

Clark Co. Courthouse Courtroom Renovation Branch 2 – Phase 1

517 Court Street, Neillsville, WI 54456

APEX PROJECT NUMBER: 25001

DECEMBER 18, 2025



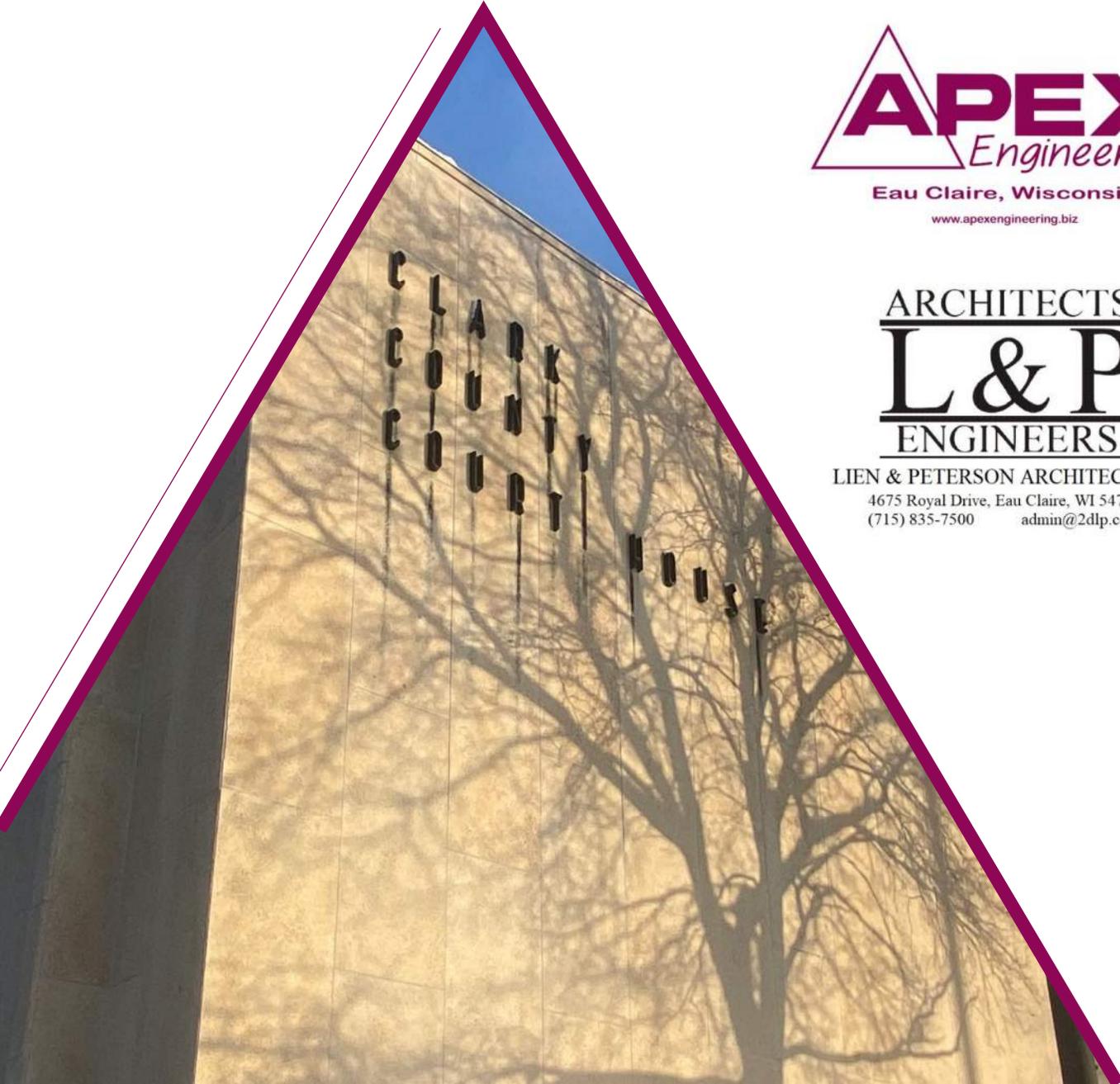
Eau Claire, Wisconsin

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1 **DOCUMENT 00 11 16**
2 **INVITATION TO BID**

3
4 **PROJECT INFORMATION**

5 Notice to Bidders: Bidders are invited to submit bids for Project as described in this Document.

6
7 Project Identification: **Courtroom Renovation for Clark County Courthouse, Branch 2 – Phase 1**
8 Project Location: **517 Court Street, Neillsville, WI 54456**
9 Owner Representative: **Daniel Giles**
10 Designer Project Number: **25001**
11 Design Firm: **Apex Engineering.**
12 Mechanical Designer: **Landon Julson**
13 Electrical Designer: **Carl Klinkenberg**
14 Plumbing Designer: **Heath Mathews**
15 Architectural Designer: **Amanda Watkins**

16
17 Construction Contract: Bids will be received for a Single-Prime Contract.

18
19 **Project Description:**

20 The project consists of renovating Courtroom Branch 2 and its associated Jury room. The Courtroom
21 renovation includes updating the space to be more accessible and replacing the ceiling, lights, flooring,
22 and updating the electrical and mechanical system. The Judges bench, jury box, and other half wall in
23 the room will be rebuilt. A new rap will be constructed to allow the Judge access to the bench. The
24 Jury room will receive new flooring, ceiling, and paint, along with a new kitchenet complete with base
25 cabinets, sink, and refrigerator.

26 The Courthouse is a secure building, coordination with the security personal will be required.

27
28 **PREBID MEETING**

29 A mandatory pre-bid walk through will be conducted on **Thursday, January 8, starting at 9:00 AM.** All
30 participants shall meet at the project site at door B103 on the North side of the building along 6th Street.

31 All questions and clarifications must be emailed to Apex Engineering, landonj@apexengineering.biz by
32 Monday, January 12, 2026. An addendum will be issued January 15th.

33
34
35 **BID SUBMITTAL AND OPENING**

36 Owner will receive sealed lump sum bids until the bid time and date indicated below:

37
38 **Bid Date:** Thursday, January 22, 2026.

39 **Bid Opening:** 2:00 p.m., local time, all bids must be submitted before 2:00 p.m.

40 **Location:** Clark County Courthouse, 517 Court Street, Neillsville, WI 54456

41 Bids will be thereafter **publicly** opened.

42
43 Bids can be mailed or hand delivered to: 517 Court Street, Neillsville, WI 54456

44 Bids can also be emailed to: daniel.giles@co.clark.wi.us

45
46 **BID SECURITY**

47 Bid security shall be submitted with each bid in the amount of 5 percent of the bid amount. No bids may be
48 withdrawn for a period of 60 days after opening of bids. Owner reserves the right to reject any and all bids
49 and to waive informalities and irregularities.

50
51 **DOCUMENTS**

52 Bid Documents can be obtained after December 18, 2025 through any of the following site(s): [La Crosse](#)
53 [Builders Exchange](#), [Northwest Regional Builders Exchange](#), and [Lien and Peterson Architects](#)

1 **TIME OF COMPLETION**

2 Bidders shall begin the Work on receipt of the Notice to Proceed. All work must be completed before
3 December 31, 2026.

4
5 **BIDDER'S QUALIFICATIONS**

6 Bidders must be properly licensed under the laws governing their respective trades and be able to obtain
7 insurance and bonds required for the Work.

8
9 **INTERPRETATION**

10 No verbal explanation or instructions will be given in regard to the meaning of the drawings or
11 specifications during the bid period. Bidders shall bring inadequacies, omissions, or conflicts to the
12 Architect/Engineer's attention at least ten (10) business days before the date set for bid opening. Prompt
13 clarification will be supplied to all bidders of record by addendum.

14
15 Failure to so request clarification or interpretation of the drawings and specifications will not relieve the
16 successful Bidder of responsibility. Signing of the contract will be considered as implicitly denoting that
17 the Contractor has thorough understanding of the scope of work and comprehension of the contract
18 documents.

19
20

END OF SECTION

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SECTION 00 21 00
INSTRUCTIONS TO BIDDERS

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DEFINITIONS

Bidding Documents include the Bidding Requirements and the Proposed Contract Documents. The Bidding Requirements consist of the invitation to bid, Instructions to Bidders, the bid form, and any other bidding forms. The Proposed Contract Documents consist of the unexecuted form of Agreement between the Owner and Contractor and that Agreement's Exhibits, Conditions of the Contract (General, Supplementary and other Conditions), Drawings, Specifications, and all Addenda.

