
      a. All trees to be removed over 6-inches caliper are to be individually posted for removal at least 2-weeks prior to removal. Postings to include Project Manager information.
      b. Coordinate posting of trees to be removed with Owner's Representative. Trees to be removed within project fencing are to be posted on outside of Construction Fencing. Trees to be removed outside of project fencing are to be individually posted.
SITE CLEARING

c. Coordinate with Owner's Representative for lumber that should be delivered to UO Facilities Services for milling and salvaging.

3. Existing Stumps: Treat as specified for other vegetation removed; remove stumps and roots to depth of 18 inches.
4. Fill holes left by removal of stumps and roots, using suitable fill material, with top surface neat in appearance and smooth enough not to constitute a hazard to pedestrians.

F. Restoration: If vegetation outside removal limits or within specified protective fences is damaged or destroyed due to subsequent construction operations, replace at no cost to Owner.

3.4 DEBRIS

A. Remove debris, junk, and trash from site.
B. Leave site in clean condition, ready for subsequent work.
C. Clean up spillage and wind-blown debris from public and private lands.

END OF SECTION
PART 1 - GENERAL

1.1 CONTRACT CONDITIONS
A. Work of this section is bound by the Contract Conditions and Division 1, bound herewith, in addition to this specification and accompanying drawings.

1.2 SECTION INCLUDES
A. Excavation and fills, including compaction, of on-site building, pavement, and landscaped areas.

1.3 RELATED SECTIONS
A. Section 00 33 00 - Available Project Information (Refer to Geotechnical Report).
B. Section 31 23 33 - Trenching and Backfill

1.4 REFERENCED SPECIFICATIONS
A. ODOT Standard Specifications (latest revision).

1.5 REFERENCED DOCUMENTS
A. Geotechnical Report: Geotechnical Investigation and Site-Specific Seismic Hazard Study, Erb Memorial Union Expansion and Renovation, University of Oregon, August 16, 2013
B. All earthwork operations shall comply with the recommendations and requirements of the Geotechnical Report.

1.6 DEFINITIONS
A. Rock: Material that cannot be removed by one-yard shovel, by backhoe with 9,500 lb. digging force, by pick and shovel, or by 200 HP Crawler fitted with normal excavating equipment. Ripper attachment as might be hooked into seam is not considered "normal" excavating equipment.
B. Unstable Soil: Soft, loose, wet, or disturbed ground that is incapable of supporting material, equipment, personnel, or structure.
C. Wet Weather Conditions: Wet Weather Conditions apply to materials placed during dry weather but which are subsequently subjected to rainfall and equipment or construction traffic. The Contractor shall be responsible for the performance of the selected type of material.

1.7 SUBMITTALS
A. Comply with Section 01 33 00, unless otherwise noted.
B. Product Data: Manufacturer's specifications and technical data including performance, construction, and manufacturing information.
   1. Submit for: Subgrade geotextile and imported material gradation documentation.
C. Field Quality Control: Submittals as specified in Part 3 of this section.
   1. Field Tests.
   2. Special Inspections for Code Compliance.

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NOTICE OF ALTERNATE BILLING CYCLE: The Contract will allow the Owner to require the submission of billings or estimates in billing cycles other than 30-day cycles. Billing or statements shall be submitted monthly ending on the last day of the month.

NOTICE OF EXTENDED CERTIFICATION PROVISION: The Contract will allow the Owner to certify billings and estimate within 20 days after the billings and estimates are received from the original contractor.

NOTICE OF EXTENDED PAYMENT PROVISION: The Contract will allow the Owner to make payment within 30 days after the date a billing or estimate is received.
D. Closeout Requirements: Comply with Section 01 70 00 and Section 01 78 00.
   1. Provide record documents.

1.8 QUALITY REQUIREMENTS

A. Manufacturer’s Qualifications: Not less than 5 years experience in the actual production of specified products.

B. Installers Qualifications: Firm with not less than 5 years experience in installation of systems similar in complexity to those required for this project.

C. Product/Material Qualifications:
   1. Design Data: Compaction testing shall be in accordance with Section 01 40 00, QUALITY REQUIREMENTS.
   2. Test Reports: Provide imported material gradation test reports. Provide material compaction test reports.

D. Regulatory Requirements:
   1. An erosion control permit is required. The Owner shall apply, pay for, and secure the permit. The contractor shall comply with the construction erosion control permit.
   2. Observation and Inspection: Owner will retain a Geotechnical Engineer to monitor earthwork operations.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Delivery, Storage and Protection: Comply with manufacturer’s recommendations.
   1. Protect from damage by the elements and construction procedures.

1.10 ADVANCE NOTICES

A. Notify Architect at least 48 hours before starting work of this section.

B. Coordinate Geotechnical Engineer’s observation of all prepared subgrade and all compaction efforts.

1.11 COORDINATION

A. Coordinate with other trades affecting or affected by work of this section.

PART 2 - PRODUCTS

2.1 STABILIZATION FILL FOR CONSTRUCTION HAUL ROADS OR OTHER HIGH DENSITY CONSTRUCTION TRAFFIC AREAS

A. Imported, clean, fragmented quarry rock, up to 6-inch nominal size material, open-gradation.

2.2 STRUCTURAL FILL (FOR BUILDING PAD, WALKWAYS, AND PAVEMENTS)

A. Imported clean crushed rock or crushed gravel, maximum size of 2 inches, free from foreign material and no more than 5% passing the No. 200 sieve.
2.3  CRUSHED ROCK FILL (FOR BUILDING PAD, WALKWAYS, AND PAVEMENTS)
   A. Imported clean 3/4" - 0 or 1-1/2" - 0 crushed rock or crushed gravel, free from foreign material and conforming to the requirements of ODOT Standard Specification (latest revision) 02630.

2.4  OPEN-GRADED CRUSHED ROCK FILL
   A. Imported, clean 3/4" - 1/4" angular, crushed rock or crushed gravel, free from foreign material with no more than 2 percent passing the No. 200 sieve.

2.5  SUBGRADE STABILIZATION GEOTEXTILE
   A. Subgrade woven geotextile; grab tensile strength 200 lb minimum per ASTM D4632 (latest revision) each direction; burst strength 400 psi per ASTM D3786 Mod. (OSHD TM814) (TF 25. Method 3); puncture strength 75 lb per ASTM D4833 (latest revision) or ASTM D3787 Mod. (OSHD TM 816); No. 40 sieve per ASTM D4751 (latest revision) or smaller opening; 0.05 sec water permittivity per ASTM D4491 (latest revision). Propex Geotex 200ST or approved.

2.6  CONDUIT
   A. Electrical conduit as specified in Division 26, ELECTRICAL.

PART 3 - EXECUTION

3.1  EXISTING CONDITIONS
   A. Prior to starting of the work of this section verify that existing grades and field conditions agree with drawings. Notify Architect of deviations.
   B. Do not start work of this section until all unsatisfactory conditions have been corrected. Commencing work implies acceptance of existing conditions.
   C. If field measurements differ slightly from drawing dimensions, modify work as required for accurate fit. If measurements differ substantially, notify Architect prior to starting work of this section.

3.2  PROTECTION
   A. Monuments: Carefully maintain bench marks, monuments, and other reference points. If disturbed or destroyed, replace as directed.
   B. Existing Utilities: Existing utilities shall be field located. Protect active utility lines encountered. Repair or replace utility lines damaged by work of this Section.
   C. Pavement Cleaning: Maintain pavements and walkways clean at all times.
   D. Dust Control: Protect persons and property against damage and discomfort caused by dust; water as necessary and when directed.
   E. Other Work and Adjacent Property: Protect against damage caused by work of this section.
3.3 GENERAL REQUIREMENTS

A. Contractor shall perform all excavation necessary or required for proper construction of the work and placement or installation of materials.

B. Cutting Pavements: Cut vertical, straight-line joints using power saw designed for cutting pavements.

C. Line and Grade: Excavate to lines and grades shown on the drawings or as established by the Architect.

D. Shoring: Shore excavations when necessary to prevent caving during excavation in unstable material, or to protect adjacent structures, utilities, property, workers, and the public or as required by local, state, or federal agencies. Shoring shall be removed, as the backfilling is done, in a manner that does not damage work or permit voids in the backfill. It shall be the sole responsibility of the Contractor to see that safety requirements are met. Contractor to retain Oregon-licensed professional Architect experienced in the design of temporary shoring systems.

E. Temporary stockpiling of Excavated Materials: Excavated materials may be placed in approved areas. Do not obstruct roadways, bikeways, or pedestrian walkways. Conform to all federal, state and local codes governing the safe loading of excavated materials adjacent to excavations.

F. Excess Excavation: Where excavation, through the Contractor's error, is carried to levels lower than those shown on drawings, backfill with specified bedding material to proper levels at Contractor's expense.

G. Drainage: Except as otherwise permitted, excavation shall be done in a manner as to provide for adequate drainage. In excavation where gravity drainage is not practical, the Contractor shall provide pumps and accessories with which to remove and dispose of all water, including but not limited to, surface water from rainfall entering the excavations, as required to accomplish the work and as required by governing jurisdictions.

H. Backfilling shall not commence until after excavations have been inspected. Backfill shall be placed in such a manner as not to disturb, damage, or subject such facilities to unbalanced loads or forces. Make fills as soon as feasible after Architect's review and acceptance.

I. If rock or unstable soil are encountered, notify Architect. Removal of rock or unstable soil will be paid for as an addition to the contract.

J. Wet Weather Conditions: If construction will extend through wet weather periods, all pavement and building pad cross sections shall be increased to provide a minimum 12”--18” inch crushed rock working pad for light construction traffic and a 18”--24” crushed rock working pad for heavy construction traffic.

3.4 GEOTEXTILE PLACEMENT

A. Acquisition and Storage: Provide complete rolls of geotextile as furnished by the manufacturer, and protect against damage and deterioration. Store all geotextile rolls in a dry place and off the ground at all times according to ASTM D4873 (latest revision). Cover all rolls and partial rolls with a dark protective covering when received. The geotextile will be rejected for use if the Architect determines it has defects, deterioration, or has been damaged.

B. Surface Preparation: Prepare the surface receiving the geotextile to a smooth condition free of obstructions, depressions, and debris unless otherwise directed. Do not drag the geotextile on the ground or mishandle it in any way.
C. Loosely place the geotextile without wrinkles so placement of the overlying material will not tear the geotextile. Lap or sew the geotextile at the ends and sides of adjoining sheets as specified.

D. On Slopes: Place the geotextile with the machine direction oriented up-down the slope. Lap the upper sheets over the top of the lower sheets. When the geotextile is placed on a slope steeper than 6:1, securely anchor the laps to the ground surface with pins or stakes as necessary to prevent slippage and tearing of the geotextile. Start placement of fill material on the geotextile at the toe of the slope and proceed upwards.

E. Overlap: Minimum overlap shall be 24 inches.

F. If the Architect determines the specified overlap is not sufficient, increase the overlap to provide adequate coverage or sew the geotextile together in the field. If field-sewn, the provisions of ODOT 00350.20 and 00350.41(a-3) apply.

G. Protection of Geotextile: Protect the geotextile at all times from ultraviolet (UV) rays, contamination by surface runoff, and construction activities.

H. Traffic or construction equipment will not be permitted directly on the geotextile except as authorized by the Architect. When placed for construction, cover the geotextile with specified cover material as soon as possible.

I. Place cover material on the geotextile in a manner that the geotextile is not torn, punctured, or shifted. Use a minimum 6-inch-thick cover layer or twice the maximum aggregate size, whichever is thicker. End-dumping cover material directly on the geotextile will not be permitted.

J. Limit construction vehicles in size and weight so rutting in the initial layer above the geotextile is not more than three inches deep or one half the layer thickness, whichever is less. Turning of vehicles on the first layer will not be permitted.

K. Repair of Geotextile: Repair or replace all torn, punctured, or contaminated geotextiles during construction at no cost to the Owner. Repair by placing a patch of the specified geotextile over the affected area. Where geotextile seams are required to be sewn, repair any damaged sheet by sewing unless otherwise indicated on the plans or special provisions or as directed.

3.5 STRIPPING, CLEARING AND GRUBBING

A. Strip, clear and grub site in all building areas, walkways, and other areas to receive structural fill.

B. Stripping and clearing shall be the removal of all existing structures, pavements, brush, grass, shrubs, trees, weeds, rubbish, loose soil, and debris flush with or slightly below original ground surface. Remove willow and blackberry, if any, to not less than 12 inches below original ground surface.

C. Grubbing shall be the removal of all stumps and roots larger than 1-1/2 inches in diameter, rocks larger than 6 inches, and existing structures to the following levels:
   1. To not less than 6 inches below grade or as required to remove brush and tree roots.

D. Dispose of all stripped, cleared and grubbed materials off site.

3.6 EXCAVATION AND FILLS AT PAVEMENT AREAS

A. Excavation equipment and procedures must prevent disturbance and softening of subgrade soils. Site excavation and grading should be completed using a track-mounted hydraulic excavator.
EARTH MOVING

Excavation should be finished using a smooth-edged bucket to produce a firm, undisturbed surface.

B. During wet conditions, construction equipment should not traffic fine-grained subgrade (silt) soils. Place 12”-18” depth Stabilization or Structural Fill for a working pad to protect subgrade for lighter construction equipment and limited traffic by dump trucks. Place 18”-24” depth Stabilization Fill for haul roads and other high-density traffic areas with subgrade geotextile.

C. Excavate the existing fill material to the depths of Fill noted in the Geotechnical report and as directed by the Geotechnical Engineer under the direction of the Geotechnical Engineer. Remove all fill material from site. It may be necessary to excavate several test pits in these areas, especially next to the existing structure to document the extent, thickness, and condition of Fill and determine whether additional overexcavation is necessary to remove soft, loose, deleterious materials.