11
12
13
14

Addenda are written or graphic instruments issued prior to Bid Deadline which modify or interpret the bidding documents, including Drawings and Specifications, by addition, deletion, clarification and/or correction. Addenda become part of the Contract Documents.

15
16
17

A Bidder is a person or entity who submits a Bid and who meets the requirements set forth in the Bidding Documents.

18
19
20

A Sub-bidder is a person or entity who submits a bid to a Bidder for materials, equipment, or labor for a portion of the Work.

21
22

The terms, Architect and A/E shall mean Lien & Peterson Architects, Inc.

23

BIDDERS REPRESENTATION

24
25
26
27

Each bidder by making his bid represents that he has read and understands the bidding documents and that he has visited the site and familiarized himself with the local conditions under which the Work is to be performed.

28

BIDDING PROCEDURES

29
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35

All bids must be prepared on the form provided in this Project Manual and submitted in accordance with the Instructions to Bidders. **REMOVE FORM FROM PROJECT MANUAL.** Do not submit entire project manual. Submit only one Bid Form. Bid shall be completed in accordance with the requirements stated in this section. Place bid in an opaque envelope and seal. No other information shall be included with the Bid Form except any required bond or information requested herein or by Addendum. Mark the exterior of the envelope as follows:

36

CONTRACTORS PROPOSAL

37

(Give Project Name)

38

(State Portion of the Work Bid Upon)

39
40

(Contractor's Name and Address)

41
42
43

No bidder shall modify, withdraw, or cancel his bid or any part thereof for thirty (30) days after the Bid Deadline.

44
45
46

A bid is invalid if it has not been deposited at the designated location prior to the Bid Deadline. Such a bid will not be opened and will be returned to the bidder.

47
48

Bids will be received for contracts as provided in the Bid/Proposal form.

49

ADDENDA

50
51
52
53

Addenda will be made available through the same online platform as the Bid Documents.

1 **EXAMINATION OF BIDDING DOCUMENTS**

2 Each bidder shall examine the bidding documents carefully and, not later than seven (7) days prior to the
3 date for receipt of bids, shall make requests to the A/E for interpretation or correction of any ambiguity,
4 inconsistency or error therein. Any interpretation or correction will be issued as an Addendum. Only a
5 written interpretation or correction by Addendum shall be binding. No bidder shall rely upon any
6 interpretation or correction given by any other method.
7

8 **BID GUARANTEE**

9 Provide a certified check, a cashier's check, or a bid bond, payable to the owner in an amount not less than
10 five percent (5%) of the maximum bid with each bid as a guarantee. If the bid is accepted, the bidder will
11 execute and deliver the proposed contract and bonds within ten (10) days after being notified in writing to
12 do so.
13

14 If the successful bidder executes and delivers the contract and bond, the bid guarantee will be returned to
15 him. If the bidder fails to furnish such contract and bond, the bid guarantee shall be forfeited to the owner
16 as liquidated damages.
17

18 The company issuing the bid bond shall be licensed to do business in the State of Wisconsin. Bid Bond
19 may be submitted on AIA document A310, Bid Bond, latest edition or a form acceptable to the Owner.
20

21 **INSURANCE REQUIREMENTS**

22 The Contractor shall purchase and maintain property insurance upon the entire Work at the site to the full
23 insurable value thereof. This insurance shall include the interests of the Owner, the Contractor,
24 Subcontractors and Sub-subcontractors in the Work and shall insure against the perils of fire and extended
25 coverage and shall include "all risk" insurance for physical loss or damage including, without duplication
26 coverage, theft, vandalism and malicious mischief.
27

28 **SUBSTITUTIONS**

29 Each bidder represents that his bid is based upon the materials and equipment described in the bidding
30 documents.
31

32 No substitution will be considered unless written request has been submitted to the A/E for approval at least
33 ten (10) days prior to the date for receipt of bids. Each such request shall include a complete description of
34 the proposed substituted, drawings, cuts, performance and test data and any other data or information
35 necessary for a complete evaluation. Approval of substitutions will be set forth by Addendum.
36

37 Approval by the A/E of a manufacturer for specified items shall not be deemed as approval of all products
38 or models that the manufacturer can furnish but only the single product which most closely duplicates the
39 item originally specified.
40

41 The responsibility for all revisions to the work required by substitutions shall be borne solely by the
42 Contractor who utilizes the substitution, including the following:
43

- 44 Additional work by other Contractors.
- 45 Changes to the building structure or room sizes.
- 46 Additional associated devices, connections, wiring, etc.
- 47 Properly notifying other contractors as to the effect of such substitutions on their contract.
48

49 **PRODUCT OR MATERIAL AVAILABILITY**

50 Prior to the receipt of bids, verify that all specified items, products, materials, etc., will be available for
51 timely inclusion in the work. Should any item not be available, notify the A/E. Extra costs resulting from
52 delays caused by failure to determine availability of specified items shall be borne by the Contractor.
53
54

1 **QUALIFICATION OF BIDDERS**

2 Before the award of any contract, the owner shall be satisfied that the bidder, (1) maintains a permanent
3 place of business, (2) has adequate equipment to do the work properly, (3) has a suitable financial status to
4 meet obligations incident to the work, (4) has appropriate technical experience, and (5) has satisfactorily
5 completed contracts of similar nature and magnitude.

6
7 **AWARD OR REJECTION OF BIDS**

8 Review the Bid Form for procedures to be followed should the bid be accepted by the Owner. Notice that
9 prompt delivery of the required documents is required. The bidder acknowledges the right of the Owner to
10 reject any or all bids and to waive any informality or irregularity in any bid received. In addition, the
11 bidder recognizes the right of the Owner to reject a bid if the bidder failed to furnish any required bid
12 security, or to submit the data required by the bidding documents, or if the bid is in any way incomplete or
13 irregular.

14
15 **SUBMISSION OF POST-BID INFORMATION**

16 Upon request by the Owner or A/E, the selected bidder shall within seven (7) days thereafter submit the
17 following:

18
19 A statement of costs for each major item of Work included in the bid.

20 A designation of the Work to be performed by the bidder with his own forces.

21 A list of names of the Subcontractors or other persons or organizations (including those who are to
22 furnish materials or equipment fabricated to a special design) proposed for the principal portions
23 of the Work.

24
25 **PERFORMANCE BOND AND PAYMENT BOND**

26 The Bidder who is awarded the work shall furnish and pay for bonds covering the faithful performance of
27 the Contract and the payment of all obligations arising thereunder in such form as the Owner may prescribe
28 and with such sureties secured through the bidder's usual sources as may be agreeable to the parties. The
29 amount of each bond shall be 100% of the Contract Amount. Bonds shall be dated not later than the date of
30 execution of the Contract. The attorney-in-fact who executes the required bonds on behalf of the surety
31 shall affix thereto a certified and current copy of his power-of-attorney indicating the limit of such power.

32
33 Bond form shall be AIA Document WIS. A311, latest edition, "Private Improvement Performance Bond"
34 and "Private Improvement Labor and Material Payment Bond" or a form acceptable to the Owner.

35
36 **ALTERNATE BIDS**

37 If alternate bids are requested, bidder shall state the amount to be added to or deducted from the base bid
38 for making the changes required under each alternate. The stated sum shall include all
39 incidental work and adjustments as may be necessary or required to fully complete the alternate work.
40 Refer to Section 01 23 00 Alternates. Space is provided on the bid form for alternates. If there is no price
41 change, the bidder shall state "NO CHANGE".

42
43 **UNIT PRICES**

44 Unit prices requested on the Bid Form shall be given and, if included in the Contract, will be used for
45 additions to or deductions from amount of work required under the Contract. Unit prices shall include all
46 costs of materials, labor, insurance, taxes, overhead and profit. The Owner reserves the right to reject any
47 unit prices as given in the bid if they are considered excessive or unreasonable, or to accept any or all of the
48 unit prices that may be considered fair and reasonable.

49
50 **RETAINAGE**

51 Retainage will be accumulated at 5% of the amount due until 85% completion. Upon substantial
52 completion, payments shall be increased to 98% of the amount due, less allowance for incomplete and
53 unsatisfactory work.

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TAX EXCEPTION

The materials for this project will be tax-exempt.

END OF SECTION

1
2 **SECTION 00 41 13**
3 **BID FORM - STIPULATED SUM (SINGLE-PRIME CONTRACT)**

4 **BID INFORMATION**

5
6
7 Bidder: _____.
8 Project Identification: **Courtroom Renovation for Clark County Courthouse, Branch 2 – Phase 1**
9 Project Location: **517 Court Street, Neillsville, WI 54456**
10 Owner Representative: **Daniel Giles**
11 Designer: **Apex Engineering, 110 E Grand Avenue, Eau Claire, WI 54701**
12 Designer Project Number: **25001**
13

14 **CERTIFICATIONS AND BASE BID**

15 Base Bid, Single-Prime (All Trades) Contract: The undersigned Bidder, having carefully examined the
16 Procurement and Contracting Requirements, Conditions of the Contract, Drawings, Specifications, and all
17 subsequent Addenda, as prepared by Apex Engineering and consultants, having visited the site, and being
18 familiar with all conditions and requirements of the Work, hereby agrees to furnish all material, labor,
19 equipment and services, including all scheduled allowances, necessary to complete the construction of the
20 above-named project, according to the requirements of the Procurement and Contracting Documents, for
21 the stipulated sum of:

22
23
24 _____ Dollars (\$ _____).

25
26 **BID GUARANTEE**

27 The undersigned Bidder agrees to execute a contract for this Work in the above amount and to furnish
28 surety as specified within 10 days after a written Notice of Award, if offered within 60 days after receipt of
29 bids, and on failure to do so agrees to forfeit to Owner the attached cash, cashier's check, certified check,
30 U.S. money order, or bid bond, as liquidated damages for such failure, in the following amount constituting
31 five percent (5%) of the Base Bid amount above:

32
33
34 _____ Dollars (\$ _____).

35
36 In the event Owner does not offer Notice of Award within the time limits stated above, Owner will return
37 to the undersigned the cash, cashier's check, certified check, U.S. money order, or bid bond.

38
39 **CONTRACTORS & SUBCONTRACTORS**

40 The following companies shall execute contracts or subcontracts for the portions of Work indicated:

41
42
43 General Work: _____.

44
45
46 Plumbing Work: _____.

47
48
49 Mechanical Work: _____.

50
51
52 Electrical Work: _____.

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1 **TIME OF COMPLETION**

2 Bidders shall begin mobilizing after received the Notice to Proceed. All work must be completed by
3 December 31, 2026

4
5 **ACKNOWLEDGMENT OF ADDENDA**

6 The undersigned Bidder acknowledges receipt of and use of the following Addenda in the preparation of
7 this Bid:

8
9 Addendum No. 1, dated _____ . Addendum No. 3, dated _____ .

10
11
12 Addendum No. 2, dated _____ . Addendum No. 4, dated _____ .

13
14 **CONTRACTOR'S LICENSE**

15 The undersigned further states that it is a duly licensed contractor, for the type of work proposed, and that
16 all fees, permits, etc., pursuant to submitting this proposal have been paid in full.

17
18 **SUBMISSION OF BID**

19 Respectfully submitted this _____ day of _____, 2026.

20
21 Submitted By: _____ (Name of bidding firm or corporation).

22
23 Authorized Signature: _____ (Handwritten signature).

24
25 Signed By: _____ (Type or print name).

26
27 Title: _____ (Owner/Partner/President/Vice President).

28
29 Witnessed By: _____ (Handwritten signature).

30
31 Attest: _____ (Handwritten signature).

32
33 By: _____ (Type or print name).

34
35 Title: _____ (Corporate Secretary or Assistant Secretary).

36
37 Street Address: _____ .

38
39 City, State, Zip: _____ .

40
41 Phone: _____ .

42
43 License No.: _____ .

44
45 Federal ID No.: _____ (Affix Corporate Seal Here).

46
47 **END OF DOCUMENT**

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1 conflicts and facilitate Owner usage. Perform the Work so as to limit interference with Owner's operations.
2 Maintain existing exits unless otherwise indicated.

3
4 Coordinate with Security personnel for site access and material deliveries. The courtroom microphones
5 and video equipment is provided through CCap (Consolidated Court Automation Programs), work with and
6 coordinate with their representative as needed.

7 8 **SECURITY**

9 The Courthouse is a secure building; Contractors must performer or have backgrounds check on all
10 personal working on site. Backgrounds checked shall be made available to Owners Security personnel
11 withing 7 business days if requested. Coordinate building access with Owners Security.

12 13 **WORK RESTRICTIONS**

14 Comply with restrictions on construction operations.

15
16 Comply with limitations on use of public streets, work on public streets, rights of way, and with other
17 requirements of authorities having jurisdiction.

18 19 **On-Site Work Hours:**

20 Work hours will be set for by the Owner. Normal business working hours will be Monday through
21 Friday. Extremely noisy work may need to be completed on nights and weekends to ensure the other
22 adjacent Courtroom is not disturbed while court is in session.

23
24 **Noise, Vibration, Dust, and Odors:** Coordinate operations that may result in high levels of noise and
25 vibration, dust, odors, or other disruption with Owner. Notify Designer and Owner not less than two days in
26 advance of proposed disruptive operations. Work to schedule disruptive operations with Owner's schedule
27 and courtroom sessions.

28 29 **Existing Utility Interruptions:**

30 Notify Construction Manager, Designer, and Owner not less than five days in advance of proposed
31 utility interruptions.

32
33 **Smoking and Controlled Substance Restrictions:** Use of tobacco products, alcoholic beverages, and other
34 controlled substances on Project site is not permitted.

35 36 **SPECIFICATION AND DRAWING CONVENTIONS**

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

40
41 Imperative mood and streamlined language are generally used in the Specifications. The words "shall,"
42 "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used
43 within a sentence or phrase.

44 Specification requirements are to be performed by Contractor unless specifically stated otherwise.

45
46 **Division 00 Contracting Requirements:** General provisions of the Contract, including General and
47 Supplementary Conditions, apply to all Sections of the Specifications.

48
49 **Division 01 General Requirements:** Requirements of Sections in Division 01 apply to the Work of all
50 Sections in the Specifications.

51
52 **PART 2 - PRODUCTS (Not Used)**

53 **PART 3 - EXECUTION (Not Used)**

54
55 **END OF SECTION**

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SECTION 01 29 00
PAYMENT PROCEDURES

PART 1 - GENERAL

SUMMARY

Section includes administrative and procedural requirements necessary to prepare and process Applications for Payment.

SCHEDULE OF VALUES

Coordination: Coordinate preparation of the schedule of values with preparation of Contractor's construction schedule.

Coordinate line items in the schedule of values with items required to be indicated as separate activities in Contractor's construction schedule.

Submit the schedule of values to Designer at earliest possible date, but no later than seven days before the date scheduled for submittal of initial Applications for Payment.

Format and Content: Use Project Manual table of contents as a guide to establish line items for the schedule of values. Provide at least one line item for each Specification Section.

Arrange schedule of values consistent with format of AIA Document G703.

Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Provide multiple line items for principal subcontract amounts in excess of five percent of the Contract Sum.

Provide a separate line item in the schedule of values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.

Differentiate between items stored on-site and items stored off-site.

Allowances: Provide a separate line item in the schedule of values for each allowance. Show line-item value of unit-cost allowances, as a product of the unit cost, multiplied by measured quantity. Use information indicated in the Contract Documents to determine quantities.

Overhead Costs: Include total cost and proportionate share of general overhead and profit for each line item.

Overhead Costs: Show cost of temporary facilities and other major cost items that are not direct cost of actual work-in-place as separate line items.

Closeout Costs. Include separate line items under Contractor and principal subcontracts for Project closeout requirements in an amount totaling five percent of the Contract Sum and subcontract amount.

Schedule of Values Revisions: Revise the schedule of values when Change Orders or Construction Change Directives result in a change in the Contract Sum. Include at least one separate line item for each Change Order and Construction Change Directive.

APPLICATIONS FOR PAYMENT

Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments as certified by Designer and paid for by Owner.

Payment Application Times: The date for each progress payment is indicated in the Agreement between Owner and Contractor. The period of construction work covered by each Application for Payment is the period indicated in the Agreement.

Payment Application Times: Submit Application for Payment to Designer by the 14 of the month. The period covered by each Application for Payment is one month, ending on the last day of the month.

1 Application for Payment Forms: Use AIA Document G702, AIA Document G703, or other form as
2 approved by Owner as form for Applications for Payment.

3
4 Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to
5 sign legal documents on behalf of Contractor. Designer will return incomplete applications without action.

6
7 Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated
8 schedules if revisions were made.

9 Include amounts for work completed following previous Application for Payment, whether or not
10 payment has been received. Include only amounts for work completed at time of Application for
11 Payment.

12 Include amounts of Change Orders and Construction Change Directives issued before last day of
13 construction period covered by application.

14
15 Transmittal: Submit 1 signed and notarized original copies of each Application for Payment to Designer by
16 email. Message shall include waivers of lien and similar attachments if required.