D. Excavate any additional existing material to the grades required on the drawings. Remove any additional excavated material from site.

E. Unstable material shall be overexcavated as directed by the Geotechnical Engineer. Overexcavated material shall be removed from site. Use Structural Fill or Crushed Rock Fill to fill the voids left after overexcavation. Place fill in 12-inch maximum loose lifts and compact to a minimum density of 95 percent relative compaction, per a maximum dry density of ASTM D698 (latest revision) at an optimum moisture content of ±2 percent.

F. Increase excavation depth and crushed rock base thickness as required for wet weather working conditions.

G. Place Structural Fill or Crushed Rock Fill to raise the grade to the bottom of the pavement section elevation. Place fill in 12-inch maximum loose lifts and compact to a minimum density of 95 percent relative compaction, per a maximum dry density of ASTM D698 (latest revision) at an optimum moisture content of ±2 percent.

H. Place Crushed Rock Pavement Base. Place base material in 12-inch maximum loose lifts and compact to a minimum density of 95 percent relative compaction, per a maximum dry density of ASTM D698 (latest revision).

3.7 EXCAVATION AND FILLS AT BUILDING AREAS

A. Excavation equipment and procedures must prevent disturbance and softening of subgrade soils. Site excavation and grading should be completed using a track-mounted hydraulic excavator. Excavation should be finished using a smooth-edged bucket to produce a firm, undisturbed surface.

B. During wet conditions, construction equipment should not traffic fine-grained subgrade (silt) soils. Place 12”-18” depth Stabilization or Structural Fill for a working pad to protect subgrade for lighter construction equipment and limited traffic by dump trucks. Place 18”-24” depth Stabilization Fill for haul roads and other high-density traffic areas with subgrade geotextile.

C. Excavate the existing fill material to the depths of fill noted in the Geotechnical report and directed by the Geotechnical Engineer under the direction of the Geotechnical Engineer. Remove all fill material from site. It may be necessary to excavate several test pits in these areas, especially next to the existing structure to document the extent, thickness, and condition of Fill and determine whether additional overexcavation is necessary to remove soft, loose, deleterious materials.
D. Excavate any additional existing material to the grades required on the drawings. Remove any additional excavated material from site.

E. Unstable material shall be overexcavated as directed Geotechnical Engineer. Overexcavated material shall be removed from site. Use Structural Fill or Crushed Rock Fill to fill the voids left after overexcavation. Place fill in 12-inch maximum loose lifts and compact to a minimum density of 95 percent relative compaction, per a maximum dry density of ASTM D698 (latest revision) at an optimum moisture content of ±2 percent.

F. Increase excavation depth and minimum crushed rock base thickness as required for wet weather working conditions.

G. Building Slab Preparation:
   1. In areas where the finished floor elevation is established near or above existing site grades and exterior finished grades:
      a. Place a minimum depth of 8 inches of Open Graded Crushed Rock Fill beneath the concrete slab-on-grade. Place fill in one lift and compact under Geotechnical Engineer’s observation until approved by the Geotechnical Engineer. It shall be the contractor’s responsibility to maintain and repair the building slab base after initial testing and approval.
   2. In areas where the structure will be embedded below existing site grades and the finished floor elevation is established below existing site grades and exterior finished grades:
      a. Place a minimum depth of 8 inches of Open Graded Crushed Rock Fill beneath the concrete slab-on-grade. Place fill in one lift and compact under Geotechnical Engineer’s observation until approved by the Geotechnical Engineer. It shall be the contractor’s responsibility to maintain and repair the building slab base after initial testing and approval.
      b. Place a minimum depth of 2 inches of 3/4"-0 Crushed Rock Fill over the Open Graded Crushed Rock Fill. Place fill in one lift and compact under Geotechnical Engineer’s observation until approved by the Geotechnical Engineer. It shall be the contractor’s responsibility to maintain and repair the building slab base after initial testing and approval.
   3. Refer to Division 7 for thermal and moisture protection requirements for new slabs on grade and retaining walls.

H. Foundation Preparation:
   1. Shallow building foundations shall be established in firm, undisturbed native soil or compacted Structural or Crushed Rock Fill. During wet-weather construction, shallow building foundations founded in fine-grained soils should be supported on a minimum of 3- to 4-inches of 3/4 - 0 Crushed Rock Fill placed in the bottom of footing excavations as soon as practical. Compact to a minimum density of 95 percent relative compaction, per a maximum dry density of ASTM D698 (latest revision) at an optimum moisture content of ±2 percent.
   2. Embedded walls shall be backfilled with Open Graded Crushed Rock Fill forming a 24-inch drainage blanket from top to bottom against the embedded wall. Fill shall be placed in 9-inch maximum loose lifts and compacted to a minimum density of 93 percent relative compaction, per a maximum dry density of ASTM D698 (latest revision) at an optimum moisture content of ±2 percent. Overcompaction of the backfill shall be avoided. Heavy compactors and large pieces of construction equipment should be kept a minimum distance of 5 feet away from any embedded wall to avoid the buildup of excessive lateral pressures. Compaction close to the walls should be accomplished using hand-operated, vibratory plate compactors.
3.8 GRADING
   A. Perform all earthwork to the lines and grades shown on the drawings. Shape and finish slopes to
      conform to the lines, grades, and cross sections as shown or approved by the Architect. Provide
      positive drainage away from buildings and sidewalks.

3.9 MAINTENANCE OF EARTHWORK
   A. Contractor shall maintain all earthwork surfaces until all work has been completed and accepted.
      Such maintenance shall include, but not be limited to, addition of appropriate backfill material to
      keep backfilled surface smooth, free from ruts and potholes, and suitable for traffic flow.

3.10 DISPOSAL OF WASTE MATERIAL AND EXCESS EXCAVATION
   A. Remove from site excess material that is unsuitable for backfilling or stockpiling at the
      Contractor's expense.

3.11 SETTLEMENT
   A. Any settlement in earthwork which occurs during the warranty period and is attributable to
      construction procedures, such as improper removal of shoring or insufficient compaction, shall be
      corrected by the Contractor at his own expense. Any piping or facilities damaged by such
      settlement shall be restored to their original condition at the Contractor's expense.

3.12 FIELD QUALITY CONTROL
   A. Refer to Section 01 40 00 for responsibilities for arranging, supervising, and payment of field
      quality control requirements.
   B. Field Tests:
      1. Subgrade compaction testing.
      2. Material compaction testing.
      3. Imported material gradation testing.
   C. Field Inspections: Notify Architect prior to work of this section.
   D. Special Inspections for Code Compliance: Obtain building inspector approvals.

3.13 CLEANING
   A. Upon completion of the work of this section promptly remove from the working area all scraps,
      debris, and surplus material.

3.14 PROTECTION
   A. Protect all work installed under this section.
   B. Replace at no additional cost to Owner, any damaged work of this Section.

END OF SECTION
PART 1 - GENERAL

1.1 CONTRACT CONDITIONS
A. Work of this section is bound by the Contract Conditions and Division 1, bound herewith, in addition to this specification and accompanying drawings.

1.2 SECTION INCLUDES
A. Excavation and fills, including compaction, of on-site private storm drain, water distribution, and natural gas distribution systems.

1.3 RELATED SECTIONS
A. Section 31 20 00 – Earth Moving

1.4 REFERENCED SPECIFICATIONS

1.5 DEFINITIONS
A. Rock: Material that cannot be removed by one-yard shovel, by backhoe with 9,500 lb. digging force, by pick and shovel, or by 200 HP Crawler fitted with normal excavating equipment. Ripper attachment as might be hooked into seam is not considered "normal" excavating equipment.
B. Unstable Soil: Soft, loose, wet, or disturbed ground that is incapable of supporting material, equipment, personnel, or structure.

1.6 SUBMITTALS
A. Comply with Section 01 33 00, unless otherwise indicated.
B. Product Data: Manufacturer's specifications and technical data including performance, construction, and manufacturing information.
   1. Imported material gradation reports.
C. Field Quality Control submittals as specified in Part 3 of this Section.
   1. Field Tests
   2. Special Inspections for Code Compliance

1.7 QUALITY REQUIREMENTS
A. Manufacturer's Qualifications: Not less than 5 years experience in the actual production of specified products.
B. Installer's Qualifications: Firm with not less than 5 years experience in installation of systems similar in complexity to those required for this project.
C. Product/Material Qualifications:
   1. Design Data: Compaction testing shall be in accordance with Section 01 40 00, QUALITY REQUIREMENTS.
TRENCHING AND BACKFILL

2. Test reports: Provide imported material gradation test reports. Provide material compaction test reports.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Delivery, Storage and Protection: Comply with manufacturer's recommendations.
   1. Protect from damage by the elements and construction procedures.

1.9 ADVANCE NOTICES

A. Notify Architect at least 48 hours before starting work of this section.
B. Coordinate Geotechnical Engineer's observation of compaction efforts.

1.10 COORDINATION

A. Coordinate with other trades affecting or affected by work of this section.

PART 2 - PRODUCTS

2.1 CRUSHED ROCK

A. Imported, clean, 3/4" - 0 crushed rock or crushed gravel, free from foreign material and meeting the requirements of ODOT Standard Specifications (current edition) 02630.
B. To be used for Pipe Base Material, Pipe Zone Material, and Trench Backfill.

2.2 CONTROLLED DENSITY FILL

A. Controlled Density Fill (CDF) shall be a mixture of cement, fly ash, aggregates, water and admixtures proportioned to provide a non-segregating, self-consolidating, free-flowing and excavatable material which will result in a hardened, dense, non-settling fill.
B. Mix Design: Mix design shall conform to the following. The weights shown are only an estimate of the amount to be used per cubic yard of CDF. The actual amounts may vary from those shown if approved by the Architect. The Contractor shall submit additional data to be approved by the Architect.

Proportions per Cubic Yard

<table>
<thead>
<tr>
<th>Property</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Compressive Strength</td>
<td>100 - 250 p.s.i.</td>
</tr>
<tr>
<td>Maximum Mixing Water</td>
<td>30 - 50 gals.</td>
</tr>
<tr>
<td>Cement</td>
<td>30 - 50 lbs.</td>
</tr>
<tr>
<td>Fly Ash</td>
<td>200 - 350 lbs.</td>
</tr>
<tr>
<td>Dry Aggregate</td>
<td>2700 - 3200 lbs.</td>
</tr>
</tbody>
</table>

C. The Contractor shall submit certified engineering data, for the proposed mixture to be used, for the following:
   1. 30 and 90 day unconfined compressive strength (C') tests as described in ASTM D4832 with the following exception: cylinders will not be capped.
   2. Yield and dry unit weight additional (ASTM D6103)
   3. Flowability (ASTM D6023)
   4. Removability (Removability Modules RE=<1.0)
5. Mixture's components and sources (company and location). Previous test results, on the same mixtures using the same components, will satisfy this requirement.

2.3 TRACER WIRE

A. Electrically conductive tracer wire, 18 - gauge, insulated copper or heavier, green in color, or other approved material. To be placed full length of trench with non-metallic pipe.

PART 3 - EXECUTION

3.1 EXISTING CONDITIONS

A. Prior to starting work of this section, verify that existing grades and field conditions agree with drawings. Notify Architect of deviations.

B. Do not start work of this section until all unsatisfactory conditions have been corrected. Commencing work implies acceptance of existing conditions.

C. If field measurements differ slightly from drawing dimensions, modify work as required for accurate fit. If measurements differ substantially, notify Architect prior to starting work of this section.

3.2 PROTECTION

A. Monuments: Carefully maintain bench marks, monuments, and other reference points. If disturbed or destroyed, replace as directed.

B. Existing Utilities: Existing utilities shall be field located. Protect active utility lines encountered. Repair or replace utility lines damaged by work of this section.

C. Pavement Cleaning: Maintain pavements and walkways clean at all times.

D. Dust Control: Protect persons and property against damage and discomfort caused by dust; water as necessary and when directed.

E. Other Work and Adjacent Property: Protect against damage caused by work of this section.

3.3 GENERAL REQUIREMENTS

A. Contractor shall do all trenching and excavating necessary or required for proper construction of the work and placement or installation of materials. Tunneling or jacking shall not be used unless approved in writing by the Architect.

B. Cutting Pavements: Cut vertical, straight-line joints using power saw designed for cutting pavements. Cut minimum one foot beyond each side of trench.

C. Obstructions: Remove all obstructions encountered within the trench area or adjacent thereto. If requested by Contractor, Architect may make minor changes in trench alignment to avoid major obstructions, provided such alignment changes can be made without adversely affecting the intended function of the facility. Contractor shall pay any additional costs resulting from such alignment changes.
TRENCHING AND BACKFILL

D. Trenching: Minimum trench width to be 12 inches greater than outside diameter of pipe. Maximum trench width at top of trench shall not be limited except where excess width of excavation would cause damage or create damage to adjacent structures or facilities.

E. Line and Grade: Excavate trench to lines and grades shown on the drawings or as established by the Architect with proper allowances for pipe thickness and special bedding when required.

F. Shoring: Shore trench when necessary to prevent caving during excavation in unstable material, or to protect adjacent structures, utilities, property, workers, and the public or as required by local, state, or federal agencies. Shoring shall be removed, as the backfilling is done, in a manner that will not damage pipe or permit voids in the backfill. It shall be the sole responsibility of the Contractor to see that safety requirements are met.

G. Temporary Stockpiling of Excavated Material: Locate at least 2 feet from trench edges. Place excavated material only within approved areas. Do not obstruct roadways, bikeways, or pedestrian walkways. Conform to all federal, state and local codes governing the safe loading of excavated materials adjacent to trenches.

H. Excess Excavation: Where excavation, through Contractor’s error, is carried to levels lower than those shown on drawings, backfill with specified bedding material to proper levels at Contractor’s expense.