17
18 Initial Application for Payment: Administrative actions and submittals that must precede or coincide with
19 submittal of first Application for Payment include the following:

20
21 List of subcontractors.

22 Schedule of values.

23 Contractor's construction schedule (preliminary if not final).

24 Products list (preliminary if not final).

25 Sustainable design action plans, including preliminary project materials cost data.

26 Schedule of unit prices.

27 Submittal schedule (preliminary if not final).

28 List of Contractor's staff assignments.

29 List of Contractor's principal consultants.

30 Copies of building permits.

31 Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.

32 Initial progress report.

33 Report of preconstruction conference.

34 Certificates of insurance and insurance policies.

35 Performance and payment bonds.

36 Data needed to acquire Owner's insurance.

37
38 Application for Payment at Substantial Completion: After Designer issues the Certificate of Substantial
39 Completion, submit an Application for Payment showing 100 percent completion for portion of the Work
40 claimed as substantially complete.

41
42 Include documentation supporting claim that the Work is substantially complete and a statement
43 showing an accounting of changes to the Contract Sum.

44 This application shall reflect Certificate(s) of Substantial Completion issued previously for Owner
45 occupancy of designated portions of the Work.

46
47 Final Payment Application: After completing Project closeout requirements, submit final Application for
48 Payment with releases and supporting documentation not previously submitted and accepted, including, but
49 not limited, to the following:

50
51 Evidence of completion of Project closeout requirements.

52 Insurance certificates for products and completed operations where required and proof that taxes, fees,
53 and similar obligations were paid.

54 Updated final statement, accounting for final changes to the Contract Sum.

55 AIA Document G706.

1 AIA Document G706A.
2 AIA Document G707.
3 Evidence that claims have been settled.
4 Final meter readings for utilities, a measured record of stored fuel, and similar data as of date of
5 Substantial Completion or when Owner took possession of and assumed responsibility for
6 corresponding elements of the Work.
7 Final liquidated damages settlement statement.

8
9 **PART 2 - PRODUCTS (Not Used)**

10
11 **PART 3 - EXECUTION (Not Used)**

12
13 **END OF SECTION**

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SECTION 01 31 00
PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

SUMMARY

Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:

- General coordination procedures.
- Coordination drawings.
- RFIs.
- Digital project management procedures.
- Project meetings.

Related Requirements:

- Section 01 73 00 "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.

INFORMATIONAL SUBMITTALS

Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:

- Name, address, telephone number, and email address of entity performing subcontract or supplying products.
- Number and title of related Specification Section(s) covered by subcontract.
- Drawing number and detail references, as appropriate, covered by subcontract.

GENERAL COORDINATION PROCEDURES

Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations included in different Sections that depend on each other for proper installation, connection, and operation.

- Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
- Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
- Make adequate provisions to accommodate items scheduled for later installation.

Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:

- Preparation of Contractor's construction schedule.
- Preparation of the schedule of values.
- Installation and removal of temporary facilities and controls.
- Delivery and processing of submittals.
- Progress meetings.
- Preinstallation conferences.
- Project closeout activities.
- Startup and adjustment of systems.

1
2 **COORDINATION DRAWINGS**

3 Coordination Drawings, General: Prepare coordination drawings according to requirements in individual
4 Sections, and additionally where installation is not completely indicated on Shop Drawings, where limited
5 space availability necessitates coordination, or if coordination is required to facilitate integration of
6 products and materials fabricated or installed by more than one entity.

7
8 Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve
9 conflicts. Do not base coordination drawings on standard printed data. Include the following
10 information, as applicable:

11 Indicate functional and spatial relationships of components of architectural, structural, civil,
12 mechanical, and electrical systems.

13 Indicate dimensions shown on Drawings. Specifically note dimensions that appear to be in conflict
14 with submitted equipment and minimum clearance requirements. Provide alternative sketches to
15 Designer indicating proposed resolution of such conflicts. Minor dimension changes and
16 difficult installations will not be considered changes to the Contract.
17

18
19 Coordination Drawing Organization: Organize coordination drawings as follows:

20
21 Floor Plans and Reflected Ceiling Plans: Show architectural and structural elements, and mechanical,
22 plumbing, fire-protection, fire-alarm, and electrical Work. Show locations of visible ceiling-mounted
23 devices relative to acoustical ceiling grid. Supplement plan drawings with section drawings where
24 required to adequately represent the Work.

25 Mechanical Rooms: Provide coordination drawings for mechanical rooms showing plans and
26 elevations of mechanical, plumbing, fire-protection, fire-alarm, and electrical equipment.

27 Structural Penetrations: Indicate penetrations and openings required for all disciplines.

28 Review: Designer will review coordination drawings to confirm that, in general, the Work is being
29 coordinated, but not for the details of the coordination, which are Contractor's responsibility. If
30 Designer determines that coordination drawings are not being prepared in sufficient scope or detail,
31 or are otherwise deficient, Designer will so inform Contractor, who shall make suitable
32 modifications and resubmit.
33

34 **REQUEST FOR INFORMATION (RFI)**

35 General: Immediately on discovery of the need for additional information, clarification, or interpretation of
36 the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
37

38 Designer will return without response those RFIs submitted to Designer by other entities controlled by
39 Contractor.

40 Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of
41 subcontractors.
42

43 Content of the RFI: Include a detailed, legible description of item needing information or interpretation and
44 the following:

45 Owner name.

46 Owner's Project number.

47 Name of Designer.

48 Designer's Project number.

49 Date.

50 Name of Contractor.

51 RFI number, numbered sequentially.

52 RFI subject.

53 Specification Section number and title and related paragraphs, as appropriate.

54 Drawing number and detail references, as appropriate.
55

1 Field dimensions and conditions, as appropriate.
2 Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or
3 the Contract Sum, Contractor shall state impact in the RFI.
4 Contractor's signature.
5 Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings,
6 coordination drawings, and other information necessary to fully describe items needing
7 interpretation.
8
9 RFI Forms: AIA Document G716 or Software-generated form with substantially the same content as
10 indicated above, acceptable to Designer.
11
12 Designer's Action: Designer will review each RFI, determine action required, and respond. Allow seven
13 days for Designer's response for each RFI. RFIs received by Designer after 1:00 p.m. will be considered as
14 received the following working day.
15
16 The following Contractor-generated RFIs will be returned without action:
17
18 Requests for approval of submittals.
19 Requests for approval of substitutions.
20 Requests for approval of Contractor's means and methods.
21 Requests for coordination information already indicated in the Contract Documents.
22 Requests for adjustments in the Contract Time or the Contract Sum.
23 Requests for interpretation of Designer's actions on submittals.
24 Incomplete RFIs or inaccurately prepared RFIs.
25
26 Designer's action may include a request for additional information, in which case Designer's time for
27 response will date from time of receipt by Designer of additional information.
28
29 If Contractor believes the RFI response warrants change in the Contract Time or the Contract
30 Sum, notify Designer in writing within five days of receipt of the RFI response.
31
32 On receipt of Designer's action, update the RFI log and immediately distribute the RFI response to affected
33 parties. Review response and notify Designer within seven days if Contractor disagrees with response.
34
35 **DIGITAL PROJECT MANAGEMENT PROCEDURES**
36 Designer's Data Files Not Available: Designer will not provide Designer's BIM model or CAD drawing
37 digital data files for Contractor's use during construction.
38
39 PDF Document Preparation: Where PDFs are required to be submitted to Designer, prepare as follows:
40
41 Assemble complete submittal package into a single indexed file incorporating submittal requirements
42 of a single Specification Section and transmittal form with links enabling navigation to each item.
43 Name file with submittal number or other unique identifier, including revision identifier.
44 Certifications: Where digitally submitted certificates and certifications are required, provide a digital
45 signature with digital certificate on where indicated.
46
47 **PROJECT MEETINGS**
48 General: Schedule and conduct meetings and conferences at Project site unless otherwise indicated.
49
50 Preconstruction Conference: Schedule and conduct a preconstruction conference before starting
51 construction, at a time convenient to Owner and Designer, but no later than 15 days after execution of the
52 Agreement.
53
54 Attendees: Authorized representatives of Owner, Designer, and their consultants; Contractor and its
55 superintendent; major subcontractors; suppliers; and other concerned parties shall attend the

1 conference. Participants at the conference shall be familiar with Project and authorized to conclude
2 matters relating to the Work.

3 Agenda: Discuss items of significance that could affect progress, including the following:
4

- 5 Responsibilities and personnel assignments.
- 6 Tentative construction schedule.
- 7 Phasing.
- 8 Critical work sequencing and long lead items.
- 9 Designation of key personnel and their duties.
- 10 Lines of communications.
- 11 Use of web-based Project software.
- 12 Procedures for processing field decisions and Change Orders.
- 13 Procedures for RFIs.
- 14 Procedures for testing and inspecting.
- 15 Procedures for processing Applications for Payment.
- 16 Distribution of the Contract Documents.
- 17 Submittal procedures.
- 18 Sustainable design requirements.
- 19 Preparation of Record Documents.
- 20 Use of the premises and existing building.
- 21 Work restrictions.
- 22 Working hours.
- 23 Owner's occupancy requirements.
- 24 Responsibility for temporary facilities and controls.
- 25 Procedures for moisture and mold control.
- 26 Procedures for disruptions and shutdowns.
- 27 Construction waste management and recycling.
- 28 Parking availability.
- 29 Office, work, and storage areas.
- 30 Equipment deliveries and priorities.
- 31 First aid.
- 32 Security.
- 33 Progress cleaning.

34
35 Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.
36

37 Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction
38 activity when required by other sections and when required for coordination with other construction.
39

40 Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the
41 installation and its coordination or integration with other materials and installations that have
42 preceded or will follow, shall attend the meeting. Advise Designer of scheduled meeting dates.

43 Agenda: Review progress of other construction activities and preparations for the particular activity
44 under consideration, including requirements for the following:
45

- 46 Contract Documents.
- 47 Options.
- 48 Related RFIs.
- 49 Related Change Orders.
- 50 Purchases.
- 51 Deliveries.
- 52 Submittals.
- 53 Sustainable design requirements.
- 54 Review of mockups.
- 55 Possible conflicts.

- 1 Compatibility requirements.
- 2 Time schedules.
- 3 Weather limitations.
- 4 Manufacturer's written instructions.
- 5 Warranty requirements.
- 6 Compatibility of materials.
- 7 Acceptability of substrates.
- 8 Temporary facilities and controls.
- 9 Space and access limitations.
- 10 Regulations of authorities having jurisdiction.
- 11 Testing and inspecting requirements.
- 12 Installation procedures.
- 13 Coordination with other work.
- 14 Required performance results.
- 15 Protection of adjacent work.
- 16 Protection of construction and personnel.
- 17
- 18 Record significant conference discussions, agreements, and disagreements, including required
- 19 corrective measures and actions.
- 20 Reporting: Distribute minutes of the meeting to each party present and to other parties requiring
- 21 information.
- 22 Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever
- 23 actions are necessary to resolve impediments to performance of the Work and reconvene the
- 24 conference at earliest feasible date.
- 25
- 26 Progress Meetings: Conduct progress meetings at intervals.
- 27
- 28 Coordinate dates of meetings with preparation of payment requests.
- 29 Attendees: In addition to representatives of Owner and Designer, each contractor, subcontractor,
- 30 supplier, and other entity concerned with current progress or involved in planning, coordination, or
- 31 performance of future activities shall be represented at these meetings. All participants at the
- 32 meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
- 33 Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of
- 34 significance that could affect progress. Include topics for discussion as appropriate to status of
- 35 Project.
- 36
- 37 Contractor's Construction Schedule: Review progress since the last meeting. Determine whether
- 38 each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's
- 39 construction schedule. Determine how construction behind schedule will be expedited; secure
- 40 commitments from parties involved to do so. Discuss whether schedule revisions are required to
- 41 ensure that current and subsequent activities will be completed within the Contract Time.
- 42
- 43 Review schedule for next period.
- 44
- 45 Review present and future needs of each entity present, including the following:
- 46
- 47 Interface requirements.
- 48 Sequence of operations.
- 49 Resolution of BIM component conflicts.
- 50 Status of submittals.
- 51 Status of sustainable design documentation.
- 52 Deliveries.
- 53 Off-site fabrication.
- 54 Access.
- 55 Site use.

- 1 Temporary facilities and controls.
- 2 Progress cleaning.
- 3 Quality and work standards.
- 4 Status of correction of deficient items.
- 5 Field observations.
- 6 Status of RFIs.
- 7 Status of Proposal Requests.
- 8 Pending changes.
- 9 Status of Change Orders.
- 10 Pending claims and disputes.
- 11 Documentation of information for payment requests.

12
13 Minutes: Entity responsible for conducting the meeting will record and distribute the meeting minutes
14 to each party present and to parties requiring information.

15
16 Schedule Updating: Revise Contractor's construction schedule after each progress meeting where
17 revisions to the schedule have been made or recognized. Issue revised schedule concurrently
18 with the report of each meeting.

19
20 **PART 2 - PRODUCTS (Not Used)**

21
22 **PART 3 - EXECUTION (Not Used)**

23
24 **END OF SECTION**

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SECTION 01 33 00
SUBMITTAL PROCEDURES

PART 1 - GENERAL

SUMMARY

Section Includes:

- Submittal schedule requirements.
- Administrative and procedural requirements for submittals.

DEFINITIONS

Action Submittals: Written and graphic information and physical samples that require Designer's responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."

Informational Submittals: Written and graphic information and physical samples that do not require Designer's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as "informational submittals."

SUBMITTAL SCHEDULE

Submittal Schedule: Submit, as an action submittal, a list of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Designer and additional time for handling and reviewing submittals required by those corrections.

SUBMITTAL FORMATS

Submittal Information: Include the following information in each submittal:

- Project name.
- Date.
- Name of Designer.
- Name of Contractor.
- Names of subcontractor, manufacturer, and/or supplier.
- Unique submittal number, including revision identifier. Include Specification Section number with sequential alphanumeric identifier; and alphanumeric suffix for resubmittals.
- Category and type of submittal.
- Submittal purpose and description.
- Number and title of Specification Section, with paragraph number and generic name for each of multiple items.
- Drawing number and detail references, as appropriate.
- Indication of full or partial submittal.
- Other necessary identification.
- Remarks.

Options: Identify options requiring selection by Designer.

Deviations and Additional Information: On each submittal, clearly indicate deviations from requirements in the Contract Documents, including minor variations and limitations; include relevant additional information and revisions, other than those requested by Designer on previous submittals. Indicate by highlighting on each submittal or noting on attached separate sheet.

Electronic Submittals: Prepare submittals as PDF package, incorporating complete information into each PDF file. Name PDF file with submittal number.

1
2 **SUBMITTAL PROCEDURES**

3 Prepare and submit submittals required by individual Specification Sections. Types of submittals are
4 indicated in individual Specification Sections.

5
6 Email: Prepare submittals as PDF package, and transmit to Designer by sending via email. Include
7 PDF transmittal form. Include information in email subject line as requested by Designer.

8
9 Coordination: Coordinate preparation and processing of submittals with performance of construction
10 activities.

11
12 Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related
13 activities that require sequential activity.

14 Submit all submittal items required for each Specification Section concurrently unless partial
15 submittals for portions of the Work are indicated on approved submittal schedule.

16 Submit action submittals and informational submittals required by the same Specification Section as
17 separate packages under separate transmittals.

18
19 Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for
20 review shall commence on Designer's receipt of submittal. No extension of the Contract Time will be
21 authorized because of failure to transmit submittals enough in advance of the Work to permit processing,
22 including resubmittals.

23
24 Initial Review: Allow 15 days for initial review of each submittal. Allow additional time if
25 coordination with subsequent submittals is required. Designer will advise Contractor when a
26 submittal being processed must be delayed for coordination.

27 Resubmittal Review: Allow 15 days for review of each resubmittal.

28
29 Resubmittals: Make resubmittals in same form and number of copies as initial submittal.

30
31 Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators,
32 installers, authorities having jurisdiction, and others as necessary for performance of construction activities.
33 Show distribution on transmittal forms.

34
35 **SUBMITTAL REQUIREMENTS**

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

38
39 If information must be specially prepared for submittal because standard published data are unsuitable
40 for use, submit as Shop Drawings, not as Product Data.

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

42 Include the following information, as applicable:

- 43
44 Manufacturer's catalog cuts.
45 Manufacturer's product specifications.
46 Standard color charts.
47 Statement of compliance with specified referenced standards.
48 Testing by recognized testing agency.
49 Application of testing agency labels and seals.
50 Notation of coordination requirements.
51 Availability and delivery time information.

52
53 For equipment, include the following in addition to the above, as applicable:

54
55 Wiring diagrams that show factory-installed wiring.

- 1 Printed performance curves.
- 2 Operational range diagrams.
- 3 Clearances required to other construction, if not indicated on accompanying Shop Drawings.

4
5 Submit Product Data before Shop Drawings, and before or concurrent with Samples.