I. Drainage: At all times keep trenches dry. Provide and operate pumping equipment necessary to keep excavations free from standing water. Dispose of water in manner to prevent damage to adjacent property and as required by governing jurisdiction.

J. If rock or unstable soil are encountered, notify Architect. Removal of rock or unstable soil will be paid for as an addition to the contract.

3.4 EXCAVATION

A. Excavate trenches to the line and grades shown on the drawings.

3.5 BACKFILL

A. Backfilling shall not commence until after pipe, conduit, structures, and other equipment and appurtenances placed in trench or similar excavations have been properly constructed or installed, as applicable, and inspected. Backfill shall be placed in such a manner as not to disturb, damage, or subject such facilities to unbalanced loads or forces. Make fills as soon as feasible after Architect’s review and acceptance.

B. Pipe Base: Place required thickness of Pipe Base Material over full width of trench. Provide uniform bearing under entire length of each pipe.

C. Pipe Zone: Place required thickness of Pipe Zone Material over full width of trench.

D. Above Pipe Zone: Backfill full width of trench to paving subgrade elevation or to within depth of loam in landscaped areas with Trench Backfill.

E. Compaction: Trench backfill shall be compacted in maximum 24 inch lifts to:
   1. 95 percent compaction under pavement or slab areas per ASTM D698 at an optimum moisture content of ±2 percent.
   2. 90 percent compaction elsewhere per ASTM D698 at an optimum moisture content of ±2 percent.
TRENCHING AND BACKFILL

3. Water settling of trench backfill will not be considered an acceptable compaction procedure.
4. Use caution when placing and compacting backfill over or adjacent to the existing utility tunnel. Compact backfill over or adjacent to the utility tunnel under the observation of the Geotechnical Engineer.

3.6 MAINTENANCE OF TRENCH BACKFILL

A. Contractor shall maintain all backfilled trench surfaces until all work has been completed and accepted. Such maintenance shall include, but not be limited to, addition of appropriate backfill material above the pipe zone to keep backfilled trench surface smooth, free from ruts and potholes, and suitable for traffic flow.

3.7 PLACEMENT OF CONTROLLED DENSITY FILL

A. Use as utility trench backfill where compaction using crushed rock backfill cannot be achieved, and where shown on Drawings.
B. The CDF material shall be protected from freezing. Filling of each pipe segment shall be as continuous as possible.
C. Field testing for flowability (ASTM D6023) each batch of CDF for a uniform 8 inch diameter spread or as approved by Architect to achieve total pipe fill.
D. Contractor shall monitor CDF filling to assure pipes are filled to the crown. Verification of total pipe fill to be submitted to Architect. Verification procedure to be approved by Architect prior to start of filling process.

3.8 DISPOSAL OF WASTE MATERIAL AND EXCESS EXCAVATION

A. Remove from site excess material and that unsuitable for backfilling.

3.9 SETTLEMENT

A. Any settlement in trench backfill which occurs during the warranty period and is attributable to construction procedures, such as improper removal of shoring or insufficient compaction, shall be corrected by the contractor at his own expense. Any piping or facilities damaged by such settlement shall be restored to their original condition at the Contractor's expense.

3.10 FIELD QUALITY CONTROL

A. Refer to Section 01 40 00 for responsibilities for arranging, supervising, and payment of field quality control requirements.
B. Field Tests:
   1. Material compaction testing:
      a. Trench Compaction: A minimum of one field density test shall be conducted on compacted material for every 100 linear feet, or fraction thereof, of trench and for every 3 feet, or fraction thereof, of fill placed.
      2. Imported material gradation testing.
C. Field Inspections: Notify Architect prior to work of this section.
D. Special Inspections for Code Compliance: Obtain building inspector approvals.
3.11 CLEANING

A. Upon completion of the work of this section promptly remove from the working area all scraps, debris, and surplus material.

3.12 PROTECTION

A. Protect all work installed under this section.

B. Replace, at no additional cost to Owner, any damaged work of this section.

END OF SECTION
PART 1 - GENERAL

1.1 CONTRACT CONDITIONS

A. Work of this section is bound by the Contract Conditions and Division 1, bound herewith, in addition to this specification and accompanying drawings.

1.2 SECTION INCLUDES

A. Prevention of erosion due to construction activities.
B. Prevention of sedimentation of waterways, open drainage ways, and storm and sanitary sewers due to construction activities.
C. Restoration of areas eroded due to insufficient preventative measures.
D. Compensation of owner fines levied by authorities having jurisdiction due to non-compliance by contractor.

1.3 RELATED SECTIONS

A. Section 02 32 00 - Available Project Information (Refer to Geotechnical Report)
B. Section 31 20 00 - Earth Moving

1.4 REFERENCED SPECIFICATIONS


1.5 SUBMITTALS

A. Comply with Section 01 33 00, unless otherwise noted.
B. Product Data: No Submittals Required.
C. LEED Documentation: Document compliance with LEED Sustainable Sites Prerequisite 1 - Construction Activity Pollution Prevention. Submit documentation in one of the following two forms
   1. Declaration that periodic inspection occurred throughout the construction process and written documentation demonstrating that erosion control plan was carried out appropriately.
   2. Date stamped photos which show the implemented measures and any corrective action that was taken.
D. Closeout Requirements: Comply with Section 01 70 00 and Section 01 78 00.

1.6 QUALITY REQUIREMENTS

A. All measures indicated in this specification may not be required. Contractor responsible for implementing erosion and sediment controls adequate to comply with permit requirements.
B. Manufacturer's Qualifications: Not less than 5 years experience in the actual production of specified products.
C. Installers Qualifications: Firm with not less than 5 years experience in installation of systems similar in complexity to those required for this project.

D. Regulatory Requirements:
1. Do not begin clearing, grading, or other work involving disturbance of ground surface cover until applicable permits have been obtained.
2. An erosion control permit is required from the City of Eugene. The Owner shall apply, pay for, and secure the permit. The contractor shall comply with the construction erosion control permit.
3. Owner will withhold payment to Contractor equivalent to all fines resulting from non-compliance with applicable regulations.
4. Action Plan: Contractor shall prepare and submit an Action Plan when Erosion and Sediment Control Measures are modified after permit registration is approved. The Action Plan shall identify revisions made to the approved Erosion and Sediment Control Plan, and shall identify corrective actions taken to cease the discharge of sediment into surface waters or stormwater systems. The Action Plan shall be prepared in accordance with the 1200-C Construction Stormwater Permit Registration Guidance document published by Oregon DEQ in June 2006. An Action Plan shall be required under the following circumstances:
   a. Emergency Situations: Emergency change in erosion control measures due to emergency situations, where immediate corrective action is required to cease the discharge of significant amounts of sediment from entering surface waters or nearby properties. In emergency situations, contractor shall take immediate action to correct the stormwater discharge. Contractor shall submit action plan to Architect within 10 calendar days of the discharge identifying the corrective actions taken to cease the discharge.
   b. Non-Emergency Changes Made Once Project is Underway: Submit Action Plan for changes in the project design affecting stormwater discharges, local conditions, project schedule, weather conditions, or other appropriate reasons. Action Plan shall be required for changes to the Erosion and Sediment Control Measures identified in the Drawings, their location, maintenance required, and any other revisions necessary to prevent and control erosion and sediment runoff. Contractor shall submit action plan to Architect DEQ at least 10 calendar days before implementing the revisions.

E. Stormwater Runoff: Control increased stormwater runoff due to disturbance of surface cover due to construction activities for this project.
1. Prevent runoff into storm sewer systems, including open drainage channels, in excess of actual capacity or amount allowed by authorities having jurisdiction, whichever is less.
2. Anticipate runoff volume due to the most extreme short term and 24-hour rainfall events that might occur in 25 years.

F. Erosion On Site: Minimize wind, water, and vehicular erosion of soil on project site due to construction activities for this project.
1. Control movement of sediment and soil from temporary stockpiles of soil.
2. Prevent development of ruts due to equipment and vehicular traffic.
3. If erosion occurs due to non-compliance with these requirements, restore eroded areas at no cost to Owner.

G. Erosion Off Site: Prevent erosion of soil and deposition of sediment on other properties caused by water leaving the project site due to construction activities for this project.
1. Prevent windblown soil from leaving the project site.
2. Prevent tracking of mud onto public roads outside site.
3. Prevent mud and sediment from flowing onto sidewalks and pavements.

NOTICE OF ALTERNATE BILLING CYCLE: The Contract will allow the Owner to require the submission of billings or estimates in billing cycles other than 30-day cycles. Billing or statements shall be submitted monthly ending on the last day of the month.
NOTICE OF EXTENDED CERTIFICATION PROVISION: The Contract will allow the Owner to certify billings and estimate within 20 days after the billings and estimates are received from the original contractor.
NOTICE OF EXTENDED PAYMENT PROVISION: The Contract will allow the Owner to make payment within 30 days after the date a billing or estimate is received.
EROSION AND SEDIMENT CONTROL

4. If erosion occurs due to non-compliance with these requirements, restore eroded areas at no cost to Owner.

H. Sedimentation of Waterways On Site: Prevent sedimentation of waterways on the project site, including rivers, streams, lakes, ponds, open drainage ways and storm sewers.
   1. If sedimentation occurs, install or correct preventive measures immediately at no cost to Owner; remove deposited sediments and relocate on site; comply with requirements of authorities having jurisdiction.

I. Sedimentation of Waterways Off Site: Prevent sedimentation of waterways off the project site, including rivers, streams, lakes, ponds, open drainage ways, storm sewers, and sanitary sewers.
   1. If sedimentation occurs, install or correct preventive measures immediately at no cost to Owner; remove deposited sediments and relocate on site; comply with requirements of authorities having jurisdiction.

J. Open Water: Prevent standing water that could become stagnant.

K. Monitoring and Inspection:
   1. Contractor shall be responsible for monitoring the construction erosion control measures and shall make adjustments to measures, in accordance with the drawings and permit, to accommodate changes in earthwork operations and weather conditions.
   2. Contractor shall be responsible for appointing an Erosion Control Inspector. Inspector shall be a person knowledgeable in the principles and practice of erosion and sediment controls, who possesses the skills to assess conditions at the construction site that could impact stormwater quality, is knowledgeable in the correct installation of the erosion and sediment controls, and is able to assess the effectiveness of any sediment and erosion control measures selected to control the quality of stormwater discharges from the construction activity. Erosion Control Inspector shall submit periodic inspection reports as noted on the Drawings.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Delivery, Storage and Protection: Comply with manufacturer's recommendations.
   1. Protect from damage by the elements and construction procedures.

1.8 ADVANCE NOTICES

A. Notify Architect at least 48 hours before starting work of this section.

1.9 COORDINATION

A. Coordinate with other trades affecting or affected by work of this section.

PART 2 - PRODUCTS

2.1 BARK/MULCH BIO BERM

A. The compost filter berm material consists of compost or a blend of compost and mulch materials according to the specifications as follows.

B. The filter berm material shall meet particle sizing specifications that when used in a filter berm system are tested in conformance with the outlined methods and scope of ASTM D6459 (latest
EROSION AND SEDIMENT CONTROL

The compost portion of the filter berm shall be derived from well-decomposed organic matter source produced by controlled aerobic (biological) decomposition that has been sanitized through the generation of heat and stabilized to the point that it is appropriate for this particular application. Compost material shall be processed through proper thermophilic composting, meeting the U.S. Environmental Protection Agency’s definition for a ‘process to further reduce pathogens’ (PFRP). The compost portion shall meet the chemical, physical and biological properties outlined below.

1. The pH shall be between 5.0 and 8.5 for berms to receive vegetation.
2. Nitrogen Content: 0.5 - 2.0%.
3. Soluble Salts: Maximum 5 mmhos/cm.
4. Compost shall be weed and pesticide free, with manmade materials comprising less than 1%.

2.2 SEDIMENT FENCE

A. Sediment Fence Fabric: Polypropylene geotextile resistant to common soil chemicals, mildew, and insects; non-biodegradable; in longest lengths possible; fabric including seams with the following minimum average roll lengths.

B. Apparent Opening Size: 30 U.S. Std. Sieve, maximum, when tested in accordance with ASTM D4751 (latest revision).

C. Permittivity: 0.05 sec⁻¹, minimum, when tested in accordance with ASTM D4491 (latest revision).

D. Ultraviolet Resistance: Retaining at least 70 percent of tensile strength, when tested in accordance with ASTM D4355 (latest revision) after 500 hours exposure.

E. Grab Tensile Strength-Supported: 100 lb-f, minimum, in cross-machine direction; 120 lb-f, minimum, in machine direction; when tested in accordance with ASTM D4632 (latest revision).

F. Grab Tensile Strength-Unsupported: 90 lb-f, minimum, in cross-machine direction; 100 lb-f, minimum, in machine direction; when tested in accordance with ASTM D4632 (latest revision).

G. Color: Manufacturer’s standard, with embedment and fastener lines preprinted.

H. Manufacturers:
   1. BP Amoco, Amoco Fabrics and Fibers; www.geotextile.com.

2.3 BIO-FILTER BAGS

A. Provide minimum size 18" x 6" x 30" plastic mesh bags with 1/2 inch openings filled with approximately 45 pounds of clean, 100% recycled wood-product waste.

2.4 SAND BAGS

A. Provide 24" x 12" x 6" durable, weather-resistant, tightly woven bags sufficient to prevent leakage of filler material. Fill bags with at least 75 lbs. of firmly packed file pcc aggregate 3/8" - 0 or round 3/8" - 3/16" pea gravel.
2.5 CATCH BASIN INSERT BAG / CURB INLET SEDIMENT DAM

A. Provide prefabricated filter inserts manufactured specifically for collecting sediment in drainage inlets. Include handles and/or fasteners sufficient to keep the insert from falling into the inlet during maintenance and removal of the insert from the inlet. Insert bags shall be included on the Oregon Qualified Products List (QPL) for Type 3 Inlet Protection, or approved. Curb Inlet Sediment Dams shall be included on the Oregon QPL for Type 6 Inlet Protection, or approved.