6
7 Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop
8 Drawings on reproductions of the Contract Documents or standard printed data.

9
10 Preparation: Fully illustrate requirements in the Contract Documents. Include the following
11 information, as applicable:

- 12 Identification of products.
- 13 Schedules.
- 14 Compliance with specified standards.
- 15 Notation of coordination requirements.
- 16 Notation of dimensions established by field measurement.
- 17 Relationship and attachment to adjoining construction clearly indicated.
- 18 Seal and signature of professional engineer if specified.

19
20
21 Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics
22 with other materials.

23
24 Transmit Samples that contain multiple, related components such as accessories together in one
25 submittal package.

26 Email Transmittal: Provide PDF transmittal. Include digital image file illustrating Sample
27 characteristics, and identification information for record.

28 Paper Transmittal: Include paper transmittal including complete submittal information indicated.

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

31
32 Number of Samples: Submit one full set(s) of available choices where color, pattern, texture, or
33 similar characteristics are required to be selected from manufacturer's product line. Designer
34 will return submittal with options selected.

35
36 **CONTRACTOR'S REVIEW**

37 Action Submittals and Informational Submittals: Review each submittal and check for coordination with
38 other Work of the Contract and for compliance with the Contract Documents. Note corrections and field
39 dimensions. Mark with approval stamp before submitting to Designer.

40
41 Contractor's Approval: Indicate Contractor's approval for each submittal with a uniform approval stamp.
42 Include name of reviewer, date of Contractor's approval, and statement certifying that submittal has been
43 reviewed, checked, and approved for compliance with the Contract Documents.

44
45 Designer will not review submittals received from Contractor that do not have Contractor's review and
46 approval.

47
48 **DESIGNER'S REVIEW**

49 Action Submittals: Designer will review each submittal, indicate corrections or revisions required, and
50 return it.

51
52 PDF Submittals: Designer will indicate, via markup on each submittal, the appropriate action.

53
54 Informational Submittals: Designer will review each submittal and will not return it, or will return it if it
55 does not comply with requirements. Designer will forward each submittal to appropriate party.

- 1
- 2 Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has
- 3 received prior approval from Designer.
- 4
- 5 Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for
- 6 resubmittal without review.
- 7
- 8 Designer will discard submittals received from sources other than Contractor.
- 9
- 10 Submittals not required by the Contract Documents will be returned by Designer without action.
- 11

PART 2 - PRODUCTS (Not Used)
PART 3 - EXECUTION (Not Used)

END OF SECTION

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SECTION 01 35 16
ALTERATION PROJECT PROCEDURES

PART 1 - GENERAL

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46

SUMMARY

Section includes special procedures for alteration work.

DEFINITIONS

Alteration Work: This term includes remodeling, renovation, repair, and maintenance work performed within existing spaces or on existing surfaces as part of the Project.

Consolidate: To strengthen loose or deteriorated materials in place.

Design Reference Sample: A sample that represents the Designer's prebid selection of work to be matched; it may be existing work or work specially produced for the Project.

Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.

Match: To blend with adjacent construction and manifest no apparent difference in material type, species, cut, form, detail, color, grain, texture, or finish; as approved by Designer.

Refinish: To remove existing finishes to base material and apply new finish to match original, or as otherwise indicated.

Repair: To correct damage and defects, retaining existing materials, features, and finishes. This includes patching, piecing-in, splicing, consolidating, or otherwise reinforcing or upgrading materials.

Replace: To remove, duplicate, and reinstall entire item with new material. The original item is the pattern for creating duplicates unless otherwise indicated.

Replicate: To reproduce in exact detail, materials, and finish unless otherwise indicated.

Reproduce: To fabricate a new item, accurate in detail to the original, and from either the same or a similar material as the original, unless otherwise indicated.

Retain: To keep an element or detail secure and intact.

Strip: To remove existing finish down to base material unless otherwise indicated.

PROJECT MEETINGS FOR ALTERATION WORK

Preliminary Conference for Alteration Work: Before starting alteration work, conduct conference at Project site.

Attendees: In addition to representatives of Owner, Designer, and Contractor, testing service representative, and chemical-cleaner manufacturer(s) shall be represented at the meeting.

Agenda: Discuss items of significance that could affect progress of alteration work, including review of the following:

Fire-prevention plan.

Governing regulations.

Areas where existing construction is to remain and the required protection.

Hauling routes.

Sequence of alteration work operations.

1 Storage, protection, and accounting for salvaged and specially fabricated items.
2 Existing conditions, staging, and structural loading limitations of areas where materials are stored.
3 Reporting: Record conference results and distribute copies to everyone in attendance and to others
4 affected by decisions or actions resulting from conference.
5

6 Coordination Meetings: Conduct coordination meetings specifically for alteration work at regular intervals.
7 Coordination meetings are in addition to specific meetings held for other purposes, such as progress
8 meetings and preinstallation conferences.
9

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

13 Reporting: Record meeting results and distribute copies to everyone in attendance and to others
14 affected by decisions or actions resulting from each meeting.
15

16 **MATERIALS OWNERSHIP**

17 Historic items, relics, and similar objects including, but not limited to, cornerstones and their contents,
18 commemorative plaques and tablets, antiques, and other items of interest or value to Owner that may be
19 encountered or uncovered during the Work, regardless of whether they were previously documented,
20 remain Owner's property.
21

22 **QUALITY ASSURANCE**

23 Title X Requirement: Each firm conducting activities that disturb painted surfaces shall be a "Lead-Safe
24 Certified Firm" according to 40 CFR 745, Subpart E, and use only workers that are trained in lead-safe
25 work practices.
26

27 Alteration Work Program: Prepare a written plan for alteration work for whole Project, including each
28 phase or process and protection of surrounding materials during operations. Show compliance with
29 indicated methods and procedures specified in this and other Sections. Coordinate this whole-Project
30 alteration work program with specific requirements of programs required in other alteration work Sections.
31

32 Dust and Noise Control: Include locations of proposed temporary dust- and noise-control partitions
33 and means of egress from occupied areas coordinated with continuing on-site operations and other
34 known work in progress.

35 Debris Hauling: Include plans clearly marked to show debris hauling routes, turning radii, and
36 locations and details of temporary protective barriers.
37

38 Fire-Prevention Plan: Prepare a written plan for preventing fires during the Work, including placement of
39 fire extinguishers, fire blankets, rag buckets, and other fire-control devices during each phase or process.
40 Coordinate plan with Owner's fire-protection equipment and requirements. Include fire-watch personnel's
41 training, duties, and authority to enforce fire safety.
42

43 Safety and Health Standard: Comply with ANSI/ASSP A10.6.
44

45 **STORAGE AND HANDLING OF SALVAGED MATERIALS**

46 Salvaged Materials:

47
48 Clean loose dirt and debris from salvaged items unless more extensive cleaning is indicated.
49 Pack or crate items after cleaning; cushion against damage during handling. Label contents of
50 containers.

51 Store items in a secure area until delivery to Owner.

52 Transport items to Owner's storage area designated by Owner.

53 Protect items from damage during transport and storage.
54

1 Salvaged Materials for Reinstallation:
2
3 Repair and clean items for reuse as indicated.
4 Pack or crate items after cleaning and repairing; cushion against damage during handling. Label
5 contents of containers.
6 Protect items from damage during transport and storage.
7 Reinstall items in locations indicated. Comply with installation requirements for new materials and
8 equipment unless otherwise indicated. Provide connections, supports, and miscellaneous materials to
9 make items functional for use indicated.

10
11 Existing Materials to Remain: Protect construction indicated to remain against damage and soiling from
12 construction work. Where permitted by Designer, items may be dismantled and taken to a suitable,
13 protected storage location during construction work and reinstalled in their original locations after
14 alteration and other construction work in the vicinity is complete.

15
16 Storage: Catalog and store items within a weathertight enclosure where they are protected from moisture,
17 weather, condensation, and freezing temperatures.

18
19 Identify each item for reinstallation with a nonpermanent mark to document its original location.
20 Indicate original locations on plans, elevations, sections, or photographs by annotating the
21 identifying marks.
22 Secure stored materials to protect from theft.
23 Control humidity so that it does not exceed 85 percent. Maintain temperatures 5 deg F or more above
24 the dew point.

25
26 **PART 2 - PRODUCTS - (Not Used)**

27
28 **PART 3 - EXECUTION**

29
30 **PROTECTION**

31 Protect persons, motor vehicles, surrounding surfaces of building, building site, plants, and surrounding
32 buildings from harm resulting from alteration work.