2.6 COMPOST/ORGANIC SOIL MULCH BLANKET

A. The blanket material consists of compost or a blend of compost and mulch materials according to the specifications as follows.

B. The blanket material shall meet particle sizing specifications that when used in an erosion blanket system are tested in conformance with the outlined methods and scope of ASTM D6459 (latest revision), standard test method for determination of Erosion Controlled Blanket (ECB) Performance in Protecting Hill Slopes from Rainfall Erosion.

C. The compost portion of the blanket material shall be derived from well-decomposed organic matter source produced by controlled aerobic (biological) decomposition that has been sanitized through the generation of heat and stabilized to the point that it is appropriate for this particular application. Compost material shall be processed through proper thermophilic composting, meeting the U.S. Environmental Protection Agency’s definition for a ‘process to further reduce pathogens’ (PFRP). The compost portion shall meet the chemical, physical, and biological properties outlined below:

1. The pH shall be between 5.0 and 5.5 for blankets to receive vegetation.
2. Nitrogen Content: 0.5 - 2%.
3. Soluble Salts: Maximum 5 mmhos/cm.
4. Compost shall be weed and pesticide free, with manmade materials comprising less than 1%.

2.7 STRAW MULCH COVER

A. Straw mulch for non-hydroseeding applications from bentgrass, bluegrass, fescue or ryegrass, singly or in combination. If grass seed straw is not available within a reasonable distance of the project, straw from barley, oat or wheat may be allowed upon approval of the Agency. Provide straw that is not moldy, caked, decayed, or of otherwise low quality. Submit certification from the supplier that the straw is free of noxious weed seeds or plant parts. Acceptable documentation will show either (1) that the straw source is from an “Oregon Certified Seed” field, or (2) the seed lab test results of the seed harvested from the straw meet minimum Oregon Certified Seed quality for weed seed content. Use a straw binder or tackifier.

2.8 EROSION BLANKET

A. Erosion blanket to be Type 2, straw and coconut. Furnish blanket consisting of undyed, untreated, biodegradable, jute, coconut coir, synthetic polypropylene fibers, or approved yarn woven into a plain weave mesh with 5/8- to 1-inch square openings. Ensure material conforms to the following:

<table>
<thead>
<tr>
<th>Material</th>
<th>Specification Minimums</th>
</tr>
</thead>
<tbody>
<tr>
<td>Straw 70%</td>
<td>Straw and Coconut mass to be 0.5 lb/sq ft (0.25” minimum thickness)</td>
</tr>
<tr>
<td>Coconut 30%</td>
<td>Photodegradable netting on bottom side.</td>
</tr>
</tbody>
</table>

SERA Architects, Inc.

Package 1 – PERMIT / CONSTRUCTION

NOTICE OF ALTERNATE BILLING CYCLE: The Contract will allow the Owner to require the submission of billings or estimates in billing cycles other than 30-day cycles. Billing or statements shall be submitted monthly ending on the last day of the month.

NOTICE OF EXTENDED CERTIFICATION PROVISION: The Contract will allow the Owner to certify billings and estimate within 20 days after the billings and estimates are received from the original contractor.

NOTICE OF EXTENDED PAYMENT PROVISION: The Contract will allow the Owner to make payment within 30 days after the date a billing or estimate is received.
2.9 HAY BALES
A. Air dry, rectangular straw bales.
B. Cross Section: 14 by 18 inches, minimum.
C. Bindings: Wire or string, around long dimension.
D. Bale Stakes: Minimum 3 feet long, steel U- or T-section, with minimum mass of 1.33 lb. per linear foot, or wood, 2" x 2" in cross section.

PART 3 - EXECUTION

3.1 EXISTING CONDITIONS
A. Examine site and identify existing features that contribute to erosion resistance; maintain such existing features to greatest extent possible.
B. Do not start work of this section until all unsatisfactory conditions have been corrected. Commencing work implies acceptance of existing conditions.
C. If field measurements differ slightly from drawing dimensions, modify work as required for accurate fit. If measurements differ substantially, notify Architect prior to starting work of this section.

3.2 INSTALLATION OF EROSION AND SEDIMENT CONTROL MEASURES
A. Install as shown on drawings, or as directed by Architect, Erosion and Sediment Control Inspector, or Local Authority Having Jurisdiction. All measures included in this specification or details shown on Drawings may not be necessary. Contractor to utilize measures, as needed, to meet the requirements of erosion control permit(s) and the intent of this specification.

3.3 EROSION CONTROL BLANKET
A. Install per manufacturer’s specifications. Assure blanket overlap and staple frequency meet manufacturer’s application guidelines. Apply seed to cut slope prior to blanket installation.

3.4 PROTECTION
A. Monuments: Carefully maintain bench marks, monuments, and other reference points. If disturbed or destroyed, replace as directed.
B. Existing Utilities: Existing utilities shall be field located. Protect active utility lines encountered. Repair or replace utility lines damaged by work of this Section.
C. Pavement Cleaning: Maintain pavements and walkways clean at all times.

* Moisture content shall not exceed 20%.
** Dimensions are approximate and may vary to meet manufacturer’s standards.

Contech’s 70% straw / 30% coconut meets these requirements.
D. Dust Control: Protect persons and property against damage and discomfort caused by dust; use water as necessary and when directed.

E. Other Work and Adjacent Property: Protect against damage caused by work of this section.

3.5 FIELD QUALITY CONTROL

A. Refer to Section 01 40 00 for responsibilities for arranging, supervising, and payment of field quality control requirements.

B. Special Inspections for Code Compliance:
   1. Obtain building approvals from Local Authority Having Jurisdiction.
   2. Provide periodic inspection reports as noted on the Drawings.

3.6 MAINTENANCE

A. Maintain temporary measures until permanent measures have been established.

B. Repair deficiencies immediately.

3.7 CLEANING

A. Remove temporary measures after permanent measures have been installed, unless permitted to remain by Architect.

B. Clean out temporary sediment control structures that are to remain as permanent measures.

C. Where removal of temporary measures would leave exposed soil, shape surface to an acceptable grade and finish to match adjacent ground surfaces.

3.8 PROTECTION

A. Protect all work installed under this section.

B. Replace at no additional cost to Owner, any damaged work of this Section.

END OF SECTION
PART 1 - GENERAL

1.1 CONTRACT CONDITIONS
A. Work of this Section is bound by the Contract Conditions and Division 1, bound herewith, in addition to this specification and accompanying drawings.

1.2 SECTION INCLUDES
A. On-site private curb, gutter, walks, and pavement improvements.

1.3 RELATED SECTIONS
A. Section 03 30 00 - Cast-In-Place Concrete
B. Section 31 20 00 - Earth Moving

1.4 DESIGN AND ENGINEERING
A. Formwork design and engineering, as well as construction, are the sole responsibility of the Contractor.

1.5 SUBMITTALS
A. Comply with Section 01 33 00, unless otherwise indicated.

B. Quality Control:
   1. Submit joint layout drawings for Architect's and Landscape Architect's review and acceptance.

C. Field Quality Control Submittals:
   1. Before starting work and in accordance with Section 01 33 00, prepare mockups for Architect's review and acceptance of concrete walk surface texture.
      b. Re-prepare, if directed, until accepted.
      c. Accepted mockup represents minimum quality standard. Work of lesser quality will be subject to rejection and replacement.
   2. Accepted mockup, in like new condition, may be used in contract work.

D. Closeout Requirements: Comply with Section 01 70 00 and Section 01 78 00.
   1. Provide record documents.

1.6 WEATHER PRECAUTIONS
A. Provide cold weather and/or hot weather protection as recommended in ACI 306 and ACI 305.

B. Unless adequate protection is provided, concrete shall not be placed during rain, sleet, or snow. Protect concrete from rain water, maintain concrete water ratio and protect concrete surface.

C. All concrete shall be adequately protected after pouring to prevent damage from freezing, by the use of suitable cover. Frozen and damaged concrete must be removed and replaced at the Contractor's expense. Do not place concrete on frozen earth.
CONCRETE CURBS, GUTTER, AND WALKS

1.7 QUALITY ASSURANCE
A. Manufacturer's Qualifications: Not less than 5 years experience in the actual production of specified products.
B. Installers Qualifications: Firm with not less than 5 years experience in installation of systems similar in complexity to those required for this project.
C. Product/Material Qualifications:
   1. Design data: Compaction testing shall be in accordance with Section 01 40 00, QUALITY REQUIREMENTS.
   2. Test reports: Provide job mix test reports.

1.8 DELIVERY, STORAGE, AND HANDLING
A. Delivery, Storage and Protection: Comply with manufacturer's recommendations.
   1. Protect from damage by the elements and construction procedures.

1.9 ADVANCE NOTICES
A. Notify Architect at least 48 hours before intended concrete placement.
B. Place no concrete until formwork and reinforcement have been inspected.

1.10 COORDINATION
A. Coordinate with other trades affecting or affected by work of this section.

PART 2 - PRODUCTS

2.1 CRUSHED ROCK PAVEMENT BASE
A. Imported, clean, 3/4"-0 Crushed Rock Pavement Base as specified in Section 31 20 00, EARTH MOVING.

2.2 CAST-IN-PLACE CONCRETE
A. Concrete shall be ready-mixed conforming to Section 03 30 00, CAST-IN-PLACE CONCRETE, and shall have a minimum compressive strength of 3,000 psi at 28 days.

2.3 FORMS
A. Conform to Section 03 30 00, CAST-IN-PLACE CONCRETE.

2.4 REINFORCEMENT
A. Conform to Section 03 30 00, CAST-IN-PLACE CONCRETE.
B. Provide where shown on drawings.

2.5 CURING COMPOUND
A. Curing compound for all other concrete shall conform to AASHTO M171, White Polyethylene Film for curing concrete or AASHTO M148, Liquid Membrane-Forming Compounds for Curing Concrete.
2.6 JOINT SEALANT
   A. Joint Sealant:
      1. Joint sealant shall be cold applied, low modulus, self leveling silicone meeting the
         requirements of ASTM D5893 Type SL; or
      2. Joint sealant shall be a one-component, self-leveling, polyethylene base material meeting
         the requirements ASTM C920, Type S, Grade P, Class 25.
   B. Joint sealant backer rod shall be closed cell, expanded polyethylene foam material meeting the
      requirements ASTM D5249 Type 1 or 3. The uncompressed diameter of rod shall be as
      recommended by the sealant manufacturer.

2.7 EXPANSION JOINT FILLER
   A. Expansion Joint Filler shall be asphalt-impregnated Cane Fiber per ASTM D1751 (latest revision);
      3/8" thickness unless otherwise indicated. Depth as required to extend through full slab depth
      and to position filler top 1/2 inch below slab top as shown on drawings.

2.8 FORMS
   A. Conform to Section 03 30 00, CAST-IN-PLACE CONCRETE.

2.9 TACTILE WARNINGS
   A. Shall be formed detectable warning surfaces for temporary curb ramps.

PART 3 - EXECUTION

3.1 EXISTING CONDITIONS
   A. Prior to starting work of this section verify that existing grades and field conditions agree with
   B. Do not start work of this section until all unsatisfactory conditions have been corrected.
      Commencing work implies acceptance of existing conditions.
   C. If field measurements differ slightly from drawing dimensions, modify work as required for
      accurate fit. If measurements differ substantially, notify Architect prior to starting work of this
      section.

3.2 EXCAVATION
   A. All excavation shall be in accordance with Section 31 20 00, EARTH MOVING.

3.3 CRUSHED ROCK BASE
   A. After the subgrade is compacted and at the proper grade, spread required thickness of 3/4-inch
      minus crushed rock. Compact by rolling or other approved method. Surface of the compacted
      base shall be at the proper level to receive the concrete. Manholes, catch basins, inlets, and
      other such structures shall be completed, adjusted, cured, and otherwise prepared, as applicable,
      and made clean and ready to have concrete placed in contact with them.
3.4 **FORMWORK**

A. Conform to the requirements of Section 03 30 00, CAST-IN-PLACE CONCRETE. Construct forms to the shape, lines, grades, and dimensions called for on the Drawings. Stake wood or steel forms securely in place, true to line and grade. Brace forms to prevent change of shape of movement in any direction resulting from the weight of the concrete during placement.

B. Allowable Tolerances: Tops of forms shall not depart from grade line more than 1/8-inch when checked with 10-foot straightedge. Alignment of straight sections shall not vary more than 1/8-inch in 10 feet.

3.5 **REINFORCEMENT**

A. Reinforcement shall conform to the requirements of Section 03 30 00, CAST-IN-PLACE CONCRETE. Provision shall be made for placing dowels, tie bars, and other devices called for by the Contract Documents, during placement of the pavement. Reinforcement shall be placed on supporting devices, or "chairs," and maintained in position while the pavement is being placed.

3.6 **FINISHING**

A. After the pavement has been struck off and consolidated, it shall be scraped with a straightedge equipped with a handle to permit operation from the edge of the pavement. Any excess water shall be removed from the surface of the pavement. Irregularities shall be corrected by adding or removing concrete. All disturbed places shall be again straightedged.

B. After the concrete has been given a preliminary finish, the surface of the pavement shall be checked by the contractor with a straightedge device. Each successive check with the straightedge device shall lap the previous check path by at least half the length of the straightedge. Surface deviations exceeding 0.01 foot shall be corrected. Upon completion of the surface floating, but before any required edge tooling or joint tooling, and before initial set of the surface pavement, the pavement shall be given a textured finish perpendicular to match the existing. The textured finish shall be accomplished by a steel tine tool that will mark the finished pavement to a depth of 1/8 inch plus or minus 1/16 of an inch. Match finish of existing pavement where new pavement is adjacent. The surface of the pavement shall not vary from a true surface, when tested with a 12 foot testing straightedge, more than 1/8 inch in 12 feet.

C. Finish shall be a light broom finish for slip resistant surface. Broom pattern to be parallel to slope.

D. Accessible Ramps: Steel trowel finish. Apply tactile warning finish.

3.7 **JOINTS**

A. Construction joints, expansion joints, transverse contraction joints, and all longitudinal contraction joints shall be placed as indicated in the drawings.

B. Contraction Joints:
   1. Longitudinal contraction joints shall consist of planes of weakness created by forming grooves in the surface of the pavement.
   2. Maximum joint spacing shall be 5 feet for sidewalks, and as shown on drawings for other work.

C. Construction Joints: Construction joints shall be placed whenever the placing of concrete is suspended for more than 45 minutes. A butt joint with dowels or a thickened-edge joint shall be used if the joint occurs at the location of a contraction joint.
3.8 SEALING JOINTS

A. Seal joints for pavements as follows: Form sealant reservoir for pavement joints per the details shown on the construction drawings. Clean reservoir, prepare joints, install backer rod and sealant all in strict accordance with the recommendations in the joint sealant manufacturer’s installation or application guide and in accordance with the appendix to ASTM D5893 (latest revision).

B. Joints to be sealed shall be filled with joint-sealing material before the pavement is opened to traffic and as soon after completion of the curing period as is feasible.

C. Each joint shall be thoroughly cleaned of all foreign material, including membrane curing compound, and joint faces shall be clean and surface-dry when seal is applied.

3.9 WALK EDGING

A. Before final finishing is completed and before final concrete set has occurred, finish concrete edges with edging tool shaped with 1/4 inch radius.
   1. Take particular care to maintain surface on both sides of joint in same plane.
   2. Do not use kneeling planks on concrete surface.

3.10 CURING

A. Minimum Curing Period: 3 days.

B. Uniformly apply compound in accordance with manufacturer’s instructions, after final Concrete finishing is complete, and after all free water has disappeared from pavement surface.

C. Apply to concrete edges immediately after formwork removal.

D. Do not use membrane compound method if pavement will be exposed to de-icing chemicals within 30 days following curing period completion.

3.11 FIELD QUALITY CONTROL

A. Refer to Section 01 40 00 for responsibilities for arranging, supervising, and payment of field quality control requirements.

B. Field Tests:
   1. Observance and approval of subgrade and base rock compaction.
   2. Concrete cylinder strength tests.
   3. Slump and air tests.

C. Field Inspections: Notify Architect prior to work of this section.

D. Special Inspections for Code Compliance: Obtain building inspector approvals.

3.12 DEFECTIVE WORK

A. Remove and replace any surfaces which show excessive cracks, pavements that do not drain properly, and other defective concrete.

B. Minimum Surface Evenness: 1/8 inch per 10 ft.
3.13 CLEANING

A. Including work of other trades, clean, repair and touch-up, or replace when directed products which have been soiled, discolored, or damaged by work of this section.

B. Upon completion of the work of this section, promptly remove from the working area all scraps, debris, and surplus material.

3.14 PROTECTING COMPLETED WORK

A. Protect all work installed under this section.

B. Replace, at no additional cost to Owner, any damaged work of this section.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES
   A. Mulch.
   B. Lawn Repair.

1.2 RELATED REQUIREMENTS
   A. Section 01 60 00 - Product Requirements.
   B. Section 32 80 00 - Irrigation.

1.3 DEFINITIONS
   A. Weeds: Any plant life not specified or scheduled. Includes seeds and roots.

1.4 PROTECTION
   A. Protect existing improvements and growth in areas to remain undisturbed until completion of project. Leave in similar condition as found.
   B. Maintain benchmarks, monuments, and other reference points. Replace if disturbed or destroyed.
   C. Contact local utility companies for verification of the location of underground utilities within the project area prior to starting excavation. Protect utilities and maintain in continuous operation or in operational condition during work. Repair damage to known utilities or related facilities in an approved manner at Contractor's expense.

1.5 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Submit manufacturer's printed data for products and a list of suppliers.

1.6 QUALITY ASSURANCE
   A. Valid Oregon Landscape Contractor's license.
   B. Valid Oregon Landscape Business license.
   C. Herbicide applicators must have valid State of Oregon Herbicide Applicator's license.

1.7 DELIVERY, STORAGE, AND HANDLING
   A. Deliver products in original unopened packaging with legible manufacturer's identification.

1.8 ENVIRONMENTAL CONDITIONS
   A. Do not install plant seed when ambient temperatures is below 32 degrees F or above 90 degrees F.
   B. Do not install plant seed when wind velocity exceeds 30 mph.
   C. Do not install plant seed when soil becomes saturated.
   D. Planting Seasons:
      1. Seeding: Permitted between April 15 and October 15 unless otherwise approved.

1.9 REVIEWS
   A. Request the following reviews by the Owner's Representative a minimum of 2 days in advance:
      1. Finish grading
      2. Completion
PART 2 PRODUCTS

2.1 SOIL MATERIALS
   A. Topsoil: On-site soil, natural, fertile, friable, with at least 10% humus; free of rock, clay, subsoil, clods, lumps, plants, roots, sticks, weeds, seeds, and other deleterious material, as approved.
   B. Planting Soil at Lawns: Imported Loamy Sand; free of rock, clay, subsoil, clods, plants, roots, sticks, weeds, seeds, and other deleterious material including any evidence of horsetail.
      1. Approved Products:
         a. ‘Ball Field Loam’ from Eugene Sand and Gravel or approved equal.

2.2 SOIL AMENDMENT MATERIALS
   A. Top Dressing: Turf Start by Rexius Inc, Eugene, Oregon, or approved.

2.3 GRASS SEED
   A. Certified Oregon Blue Tag Free of Weed seed with dealer's statement analysis guarantee.
   B. Current or latest season's crop labeled in conformance with State and US Department of Agriculture laws and regulations:
      1. Purity: 98% by weight
      2. Germination: 90%
   C. Products:
      1. Lawn Seed:
         a. Natural Knit by Ledeboer Seed LLC, 503-678-7333, Aurora, Oregon
      2. Substitutions: See Section 01 60 00 - Product Requirements.

2.4 MULCH MATERIALS
   A. Bark Mulch:
      1. Products: Quarter Coarse Fir Bark from Lane Forest Products, Eugene, Oregon, or approved.

2.5 HERBICIDE
   A. Selective for Broadleaves: Speed Zone, Weed-B-Gone, or approved.

2.6 SOURCE QUALITY CONTROL
   A. Provide testing of imported Soil Material to demonstrate soil texture based on the USDA classification system.

PART 3 EXECUTION

3.1 EXAMINATION
   A. Prior to installation of Work of this Section, carefully inspect the work of others and verify that such work is complete to the point where this installation may properly commence.

3.2 PLACING SOIL MATERIAL
   A. Soil Placement Schedule:
      1. At Lawn Repair Areas: place Soil Material as required to blend grades and establish positive drainage.
   B. Place Soil Material in a relatively dry state to depths specified at locations shown on Drawings:
      1. Remove stones, roots, grass, weeds, debris, and foreign material while spreading.
PLANTING

2. Manually spread around existing trees, paving, and other structures to prevent damage.
3. Establish levels, profiles, slopes, contours, and uniform gradients between given grade points as shown on Drawings.
4. Eliminate uneven or low spots at lawns and plant beds.
5. Fine grade Soil Material within specified tolerances.

3.3 INITIAL WEED CONTROL
A. Inspect lawns for the presence of weeds. If weeds are present apply broad spectrum herbicide.

3.4 SOIL PREPARATION AND FINISH GRADING
A. Remove debris, sticks, roots, clods, stones, and soils contaminated by petroleum products at lawns. Rake smooth, eliminate uneven areas or low spots in Soil Material, and set grades for positive drainage.
B. At lawn repair areas:
   1. Apply herbicide to remove weeds as described in Initial Weed Control.
   2. Place additional Soil Material as necessary to fill in depressions and blend grades with surrounding lawns, plant beds, and paving.
   3. Set finish grades to ensure that finish grade of lawn will be flush with surrounding surfaces.
   4. Establish a friable, fine textured seed bed free of bumps and depressions immediately before seeding.
   5. Firm seed bed with a lawn roller making passes in 2 directions.
C. Notify Owner’s Representative for Finish Grading Review prior to proceeding with Work.

3.5 LAWN INSTALLATION
A. Install lawns using one of the following methods. Terraseeding is required at Lawn Repair in Tree Protection zones.
   1. Hydroseeding:
      a. Mix components are the following rates and apply uniformly and completely:
         1) Seed: 8 lbs per 1000 square feet
         2) Lawn Installation Fertilizer: 15 lbs per 1000 square feet
         3) Sufficient hydromulch to keep areas moist during germination and protect seed from wind erosion.
      b. Ensure all equipment, including hoses, is clean and contains only the specified seed.
   2. Terraseeding:
      a. Apply a 1 inch layer of Top Dressing injected with the following:
         1) Seed: 6 lbs per 1000 square feet or per manufacturer's specifications.
         2) Lawn Installation Fertilizer: 15 lbs per 1000 square feet.
      b. Do not install Top Dressing within mulch circles at trees.
      c. Approved Installer: Rexius Forest Byproducts, Eugene, Oregon, or approved.
   B. Apply water with fine spray immediately after each area is sown.
   C. Provide a temporary barrier at the limits of newly planted lawns.

3.6 MAINTENANCE
A. At lawns during period between installation and Final Completion:
PLANTING

1. Water, weed, mow, reseed, top dress, and fertilize as necessary to establish a healthy, dense, uniform, weed free stand of grass; maintain at 2 inches high. This includes unirrigated lawns, unless otherwise noted on drawings.

2. Conduct first mowing after grass is firmly rooted and secure. Mow grass when it exceeds 2 inches in height, cutting no more than 1/3 of the grass height at a time. Remove all clippings.

3. Maintain surfaces and supply additional Soil Material and Seed where necessary.

4. After first mowing apply Lawn Maintenance Fertilizer at a rate of 8 lbs per 1000 square feet. Thoroughly water after application.

5. Apply Herbicide (selective) to remove weeds.

3.7 CLEANING

A. Remove excess materials from site. Protect drain inlets and underground piping as necessary and clean improvements soiled by Work of this Section.

3.8 COMPLETION REVIEW

A. Notify Owner’s Representative for Completion Review when Work of this Section is complete.

END OF SECTION
PART 1 - GENERAL

1.1 CONTRACT CONDITIONS
   A. Work of this Section is bound by the Contract Conditions and Division 1, bound herewith, in addition to this specification and accompanying drawings.

1.2 SECTION INCLUDES
   A. Private on-site water distribution system improvements for domestic system.

1.3 WORK INCLUDED BUT SPECIFIED IN OTHER SECTIONS
   A. Section 31 23 33 - Trenching and Backfill

1.4 REFERENCED SPECIFICATIONS
   A. ASTM Standards (current edition)
   B. AWWA Standards (current edition)
   C. NFPA Standards (current edition)

1.5 SUBMITTALS
   A. Comply with Section 01 33 00, unless otherwise indicated.
   B. Product Data: Manufacturer’s specifications and technical data including performance, construction, and fabrication information.
      1. Submit for: None required. Pipe materials and fittings.
   C. Field Quality Control submittals as specified in Part 3 of this Section:
      1. Field Tests
      2. Special Inspections for Code Compliance
   D. Closeout Requirements: Comply with Section 01 70 00 and Section 01 78 00.
      1. Provide record documents.

1.6 QUALITY ASSURANCE
   A. Manufacturer’s Qualifications: Not less than 5 years experience in the actual production of specified products.
   B. Installer’s Qualifications: Firm with not less than 5 years experience in installation of systems similar in complexity to those required for this project.

1.7 DELIVERY, STORAGE, AND HANDLING
   A. Packing and Shipping: Deliver products in original, unopened packaging with legible manufacturer’s identification.
   B. Storage and Protection: Comply with manufacturer’s recommendations.
      1. Protect from damage by the elements and construction procedures.
WATER UTILITIES

SECTION 33 10 00

1.8 ADVANCE NOTICES
A. Notify Architect at least 48 hours before starting work of this section.

1.9 COORDINATION
A. Coordinate with other trades affecting or affected by work of this section.

PART 2 - PRODUCTS

2.1 DOMESTIC WATER, PIPE AND FITTINGS (4 INCH AND LARGER) (UNLESS OTHERWISE NOTED)
A. Polyvinyl Chloride Plastic Pipe:
   1. Pipe: PVC, AWWA C900 (4" to 12"), AWWA C905 (14" to 16"), DR 18.
   2. Fittings: Gray or Ductile iron, mechanical joint, conforming to AWWA C110 or AWWA C153, with exterior asphaltic seal coat and cement mortar lining per AWWA C104 or Fusion Bonded Epoxy in accordance with AWWA C116.
   3. Joints:
      a. Unless otherwise specified: Gasket, push-on joints unless otherwise specified, conforming to ASTM D3139.
      b. Mechanical Joints: AWWA C110, with gasket joints per AWWA C111 and corrosion resistant bolts.

B. Restrained Joints: Provide as indicated on the drawings according to the following:
   1. Mechanical Joints: UL and FM approved, ductile iron mechanical joint follower gland with restraining wedges secured to pipe by torque-limiting twist-off nuts, EBBA Iron Sales "Mega Lug" Series 2000 PV or Romac "Romagrip".

2.2 MECHANICAL JOINT RESTRAINT RESTRAINED JOINTS

2.3 CONCRETE
A. Concrete shall be ready-mixed conforming to Section 03 30 00, CAST-IN-PLACE CONCRETE, and shall have a compressive strength of 3,000 psi at 28 days. Maximum size of aggregate shall be 1½ inches.