33
34 Use only proven protection methods, appropriate to each area and surface being protected.
35 Provide temporary barricades, barriers, and directional signage to exclude the public from areas where
36 alteration work is being performed.
37 Erect temporary barriers to form and maintain fire-egress routes.
38 Erect temporary protective covers over walkways and at points of pedestrian and vehicular entrance
39 and exit that must remain in service during alteration work.
40 Contain dust and debris generated by alteration work, and prevent it from reaching the public or
41 adjacent surfaces.
42 Provide shoring, bracing, and supports as necessary. Do not overload structural elements.
43 Protect floors and other surfaces along hauling routes from damage, wear, and staining.
44 Provide supplemental sound-control treatment to isolate demolition work from other areas of the
45 building.

46
47 Temporary Protection of Materials to Remain:

48
49 Protect existing materials with temporary protections and construction. Do not remove existing
50 materials unless otherwise indicated.
51 Do not attach temporary protection to existing surfaces except as indicated as part of the alteration
52 work program.
53

1 Comply with each product manufacturer's written instructions for protections and precautions. Protect
2 against adverse effects of products and procedures on people and adjacent materials, components, and
3 vegetation.

4
5 Utility and Communications Services:

- 6
7 Notify Owner, Designer, authorities having jurisdiction, and entities owning or controlling wires,
8 conduits, pipes, and other services affected by alteration work before commencing operations.
9 Disconnect and cap pipes and services as required by authorities having jurisdiction, as required for
10 alteration work.
11 Maintain existing services unless otherwise indicated; keep in service, and protect against damage
12 during operations. Provide temporary services during interruptions to existing utilities.
13

14 **PROTECTION FROM FIRE**

15 General: Follow fire-prevention plan and the following:

- 16
17 Comply with NFPA 241 requirements unless otherwise indicated.
18 Remove and keep area free of combustibles, including rubbish, paper, waste, and chemicals, unless
19 necessary for the immediate work.
20 If combustible material cannot be removed, provide fire blankets to cover such materials.
21

22 Heat-Generating Equipment and Combustible Materials: Comply with the following procedures while
23 performing work with heat-generating equipment or combustible materials, including welding, torch-
24 cutting, soldering, brazing, removing paint with heat, or other operations where open flames or implements
25 using high heat or combustible solvents and chemicals are anticipated:
26

- 27 Obtain Owner's approval for operations involving use of open-flame or welding or other high-heat
28 equipment. Notify Owner at least 72 hours before each occurrence, indicating location of such work.
29 As far as practicable, restrict heat-generating equipment to shop areas or outside the building.
30 Do not perform work with heat-generating equipment in or near rooms or in areas where flammable
31 liquids or explosive vapors are present or thought to be present. Use a combustible gas indicator test
32 to ensure that the area is safe.
33 Use fireproof baffles to prevent flames, sparks, hot gases, or other high-temperature material from
34 reaching surrounding combustible material.
35 Prevent the spread of sparks and particles of hot metal through open windows, doors, holes, and cracks
36 in floors, walls, ceilings, roofs, and other openings.
37 Fire Watch: Before working with heat-generating equipment or combustible materials, station
38 personnel to serve as a fire watch at each location where such work is performed. Fire-watch
39 personnel shall have the authority to enforce fire safety. Station fire watch according to NFPA 51B,
40 NFPA 241, and as follows:

- 41
42 Train each fire watch in the proper operation of fire-control equipment and alarms.
43 Prohibit fire-watch personnel from other work that would be a distraction from fire-watch duties.
44 Cease work with heat-generating equipment whenever fire-watch personnel are not present.
45 Have fire-watch personnel perform final fire-safety inspection each day beginning no sooner than
46 30 minutes after conclusion of work in each area to detect hidden or smoldering fires and to
47 ensure that proper fire prevention is maintained.
48 Maintain fire-watch personnel at each area of Project site until 60 minutes after conclusion of
49 daily work.
50

51 Fire-Control Devices: Provide and maintain fire extinguishers, fire blankets, and rag buckets for disposal of
52 rags with combustible liquids. Maintain each as suitable for the type of fire risk in each work area. Ensure
53 that nearby personnel and the fire-watch personnel are trained in fire-extinguisher and blanket use.
54

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SECTION 01 50 00
TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

SUMMARY

Section includes requirements for temporary utilities, support facilities, and security and protection facilities.

Related Requirements:

Section 01 10 00 "Summary" for work restrictions and limitations on utility interruptions.

USE CHARGES

General: Installation and removal of and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities engaged in the Project to use temporary services and facilities without cost, including, but not limited to, Owner's construction forces, Designer, occupants of Project, testing agencies, and authorities having jurisdiction.

Water and Sewer Service from Existing System: Water from Owner's existing water system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.

Electric Power Service from Existing System: Electric power from Owner's existing system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.

INFORMATIONAL SUBMITTALS

Site Utilization Plan: Show temporary facilities, temporary utility lines and connections, staging areas, construction site entrances, vehicle circulation, and parking areas for construction personnel.

Project Identification and Temporary Signs: Show fabrication and installation details, including plans, elevations, details, layouts, typestyles, graphic elements, and message content.

Fire-Safety Program: Show compliance with requirements of NFPA 241 and authorities having jurisdiction. Indicate Contractor personnel responsible for management of fire-prevention program.

Moisture-and Mold-Protection Plan: Describe procedures and controls for protecting materials and construction from water absorption and damage and mold.

QUALITY ASSURANCE

Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

Accessible Temporary Egress: Comply with applicable provisions in the United States Access Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.

PROJECT CONDITIONS

Temporary Use of Permanent Facilities: Engage Installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.

1 **PART 2 - PRODUCTS**

2
3 **TEMPORARY FACILITIES**

4 Field Offices, General: Prefabricated or mobile units with serviceable finishes, temperature controls, and
5 foundations adequate for normal loading. A field office is not required.

6
7 **DUMPSTERS**

8 Construction Manager and owner will provide necessary dumpsters for construction waste disposal.

9
10 **EQUIPMENT**

11 Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and
12 classes of fire exposures.

13
14 **PART 3 - EXECUTION**

15
16 **TEMPORARY FACILITIES, GENERAL**

17 Conservation: Coordinate construction and use of temporary facilities with consideration given to
18 conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.

19
20 Salvage materials and equipment involved in performance of, but not actually incorporated into, the
21 Work. See other Sections for disposition of salvaged materials that are designated as Owner's
22 property.

23
24 **INSTALLATION, GENERAL**

25 Locate facilities where they will serve Project adequately and result in minimum interference with
26 performance of the Work. Relocate and modify facilities as required by progress of the Work.

27
28 Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer
29 needed or are replaced by authorized use of completed permanent facilities.

30
31 **TEMPORARY UTILITY INSTALLATION**

32 General: Install temporary service or connect to existing service.

33
34 Arrange with utility company, Owner, and existing users for time when service can be interrupted, if
35 necessary, to make connections for temporary services.

36
37 Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction
38 personnel. Comply with requirements of authorities having jurisdiction for type, number, location,
39 operation, and maintenance of fixtures and facilities.

40
41 Electric Power Service: Provide electric power service and distribution system of sufficient size, capacity,
42 and power characteristics required for construction operations.

43
44 Lighting: Provide temporary lighting with local switching that provides adequate illumination for
45 construction operations, observations, inspections, and traffic conditions.

46
47 Install and operate temporary lighting that fulfills security and protection requirements without
48 operating entire system.

49
50 **SECURITY AND PROTECTION FACILITIES INSTALLATION**

51 Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other
52 improvements at Project site and on adjacent properties, except those indicated to be removed or altered.
53 Repair damage to existing facilities.

1 Where access to adjacent properties is required in order to affect protection of existing facilities, obtain
2 written permission from adjacent property owner to access property for that purpose.

3

4 **OPERATION, TERMINATION, AND REMOVAL**

5 Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit
6 availability of temporary facilities to essential and intended uses.

7

8 Maintenance: Maintain facilities in good operating condition until removal.

9

10 Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and
11 similar facilities on a 24-hour basis where required to achieve indicated results and to avoid
12 possibility of damage.

13

14 Temporary Facility Changeover: Do not change over from using temporary security and protection
15 facilities to permanent facilities until Substantial Completion.

16

17 Termination and Removal: Remove each temporary facility when need for its service has ended, when it
18 has been replaced by authorized use of a permanent facility, or no later than Substantial Completion.
19 Complete or, if necessary, restore permanent construction that may have been delayed because of
20 interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace
21 construction that cannot be satisfactorily repaired.

22

23 Materials and facilities that constitute temporary facilities are property of Contractor. Owner reserves
24 right to take possession of Project identification signs.