2.4 OTHER MATERIALS
A. Recommended by Manufacturer and subject to Architect's review and acceptance. Provide all materials required to complete and make water system operational.
PART 3 - EXECUTION

3.1 EXISTING CONDITIONS

A. Prior to installation, carefully inspect trench, excavations and base to verify that all such work is complete to the point where this installation may properly commence.

B. Do not install work of this Section until all unsatisfactory conditions have been corrected. Commencing work implies acceptance of existing conditions.

C. If field measurements differ slightly from drawing dimensions, modify work as required for accurate fit. If measurements differ substantially, notify Architect prior to starting work of this section.

3.2 TRENCHING AND BACKFILL

A. Trenching and backfill shall conform to the requirements of Section 31 23 33, TRENCHING AND BACKFILL.

3.3 PIPE INSTALLATION

A. Installation shall be in accordance with the manufacturer’s recommendations. All pipe ends and interiors shall be thoroughly cleaned of all foreign matter and shall be kept clean during installation. When work is not in progress, all open ends of pipe and fittings shall be securely closed so that no trench water, earth, animal life or other substance may enter.

B. Cutting of pipe to be done in a neat and workmanlike manner by method which will not damage pipe and as recommended by manufacturer.

C. Install piping within 0.02 feet of indicated grade and location.

D. All ductile iron pipe joints and fittings shall be fully covered with asphaltic coating.

3.4 THRUST BLOCKS AND MECHANICAL JOINT RESTRAINT

A. Install mechanical joint restraint at all fittings and pipe joints unless otherwise indicated on drawings.

B. Install straddle block thrust blocks where shown on the drawings.

3.5 VALVES, FITTINGS AND CAPS

A. Shall be set and joined to the pipe as shown on the drawings. All pipe shall be supported to prevent stress on valves. All dead ends shall be closed with plugs or caps that are suitably restrained to prevent blowing off under test pressure.

3.6 CONNECTIONS TO EXISTING WATER MAINS

A. Prepare shut-down plan and submit to Architect for approval.

B. Water mains that are to be cut into for new connections shall be repaired per Oregon DHS Drinking Water Program requirements.
WATER UTILITIES

C. Connections to existing mains shall be not result in shut down of water service to existing facilities for more than 6 hours. Schedule additional crews as needed to complete work within necessary time frame. Conduct work during non-peak hours as directed by Owner.

D. Preparation for Repair:
1. Turn valve down to reduce mainline flow but maintain positive pressure.
2. Excavate below the main creating a sump and dewater.
3. Isolate mainline by shutting other services off providing advance notice to all users as required. Notify Owner 48 hours prior to starting work.

E. Repair process:
1. Treat exterior of exposed pipe with hypochlorite solution (account for control of residual chlorine in discharge water).
2. Disinfect all repair items, piping and appurtenances per AWWA C651 Standard.
3. Conduct the repair with disinfected parts and ensure sump dewatering system is operational.

F. Cut-in process:
1. Initiate the cut in procedure by removing existing pipe and dewatering the remaining pipe.
2. Treat exterior of exposed pipe with hypochlorite solution (account for control of residual chlorine in discharge water).
3. Disinfect all repair items, piping and appurtenances per AWWA C651 Standard. Complete the cut in procedure with disinfected parts.

G. Finalizing connection construction:
1. Repressurize the main by opening mainline valve and check for leaks.
2. Flush the line through a fire hydrant or blowoff.
3. Flush in a direction to best clear the main of any debris/sediment and until air is gone and water flows clear.
4. For water systems that apply and maintain a chlorine residual, check the chlorine residual at a point downstream of the main break. Residual should be consistent (not lower) with surrounding area.
5. Collect a coliform bacteria sample per AWWA C651 Standard to provide a record of repair procedure effectiveness. Mark as a “special sample” and retain in records for 2 years.
6. Restore all valves to their normal operating positions.
7. Open user services and operate the outdoor hose bib to remove air and turbid water. If no outside bib is accessible, coordinate building access with Owner.
8. If the post-construction coliform sample result shows the presence of coliforms, resample per coliform sampling procedures. If second sample results show presence of coliforms, contact Architect to consult on corrective action.

3.7 FIELD QUALITY CONTROL

A. Refer to Section 01 40 00 for responsibilities for arranging, supervising, and payment of field quality control requirements.

B. Field Tests:
1. Hydrostatic tests as described below.
2. Disinfection Tests.

C. Field Inspections: Notify Architect prior to work of this section.

D. Special Inspections for Code Compliance:
WATER UTILITIES

1. Test hydrostatically. All testing, acceptance, and documentation shall comply with Oregon State Plumbing Specialty Code (current edition) and NFPA and AWWA specifications as applicable.

2. Prior to testing partially backfill or provide other means of restraint to prevent any movement during the test.

3. Observance: Plumbing inspector to observe testing. Contractor shall notify plumbing inspector at least 48 hours prior to testing.

4. Obtain plumbing inspector approvals and submit to Architect.

3.8 FLUSHING AND DISINFECTION

A. Flushing:
   1. Contractor shall flush and clean all parts of all completed system. All pipe and structures shall be clean and free of all construction debris, rocks, gravel, mud, sand, silt, and other foreign material, and as directed by the Architect.

B. Disinfection:
   1. Disinfect all domestic water supply piping and appurtenances in accordance with AWWA C651 and Oregon State Health Department requirements.
   2. Provide written certification from a firm specializing in disinfection that the disinfection has been successfully completed.
   3. Dispose of test water in accordance with all governing rules and regulations.

3.9 CLEANING

A. Upon completion of the work of this section promptly remove from the working area all scraps, debris and surplus material.

3.10 PROTECTION

A. Protect all Work installed under this section.

B. Replace, at no additional cost to Owner, any damaged work of this section.

END OF SECTION
PART 1 - GENERAL

1.1 CONTRACT CONDITIONS
A. Work of this Section is bound by the Contract Conditions and Division 1, bound herewith, in addition to this specification and accompanying drawings.

1.2 SECTION INCLUDES
A. On-site private sanitary sewer system improvements.

1.3 WORK INCLUDED BUT SPECIFIED IN OTHER SECTIONS
A. Section 31 23 33 - Trenching and Backfill
B. Section 33 39 13 - Sanitary Utility Sewerage Manholes, Frames, and Covers

1.4 SUBMITTALS
A. Comply with Section 01 33 00, unless otherwise indicated.
B. Product Data: Manufacturer's specifications and technical data including performance, construction, fabrication, and installation information.
   1. Submit for: Pipe, fittings, and cleanout covers.
C. Field Quality Control submittals as specified in Part 3 of this Section:
   1. Field Tests
   2. Special Inspections for Code Compliance
D. Closeout Requirements: Comply with Section 01 70 00 and Section 01 78 00.
   1. Provide record documents.

1.5 QUALITY ASSURANCE
A. Manufacturer's Qualifications: Not less than 5 years experience in the actual production of specified products.
B. Installer's Qualifications: Firm with not less than 5 years experience in installation of systems similar in complexity to those required for this project.

1.6 DELIVERY, STORAGE, AND HANDLING
A. Packing and Shipping: Deliver products in original, unopened packaging with legible manufacturer's identification.
B. Storage and Protection: Comply with manufacturer's recommendations.
   1. Protect from damage by the elements and construction procedures.

1.7 ADVANCE NOTICE
A. Notify Architect at least 48 hours before starting work of this section.
1.8 COORDINATION

A. Coordinate with other trades affecting or affected by work of this section.

PART 2 - PRODUCTS

2.1 SANITARY SEWER PIPE AND FITTINGS (6 INCH AND SMALLER)

A. Pipe: PVC, Type PSM, SDR 35, ASTM D3034.

B. Fittings: PVC, ASTM D3034 and applicable portions of ASTM D1785, ASTM D2729, ASTM D2466, ASTM D2467, and ASTM F789. For 90-degree changes in flow direction, use combination wye and one eighth fittings. Tee fittings and sanitary tee fittings will not be allowed unless specifically approved by Architect.

C. Joints: Bell and spigot with rubber gaskets, conforming to ASTM D3212 and ASTM F477.

2.2 SANITARY SEWER PIPE AND FITTINGS (BUILDING APPROVED MATERIAL, FOR USE UNDER AND WITHIN 2 FEET OF THE BUILDING)

A. Cast Iron Soil Pipe, Service Weight (No-Hub), as specified in Division 22.

2.3 SANITARY SEWER PRESSURE PIPE (FROM PUMP DISCHARGE)

A. Pipe: PVC Schedule 40, ASTM D1784.

B. Fittings: PVC, ASTM D1784 and D2466.

C. Joints: Solvent-cemented, in accordance with ASTM D2564.

2.4 CLEANOUTS

A. Shall be constructed from solid wall pipe and fittings specified above with traffic grade frame and cover. Frame and cover shall be H20 rated cast iron valve box as detailed on drawings with "sewer" marking. Olympic Foundry 910.

2.5 CONCRETE

A. Concrete shall be ready-mixed conforming to Section 03 30 00, CAST-IN-PLACE CONCRETE, and shall have a compressive strength of 3,000 psi at 28 days. Maximum size of aggregate shall be 1-1/2 inches.

2.6 OTHER MATERIALS

A. Recommended by Manufacturer and subject to Architect's review and acceptance. Provide all materials required to complete and make drainage system operational.

PART 3 - EXECUTION

3.1 EXISTING CONDITIONS

A. Prior to starting work of this section, carefully inspect trench, excavations, and pipe bedding to verify that all such work is complete to the point where this installation may properly commence.
SANITARY SEWERAGE UTILITIES

B. Do not install work of this section until unsatisfactory conditions have been corrected. Commencing work implies acceptance of existing conditions.

C. If field measurements differ slightly from drawing dimensions, modify work as required for accurate fit. If measurements differ substantially, notify Architect prior to starting work of this section.

3.2 TRENCHING AND BACKFILL

A. Trenching and backfill shall conform to the requirements of Section 31 23 33, TRENCHING AND BACKFILL.

3.3 PIPE INSTALLATION

A. Installation shall be in accordance with the manufacturer’s recommendation. All pipe ends and interiors shall be thoroughly cleaned of all foreign matter and shall be kept clean during installation. When work is not in progress, all open ends of pipe and fittings shall be securely closed so that no water, earth, animal life, or other substance may enter.

B. Cutting pipe shall be done in a neat and workmanlike manner by method which will not damage pipe and as recommended by manufacturer.

C. Install piping within 0.02 foot of indicated grade and location.

D. Trim pipe ends flush with manhole interior walls.

3.4 CLEANOUTS

A. Construct on compacted 4" minimum depth 3/4" - 0 crushed rock base level, plumb, and square with adjacent surfaces. Set rim flush with adjacent finished surfaces unless otherwise noted.

3.5 FIELD QUALITY CONTROL

A. Refer to Section 01 40 00 for responsibilities for arranging, supervising, and payment of field quality control requirements.

B. Field Tests:
   1. Hydrostatic or air test as described below.

C. Field Inspections: Notify Architect prior to work of this section.

D. Special Inspections for Code Compliance:
   1. Provide hydrostatic test or air test per State of Oregon Plumbing Specialty Code.
   2. Obtain plumbing inspector approvals and submit to Architect.

3.6 CLEANING

A. Prior to final acceptance, Contractor shall flush and clean all elements of the completed system. All pipe and structures shall be clean and free of all construction debris, rocks, gravel, mud, sand, silt, and other foreign material, and as directed by the Architect.

B. Upon completion of work of this section promptly remove from the working area all scraps, debris, and surplus material.
3.7 PROTECTION

A. Protect all work installed under this section.

B. Replace at no additional cost to Owner, any damaged work of this section.

END OF SECTION
PART 1 - GENERAL

1.1 CONTRACT CONDITIONS
A. Work of this Section is bound by the Contract Conditions and Division 1, bound herewith, in addition to this specification and accompanying drawings.

1.2 SECTION INCLUDES
A. Manholes for on-site private sanitary sewer system improvements.

1.3 WORK INCLUDED BUT SPECIFIED IN OTHER SECTIONS
A. Section 31 23 33 - Trenching and Backfill
B. Section 33 30 00 - Sanitary Sewerage Utilities

1.4 SUBMITTALS
A. Comply with Section 01 33 00, unless otherwise indicated.
B. Product Data: Manufacturer's specifications and technical data including performance, construction, and fabrication information.
   1. Submit for manholes, frames, and covers.
C. Field Quality Control submittals as specified in Part 3 of this Section:
   1. Field Tests
   2. Special Inspections for Code Compliance.
D. Closeout Requirements: Comply with Section 01 70 00 and Section 01 78 00.
   1. Provide record documents.

1.5 QUALITY ASSURANCE
A. Manufacturer's Qualifications: Not less than five years of experience in the actual production of specified products.
B. Installer's Qualifications: Firm with not less than five years of experience in installation of systems similar in complexity to those required for this Project.

1.6 DELIVERY, STORAGE, AND HANDLING
A. Packing and Shipping: Deliver products in original, unopened packaging with legible manufacturer's identification.
B. Storage and Protection: Comply with manufacturer's recommendations.
   1. Protect from damage by the elements and construction procedures.

1.7 ADVANCE NOTICES
A. Notify Architect at least 48 hours before starting work of this section.

SERAs Architects, Inc. Package 1 – PERMIT / CONSTRUCTION
1.8 COORDINATION

A. Coordinate with other trades affecting or affected by work of this section.

PART 2 - PRODUCTS

2.1 MANHOLE BASES, RISERS, AND CONES

A. Standard precast manhole sections shall conform to ASTM C478 (latest revision) and consist of circular sections in standard nominal diameters. No more than two lift holes shall be cast into each section. Holes shall be located so as to not damage reinforcing or expose it to corrosion. At the manufacturer’s option, steel loops may be provided for handling in lieu of lift holes. Standard precast cones shall be eccentric unless otherwise specified and shall conform to ASTM C478 (latest revision).

2.2 CONCRETE

A. Concrete shall be ready-mixed conforming to Section 03 30 00, CAST-IN-PLACE CONCRETE, and shall have a compressive strength of 3,000 psi at 28 days. Maximum size of aggregate shall be 1-1/2 inches.

2.3 MORTAR

A. Cement mortar in precast manhole joint shall conform to ASTM C387 (latest revision) and consist of one part portland cement and two parts clean, well graded sand which will pass a 1/8” screen with water as necessary to obtain the consistency such that it will readily adhere to the precast concrete. Mortar shall be used within 30 minutes after it is prepared.

2.4 MANHOLE JOINT SEALANT

A. Preformed plastic gaskets, such as Kent Seal, or approved.

2.5 PLASTIC PIPE SEALANT

A. At PVC pipe penetrations: KOR-N-SEAL Boot or approved.

2.6 MANHOLE FRAMES AND COVERS

A. Manhole frames shall have a 24” clear frame opening. Bearing and wedging surface shall be machined to ensure a tight fit of the cover and to prevent rocking.

B. Covers, grates, and frames shall be cast iron conforming to ASTM A48 (latest revision), Class 30. Covers shall be locking/water-tight.

C. Cover shall be marked “sewer” or other appropriate marking to indicate sanitary sewer system.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Prior to starting work of this section, carefully inspect trench, excavations, and base to verify that all such work is complete to the point where this installation may properly commence.
SANITARY UTILITY SEWERAGE MANHOLES, FRAMES AND COVERS

B. Do not install work of this section until unsatisfactory conditions have been corrected. Commencing work implies acceptance of existing conditions.

C. If field measurements differ slightly from drawing dimensions, modify work as required for accurate fit. If measurements differ substantially, notify Architect prior to starting work of this section.

3.2 EXCAVATION AND BACKFILL

A. Excavation and backfill shall conform to the requirements of Section 31 23 33, TRENCHING AND BACKFILL.

3.3 MANHOLE BASES (WITHOUT SUMP)

A. Manhole bases shall be precast or cast-in-place concrete. Placement of cast-in-place concrete shall conform to Section 03 30 00, CAST-IN-PLACE CONCRETE. If a precast manhole is used, the channels shall be poured and shaped after manhole is in place as indicated on drawings. Base sections shall be constructed to form a watertight structure.

B. Where indicated on drawings, the invert shall be constructed to a section identical with that of the sewer pipe. Where the size of sewer pipe is changed at the manhole, the invert shall be constructed to form a smooth transition without abrupt breaks or unevenness of the invert surfaces. Where a full section of concrete sewer pipe is laid through the manhole, the top shall be broken out to the spring line of the pipe for the full width of the manhole, and the exposed edge of the pipe completely covered with mortar. During construction, the Contractor shall divert existing flows of water or sewage from new concrete or mortar surfaces to prevent damage to the fresh concrete or mortar until the initial set has been achieved.

C. Construct on 4” minimum depth, 3/4”-0 crushed rock base; level and plumb.

3.4 PIPE OPENINGS

A. Openings to receive pipe shall be circular, tapered in toward the inside of the section and held to the minimum size possible to accommodate the pipe to be inserted and to effectively seal the joints.

B. For PVC pipe make manhole connections using KOR-N-SEAL Boot.

C. Trim pipe ends flush with manhole interior wall. Grout between pipe and manhole for a smooth transition.

3.5 JOINT SEALING

A. Pipe gaskets shall be installed in conformance with the manufacturer’s recommendations. All mortar joints shall be clean and wet before setting risers and tops in a full bed of Portland cement mortar. Joints shall be watertight, grouted inside and have a smooth finish. Outside joints shall be grouted before backfilling.

3.6 GRADE RINGS

A. Grade rings shall be laid in mortar with the sides plumb and the top level. The joints shall be sealed with mortar. The extensions shall be watertight.
SANITARY UTILITY SEWERAGE MANHOLES, FRAMES AND COVERS

3.7 MANHOLE FRAMES AND COVERS

A. Frames shall be set in a bed of mortar. Frames shall be set so the rim is flush with adjacent surfaces unless otherwise noted on drawings. Frames and covers shall be installed in such a manner as to prevent infiltration of surface or ground water between the frame and the concrete of the manhole section.

3.8 FIELD QUALITY CONTROL

A. Refer to Section 01 40 00 for responsibilities for arranging, supervising, and payment of field quality control requirements.

B. Field Tests:
   1. Hydrostatic or air test as described below.

C. Field Inspections: Notify Architect prior to backfilling.

D. Special Inspections for Code Compliance:
   1. Obtain plumbing inspector approvals and submit to Architect.

3.9 CLEANING

A. Prior to final acceptance, Contractor shall flush and clean all elements of the completed systems. All manholes shall be clean and free of all construction debris, rocks, gravel, mud, sand, silt, and other foreign material, and as directed by the Architect.

B. Upon completion of work of this section, promptly remove from the working area all scraps, debris, and surplus material.

3.10 PROTECTION

A. Protect all work installed under this section.

B. Replace, at no additional cost to Owner, any damaged work of this section.

END OF SECTION
PART 1 - GENERAL

1.1 CONTRACT CONDITIONS
A. Work of this Section is bound by the Contract Conditions and Division 1, bound herewith, in addition to this specification and accompanying drawings.

1.2 SECTION INCLUDES
A. On-site private storm drain system improvements.

1.3 RELATED SECTIONS
A. Section 31 23 33 - Trenching and Backfill
B. Section 33 49 13 - Storm Drainage Manholes, Frames, and Covers

1.4 SUBMITTALS
A. Comply with Section 01 33 00, unless otherwise indicated.
B. Product Data: Manufacturer’s specifications and technical data including performance, construction, fabrication, and installation information.
   1. Submit for: None required. Pipe and fittings, cleanout covers, and storm drain treatment structure.
C. Field Quality Control submittals as specified in Part 3 of this Section:
   1. Field Tests
   2. Special Inspections for Code Compliance
D. Closeout Requirements: Comply with Section 01 70 00 and Section 01 78 00.
   1. Provide record documents.

1.5 QUALITY ASSURANCE
A. Manufacturer’s Qualifications: Not less than 5 years experience in the actual production of specified products.
B. Installer’s Qualifications: Firm with not less than 5 years experience in installation of systems similar in complexity to those required for this project.

1.6 DELIVERY, STORAGE, AND HANDLING
A. Packing and Shipping: Deliver products in original, unopened packing with legible manufacturer’s identification.
B. Storage and Protection: Comply with manufacturer’s recommendations.
   1. Protect from damage by the elements and construction procedures.

1.7 ADVANCE NOTICES
A. Notify Architect at least 48 hours before starting work of this section.
1.8 COORDINATION

A. Coordinate with other trades affecting or affected by work of this section.

PART 2 - PRODUCTS

2.1 STORM DRAIN PIPE AND FITTINGS (UNLESS OTHERWISE NOTED)


B. Fittings: PVC, ASTM D3034.

C. Joints: Bell and spigot with rubber gaskets, conform to ASTM D3212 and ASTM F477.

2.2 STORM DRAIN PIPE AND FITTINGS (BUILDING APPROVED MATERIAL, FOR USE UNDER AND WITHIN 2 FEET OF BUILDING)

A. Cast Iron Soil Pipe, Service Weight (No-Hub), as specified in Division 22.

2.3 DECK DRAIN

A. Comply with Floor Drain, FD-1 product requirements, as specified in Division 22.

2.4 FLEX-TRANSITION COUPLER

A. Shall be Fernco, 1000 series. Use fittings manufactured for the specific pipe size and material types being connected.

2.5 CLEANOUTS

A. Shall be constructed from solid wall pipe and fittings specified above with traffic grade frame and cover. Frame and cover shall be H20 rated cast iron valve box with flange top as detailed on drawings with "storm" marking. Olympic Foundry VB910.

2.6 STORMWATER TREATMENT STRUCTURE

A. Refer to Section 33 49 13.

2.7 STORM DRAIN DIVERSION MANHOLE

A. Refer to Section 33 49 13.

2.8 SAND / SEDIMENT INTERCEPTOR / SWITCHING STATION (SS-1)

A. Interceptor Structure: Prefabricated steel, each chamber to be 24 inches square, 24” minimum sump depth, 10 gauge minimum, asphalt paint inside and out. 6 inch minimum water seal with hinged lid on trap, outlet size as specified on drawings. Outlet location shall be in accordance with catch basin orientation as shown on plan.

B. Cover: Cast-iron, slip resistant cover, lift hole, H-20 rated, Olympic Foundry Model SM76 GSB.

C. Sump Pump: Sump pump shall be submersible, oil filled motor, built-in auto reset overloads with permanently lubricated ball bearings, thermoplastic impeller and carbon/ceramic mechanical seal.
STORM DRAINAGE UTILITIES

Provide with internal control system. Capacity: 18 gpm, at 22 ft total head, 1/3 HP, 120 volt, 1 phase. Provide 3-wire cord on sump pump, length as required to reach adjacent junction box. Hydromatic W-A1.

D. Sump Pump Power Supply: Refer to Division 26 for power supply and Electrical Drawings for power routing. Power supply to be controlled by manually activated timer switch.

E. Sump Pump Discharge Piping:
1. Piping: Refer to Section 33 30 00 for Pressure Sanitary Sewer piping.
2. Gate Valves: Bronze body, class 125, rated working pressure of 125 psig steam, wheel handle, female threaded connections, non-rising bronze or stainless steel stem, solid bronze wedge, stuffing box to be repackable under pressure, conforming to MSS-SP-80. Crane, Nibco, Powell. Similar to Nibco T113.
3. Check Valves: Bronze body, class 125, rated working pressure of 125 psig steam, female threaded connections, conforming to MSS-SP-80. Crane, Nibco, Powell. Similar to Hammond IB940.
4. Transition Union: PVC (socket) x Female Pipe Thread transition union with metal threaded insert. Harrington, Spears. Harrington 459-020 BR or approved equal. Provide where indicated on drawings to transition from metal pipe to plastic pipe.

2.9 TEMPORARY AREA DRAINS

A. Shall be prefabricated steel, 12 inches square by 24 (minimum) inches deep, 10 gauge minimum, asphalt paint inside and out, 6 inch minimum water seal with hinged lid on trap, outlet size as specified on drawings. Cast iron or steel grate with bicycle bars. Lynch or Gibson

2.10 TEMPORARY CATCH BASINS

A. Shall be prefabricated steel, 24 inches square by 36 (minimum) inches deep, 10 gauge minimum, asphalt paint inside and out, 6 inch minimum water seal with hinged lid on trap, outlet size as specified on drawings. Cast iron or steel grate with bicycle bars. Lynch or Gibson. Gibson catch basin.

2.11 CONCRETE

A. Concrete shall be ready-mixed conforming to Section 03 30 00, CAST-IN-PLACE CONCRETE, and shall have a compressive strength of 3,000 psi at 28 days. Maximum size of aggregate shall be 1½ inches.

2.12 OTHER MATERIALS

A. Recommended by Manufacturer and subject to Architect's review and acceptance. Provide all materials required to complete and make drainage system operational.

PART 3 - EXECUTION

3.1 EXISTING CONDITIONS

A. Prior to starting work of this section, carefully inspect trench, excavations, and pipe bedding to verify that all such work is complete to the point where this installation may properly commence.

B. Do not install work of this section until unsatisfactory conditions have been corrected. Commencing work implies acceptance of existing conditions.

SERA Architects, Inc.

NOTICE OF ALTERNATE BILLING CYCLE: The Contract will allow the Owner to require the submission of billings or estimates in billing cycles other than 30-day cycles. Billing or statements shall be submitted monthly ending on the last day of the month.

NOTICE OF EXTENDED CERTIFICATION PROVISION: The Contract will allow the Owner to certify billings and estimate within 20 days after the billings and estimates are received from the original contractor.

NOTICE OF EXTENDED PAYMENT PROVISION: The Contract will allow the Owner to make payment within 30 days after the date a billing or estimate is received.
STORM DRAINAGE UTILITIES

C. If field measurements differ slightly from drawing dimensions, modify work as required for accurate fit. If measurements differ substantially, notify Architect prior to starting work of this section.

3.2 TRENCHING AND BACKFILL

A. Trenching and backfill shall conform to the requirements of Section 31 23 33, TRENCHING AND BACKFILL.

3.3 PIPE INSTALLATION

A. Installation shall be in accordance with the manufacturer’s recommendation. All pipe ends and interiors shall be thoroughly cleaned of all foreign matter and shall be kept clean during installation. When work is not in progress, all open ends of pipe and fittings shall be securely closed so that no water, earth, animal life, or other substance may enter.

B. Cutting pipe shall be done in a neat and workmanlike manner by method which will not damage pipe and as recommended by manufacturer.

C. Install piping within 0.02 foot of indicated grade and location.

D. Trim pipe ends flush with manhole and catch basin interior walls.

E. All ductile iron pipe joints and fitting joints within 5 feet of building and beneath building shall be fully covered with asphaltic coating. Wrap ductile iron pipe and fittings within 5 feet of building and beneath building with Polywrap.

3.4 CLEANOUTS

A. Construct on compacted 4” minimum depth 3/4” - 0 crushed rock base level, plumb, and square with adjacent surfaces. Set rim flush with adjacent finished surfaces unless otherwise noted.

3.5 SAND / SEDIMENT INTERCEPTER / SWITCHING STATION

A. Construct on compacted 4” minimum depth, 3/4” - 0 crushed rock base level, plumb, and square with adjacent construction. Set rim flush with adjacent finished surfaces unless otherwise noted.

B. Coordinate power conduit and cable routing with Building Electrical Contractor.

C. All electrical system installation and wiring must be performed by a qualified electrician and according to the National Electrical Code.

3.6 AREA DRAINS AND CATCH BASINS

A. Construct on compacted 4” minimum depth, 3/4” - 0 crushed rock base level, plumb, and square with adjacent construction. Set rim flush with adjacent finished surfaces unless otherwise noted.

B. Coordinate installation with concrete work and structure installation to ensure concrete joint lines align with structure as indicated on drawings.

3.7 FIELD QUALITY CONTROL

A. Refer to Section 01 40 00 for responsibilities for arranging, supervising, and payment of field quality control requirements.
STORM DRAINAGE UTILITIES

B. Field Tests:
   1. TV Inspections and Reports:
      a. Provide for proposed storm drains 8" and larger.
      b. Provide for existing storm drains at locations shown in plan.
      c. TV inspections to be completed using high-resolution camera with sufficient lighting to observe interior of pipe. Track-mounted cameras to be used where possible.
      d. Excavation may necessary to expose some pipes to accommodate TV-inspection.
      e. Submit reports in DVD format with hardcopy inspection reports.
   2. Deflection Test:
      a. Conduct on Pipes 8" and larger.
      b. Conduct deflection tests of flexible pipe. The testing shall be conducted by pulling an approved mandrel through the completed pipeline. The diameter of the mandrel shall be 95 percent of the pipe initial inside diameter. Conduct testing on a manhole-to-manhole basis after flushing and cleaning.
      c. The mandrel shall be pulled in front of the camera so the deflection testing is clearly recorded on the video tape unless approved by the Architect.
      d. A water depth gauge shall be provided, located on the TV camera side of the mandrel. The gauge shall be graduated with marks at 0.50" increments clearly visible during TV inspection. The gauge shall be capable of measuring depth of water in 0.50" increments from 0.50" to 2.5". The gauge shall be designed so it will remain plumb regardless of the rotation of the mandrel or camera.
      e. Deflection testing shall be conducted and accepted prior to any paving being done.

C. Field Inspections: Notify Architect prior to work of this section.

D. Special Inspections for Code Compliance: Obtain plumbing inspector approvals.

3.8 CLEANING

A. Prior to final acceptance, Contractor shall flush and clean all elements of the completed system. All pipe and structures shall be clean and free of all construction debris, rocks, gravel, mud, sand, silt, and other foreign material, and as directed by the Architect.

B. Upon completion of work of this section promptly remove from the working area all scraps, debris, and surplus material.

3.9 PROTECTION

A. Protect all work installed under this section.

B. Replace, at no additional cost to Owner, any damaged work of this section.

END OF SECTION
PART 1 - GENERAL

1.1 CONTRACT CONDITIONS
A. Work of this Section is bound by the Contract Conditions and Division 1, bound herewith, in addition to this specification and accompanying drawings.

1.2 SECTION INCLUDES
A. Manholes for on-site private storm drain system improvements.

1.3 RELATED SECTIONS
A. Section 31 23 33 - Trenching and Backfill
B. Section 33 40 00 - Storm Drainage Utilities

1.4 SUBMITTALS
A. Comply with Section 01 33 00, unless otherwise indicated.
B. Product Data: Manufacturer's specifications and technical data including performance, construction and fabrication information.
   1. Submit for manholes, frames, and covers, stormwater treatment structure, storm drain diversion manhole.
C. Field Quality Control submittals as specified in Part 3 of this Section:
   1. Field Tests
   2. Special Inspections for Code Compliance.
D. Closeout Requirements: Comply with Section 01 70 00 and Section 01 78 00.
   1. Provide record documents.

1.5 QUALITY ASSURANCE
A. Manufacturer's Qualifications: Not less than five years of experience in the actual production of specified products.
B. Installer's Qualifications: Firm with not less than five years of experience in installation of systems similar in complexity to those required for this Project.

1.6 DELIVERY, STORAGE, AND HANDLING
A. Packing and Shipping: Deliver products in original, unopened packaging with legible manufacturer's identification.
B. Storage and Protection: Comply with manufacturer's recommendations.
   1. Protect from damage by the elements and construction procedures.

1.7 ADVANCE NOTICES
A. Notify Architect at least 48 hours before starting work of this section.
STORM DRAINAGE MANHOLES, FRAMES AND COVERS

1.8 COORDINATION

A. Coordinate with other trades affecting or affected by work of this section.

PART 2 - PRODUCTS

2.1 MANHOLE BASES, RISERS, AND CONES

A. Standard precast manhole sections shall conform to ASTM C478 (latest revision) and consist of circular sections in standard nominal diameters. No more than two lift holes shall be cast into each section. Holes shall be located so as to not damage reinforcing or expose it to corrosion. At the manufacturer's option, steel loops may be provided for handling in lieu of lift holes. Standard precast cones shall be eccentric unless otherwise specified and shall conform to ASTM C478 (latest revision).

2.2 STORMWATER TREATMENT STRUCTURE


2.3 STORM DRAIN DIVERSION MANHOLE

A. Precast concrete manhole meeting the requirements of this section. Construct cast-in-place weir at the elevations shown on the drawings.

2.4 CONCRETE

A. Concrete shall be ready-mixed conforming to Section 03 30 00, CAST-IN-PLACE CONCRETE, and shall have a compressive strength of 3,000 psi at 28 days. Maximum size of aggregate shall be 1-1/2 inches.

2.5 MORTAR

A. Cement mortar in precast manhole joint shall conform to ASTM C387 (latest revision) and consist of one part portland cement and two parts clean, well graded sand which will pass a 1/8" screen with water as necessary to obtain the consistency such that it will readily adhere to the precast concrete. Mortar shall be used within 30 minutes after it is prepared.

2.6 MANHOLE JOINT SEALANT

A. Preformed plastic gaskets, such as Kent Seal, or approved.

2.7 PLASTIC PIPE SEALANT

A. At PVC pipe penetrations: KOR-N-SEAL Boot or approved.

2.8 MANHOLE FRAMES AND COVERS

A. Manhole frames shall have a 24" clear frame opening. Bearing and wedging surface shall be machined to ensure a tight fit of the cover and to prevent rocking.

B. Covers, grates, and frames shall be cast iron conforming to ASTM A48 (latest revision), Class 30. Covers shall be non-locking.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Prior to starting work of this section, carefully inspect trench, excavations, and base to verify that all such work is complete to the point where this installation may properly commence.

B. Do not install work of this section until unsatisfactory conditions have been corrected. Commencing work implies acceptance of existing conditions.

C. If field measurements differ slightly from drawing dimensions, modify work as required for accurate fit. If measurements differ substantially, notify Architect prior to starting work of this section.

3.2 EXCAVATION AND BACKFILL

A. Excavation and backfill shall conform to the requirements of Section 31 23 33, TRENCHING AND BACKFILL.

3.3 MANHOLE BASES (WITHOUT SUMP)

A. Manhole bases shall be precast or cast-in-place concrete. Placement of cast-in-place concrete shall conform to Section 03 30 00, CAST-IN-PLACE CONCRETE. If a precast manhole is used, the channels shall be poured and shaped after manhole is in place as indicated on drawings. Base sections shall be constructed to form a watertight structure.

B. Where indicated on drawings, the invert shall be constructed to a section identical with that of the sewer pipe. Where the size of sewer pipe is changed at the manhole, the invert shall be constructed to form a smooth transition without abrupt breaks or unevenness of the invert surfaces. Where a full section of concrete sewer pipe is laid through the manhole, the top shall be broken out to the spring line of the pipe for the full width of the manhole, and the exposed edge of the pipe completely covered with mortar. During construction, the Contractor shall divert existing flows of water or sewage from new concrete or mortar surfaces to prevent damage to the fresh concrete or mortar until the initial set has been achieved.

C. Construct on 4" minimum depth, 3/4"-0 crushed rock base; level and plumb.

3.4 MANHOLE BASES (WITH SUMP)

A. Manhole bases shall be precast. Base sections shall be constructed to form a watertight structure.

B. Construct on 4" minimum depth, 3/4"-0 crushed rock base; level and plumb.

3.5 PIPE OPENINGS

A. Openings to receive pipe shall be circular, tapered in toward the inside of the section and held to the minimum size possible to accommodate the pipe to be inserted and to effectively seal the joints.

B. For PVC pipe make manhole connections using KOR-N-SEAL Boot.

SERA Architects, Inc.

NOTICE OF ALTERNATE BILLING CYCLE: The Contract will allow the Owner to require the submission of billings or estimates in billing cycles other than 30-day cycles. Billing or statements shall be submitted monthly ending on the last day of the month.

NOTICE OF EXTENDED CERTIFICATION PROVISION: The Contract will allow the Owner to certify billings and estimates within 20 days after the billings and estimates are received from the original contractor.

NOTICE OF EXTENDED PAYMENT PROVISION: The Contract will allow the Owner to make payment within 30 days after the date a billing or estimate is received.
3.6 **JOINT SEALING**

A. Pipe gaskets shall be installed in conformance with the manufacturer’s recommendations. All mortar joints shall be clean and wet before setting risers and tops in a full bed of Portland cement mortar. Joints shall be watertight, grouted inside and have a smooth finish. Outside joints shall be grouted before backfilling.

3.7 **GRADE RINGS**

A. Grade rings shall be laid in mortar with the sides plumb and the top level. The joints shall be sealed with mortar. The extensions shall be watertight.

3.8 **MANHOLE FRAMES AND COVERS**

A. Frames shall be set in a bed of mortar. Frames shall be set so the rim is flush with adjacent surfaces unless otherwise noted on drawings. Frames and covers shall be installed in such a manner as to prevent infiltration of surface or ground water between the frame and the concrete of the manhole section.

3.9 **FIELD QUALITY CONTROL**

A. Refer to Section 01 40 00 for responsibilities for arranging, supervising, and payment of field quality control requirements.

B. Field Inspections: Notify Architect prior to backfilling.

C. Special Inspections for Code Compliance:
   1. Obtain plumbing inspector approvals and submit to Architect.

3.10 **CLEANING**

A. Prior to final acceptance, Contractor shall flush and clean all elements of the completed systems. All manholes shall be clean and free of all construction debris, rocks, gravel, mud, sand, silt, and other foreign material, and as directed by the Architect.

B. Upon completion of work of this section, promptly remove from the working area all scraps, debris, and surplus material.

3.11 **PROTECTION**

A. Protect all work installed under this section.

B. Replace, at no additional cost to Owner, any damaged work of this section.

**END OF SECTION**
PART 1 - GENERAL

1.1 CONTRACT CONDITIONS
   A. Work of this Section is bound by the Contract Conditions and Division 1, bound herewith, in addition to this specification and accompanying drawings.

1.2 SECTION INCLUDES
   A. Private on-site natural gas distribution system improvements.

1.3 WORK INCLUDED BUT SPECIFIED IN OTHER SECTIONS
   A. Section 31 23 33 - Trenching and Backfill.

1.4 SUBMITTALS
   A. Comply with Section 01 33 00, unless otherwise indicated.
   B. Closeout Requirements: Comply with Section 01 70 00 and Section 01 78 00.
      1. Provide record documents.

1.5 QUALITY ASSURANCE
   A. Manufacturer's Qualifications: Not less than 5 years experience in the actual production of specified products.
   B. Installers Qualifications: Firm with not less than 5 years experience in installation of systems similar in complexity to those required for this project.

1.6 ADVANCE NOTICES
   A. Notify Architect at least 48 hours before starting work of this section.

1.7 COORDINATION
   A. Coordinate with other trades affecting or affected by work of this section.
   B. Coordinate work with NW Natural Gas.

PART 2 - PRODUCTS

2.1 GAS DISTRIBUTION PIPE AND FITTINGS
   A. Provided by NW Natural.

2.2 OTHER MATERIALS
   A. Recommended by manufacturer and subject to Architect's review and acceptance. Provide all materials required to complete and make natural gas system operational.
PART 3 - EXECUTION

3.1 EXISTING CONDITIONS

A. Prior to starting of the work of this section carefully inspect trench, excavations, and pipe bedding to verify that all such work is complete to the point where this installation may properly commence.

B. Do not start work of this section until all unsatisfactory conditions have been corrected. Commencing work implies acceptance of existing conditions.

C. If field measurements differ slightly from drawing dimensions, modify work as required for accurate fit. If measurements differ substantially, notify Architect prior to starting work of this section.

3.2 TRENCHING AND BACKFILL

A. Trenching and backfill shall conform to the requirements of Section 31 23 33, TRENCHING AND BACKFILL.

3.3 PIPE INSTALLATION

A. By Northwest Natural. Contractor shall coordinate with Northwest Natural’s commercial marketing personnel then contact Northwest Natural three (3) business days prior to the trench being opened. Northwest Natural will then have the service line installed within four (4) business days of the trench being opened.

3.4 FIELD QUALITY CONTROL

A. Refer to Section 01 40 00 for responsibilities for arranging, supervising, and payment of field quality control requirements.

B. Field Inspections: Notify Architect prior to work of this Section.

C. Special Inspections for Code Compliance:
   1. NW Natural to provide testing. Refer to Division 22 for additional testing requirements.
   2. Notify Architect 48 hours prior to testing and inspection procedures.
   3. Obtain plumbing inspector approvals.

3.5 CLEANING

A. Prior to final acceptance, contractor shall flush and clean all elements of the completed system. All pipe structures shall be clean and free of all construction debris, rocks, gravel, mud, sand, silt, and other foreign material, and as directed by the general contractor.

B. Upon completion of work of this section promptly remove from the working area all scraps, debris and surplus material.

3.6 PROTECTION

A. Protect all work installed under this section.

B. Replace, at no additional cost to Owner, any damaged work of this section.

END OF SECTION