25

26 At Substantial Completion, repair, renovate, and clean permanent facilities used during construction
27 period. Comply with final cleaning requirements specified in Section 01 77 00 "Closeout
28 Procedures."

28

29

END OF SECTION

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1 Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written
2 recommendations and instructions for installation of specified products and equipment.

3 4 **PART 2 - PRODUCTS**

5 6 **MATERIALS**

7 Comply with requirements specified in other Sections.

8
9 For projects requiring compliance with sustainable design and construction practices and procedures,
10 use products for patching that comply with sustainable design requirements.

11
12 In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use
13 materials that visually match in-place adjacent surfaces to the fullest extent possible.

14
15 If identical materials are unavailable or cannot be used, use materials that, when installed, will provide
16 a match acceptable to Designer for the visual and functional performance of in-place materials. Use
17 materials that are not considered hazardous.

18
19 Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the
20 surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that
21 might damage finished surfaces.

22
23 Use cleaning products that comply with Green Seal's GS-37, or if GS-37 is not applicable, use products
24 that comply with the California Code of Regulations maximum allowable VOC levels.

25 26 **PART 3 - EXECUTION**

27 28 **EXAMINATION**

29 Existing Conditions: The existence and location of underground and other utilities and construction
30 indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence
31 and location of underground utilities, mechanical and electrical systems, and other construction affecting
32 the Work.

33
34 Before construction, verify the location and invert elevation at points of connection of sanitary sewer,
35 storm sewer, gas service piping, and water-service piping; underground electrical services; and other
36 utilities.

37 Furnish location data for work related to Project that must be performed by public utilities serving
38 Project site.

39
40 Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine
41 substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with
42 requirements for installation tolerances and other conditions affecting performance. Record observations.

43
44 Examine roughing-in for mechanical and electrical systems to verify actual locations of connections
45 before equipment and fixture installation.

46 Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
47 Verify compatibility with and suitability of substrates, including compatibility with existing finishes or
48 primers.

49
50 Written Report: Where a written report listing conditions detrimental to performance of the Work is
51 required by other Sections, include the following:

52
53 Description of the Work, including Specification Section number and paragraph, and Drawing sheet
54 number and detail, where applicable.

55 List of detrimental conditions, including substrates.

1 List of unacceptable installation tolerances.
2 Recommended corrections.
3
4 Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the
5 Work indicates acceptance of surfaces and conditions.
6

7 **PREPARATION**

8 Existing Utility Information: Furnish information to local utility and Owner that is necessary to adjust,
9 move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances
10 located in or affected by construction. Coordinate with authorities having jurisdiction.
11

12 Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements
13 before installing each product. Where portions of the Work are indicated to fit to other construction, verify
14 dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule
15 with construction progress to avoid delaying the Work.
16

17 Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on
18 Drawings.
19

20 Review of Contract Documents and Field Conditions: Immediately on discovery of the need for
21 clarification of the Contract Documents, submit a request for information to Designer in accordance with
22 requirements in Section 01 31 00 "Project Management and Coordination."
23

24 **INSTALLATION**

25 Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
26

27 Make vertical work plumb, and make horizontal work level.
28 Where space is limited, install components to maximize space available for maintenance and ease of
29 removal for replacement.
30 Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
31 Maintain minimum headroom clearance of 96 inches in occupied spaces and 90 inches in unoccupied
32 spaces, unless otherwise indicated on Drawings.
33

34 Comply with manufacturer's written instructions and recommendations for installing products in
35 applications indicated.
36

37 Install products at the time and under conditions that will ensure satisfactory results as judged by Designer.
38 Maintain conditions required for product performance until Substantial Completion.
39

40 Conduct construction operations, so no part of the Work is subjected to damaging operations or loading in
41 excess of that expected during normal conditions of occupancy of type expected for Project.
42

43 Sequence the Work and allow adequate clearances to accommodate movement of construction items on-site
44 and placement in permanent locations.
45

46 Tools and Equipment: Select tools or equipment that minimize production of excessive noise levels.
47

48 Templates: Obtain and distribute to the parties involved templates for Work specified to be factory
49 prepared and field installed. Check Shop Drawings of other portions of the Work to confirm that adequate
50 provisions are made for locating and installing products to comply with indicated requirements.
51

52 Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and
53 number to securely anchor each component in place, accurately located and aligned with other portions of
54 the Work. Where size and type of attachments are not indicated, verify size and type required for load
55 conditions with manufacturer.

1
2 Mounting Heights: Where mounting heights are not indicated, mount components at heights directed
3 by Designer.

4 Allow for building movement, including thermal expansion and contraction.
5

6 Joints: Make joints of uniform width. Where joint locations in exposed Work are not indicated, arrange
7 joints for the best visual effect, as judged by Designer. Fit exposed connections together to form hairline
8 joints.
9

10 **CUTTING AND PATCHING**

11 General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the
12 earliest feasible time, and complete without delay.
13

14 Cut in-place construction to provide for installation of other components or performance of other
15 construction, and subsequently patch as required to restore surfaces to their original condition.
16

17 Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during
18 installation or cutting and patching operations, by methods and with materials so as not to void existing
19 warranties.
20

21 Temporary Support: Provide temporary support of Work to be cut.
22

23 Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection
24 from adverse weather conditions for portions of Project that might be exposed during cutting and patching
25 operations.
26

27 Adjacent Occupied Areas: Where interference with use of adjoining areas or interruption of free passage to
28 adjoining areas is unavoidable, coordinate cutting and patching in accordance with requirements in
29 Section 01 10 00 "Summary."
30

31 Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required
32 to be removed, relocated, or abandoned, bypass such services/systems before cutting to minimize
33 interruption to occupied areas.
34

35 Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations,
36 including excavation, using methods least likely to damage elements retained or adjoining construction. If
37 possible, review proposed procedures with original Installer; comply with original Installer's written
38 recommendations.
39

40 In general, use hand or small power tools designed for sawing and grinding, not hammering and
41 chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of
42 adjacent surfaces. Temporarily cover openings when not in use.

43 Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.

44 Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.

45 Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap,
46 valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other
47 foreign matter after cutting.

48 Proceed with patching after construction operations requiring cutting are complete.
49

50 Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following
51 performance of other Work. Patch with durable seams that are as invisible as practicable, as judged by
52 Designer. Provide materials and comply with installation requirements specified in other Sections, where
53 applicable.
54

1 Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical
2 integrity of installation.

3 Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained
4 adjoining construction in a manner that will eliminate evidence of patching and refinishing.

5
6 Clean piping, conduit, and similar features before applying paint or other finishing materials.
7 Restore damaged pipe covering to its original condition.

8
9 Floors and Walls: Where walls or partitions that are removed extend one finished area into another,
10 patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish,
11 color, texture, and appearance. Remove in-place floor and wall coverings and replace with new
12 materials, if necessary, to achieve uniform color and appearance.

13
14 Where patching occurs in a painted surface, prepare substrate and apply primer and intermediate
15 paint coats appropriate for substrate over the patch, and apply final paint coat over entire
16 unbroken surface containing the patch, corner to corner of wall and edge to edge of ceiling.
17 Provide additional coats until patch blends with adjacent surfaces.

18
19 Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of
20 uniform appearance.

21 Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight
22 condition and ensures thermal and moisture integrity of building enclosure.

23
24 Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils,
25 putty, and similar materials from adjacent finished surfaces.

26
27 **COORDINATION OF OWNER'S PORTION OF THE WORK**

28 Site Access: Provide access to Project site for Owner's construction personnel and Owner's separate
29 contractors.

30
31 Provide temporary facilities required for Owner-furnished, Contractor-installed products.
32 Refer to Section 01 10 00 "Summary" for other requirements for Owner-furnished, Contractor-installed
33 products

34
35 Coordination: Coordinate construction and operations of the Work with work performed by Owner's
36 construction personnel and Owner's separate contractors.

37
38 Construction Schedule: Inform Owner of Contractor's preferred construction schedule for Owner's
39 portion of the Work. Adjust construction schedule based on a mutually agreeable timetable. Notify
40 Owner if changes to schedule are required due to differences in actual construction progress.

41
42 **PROGRESS CLEANING**

43 Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of
44 materials lawfully.

45
46 Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
47 Do not hold waste materials more than seven days during normal weather or three days if the
48 temperature is expected to rise above 80 deg F.

49 Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers
50 appropriately and dispose of legally, in accordance with regulations.

51
52 Use containers intended for holding waste materials of type to be stored.

53
54 Coordinate progress cleaning for joint-use areas where Contractor and other contractors are working
55 concurrently.

1
2 Site: Maintain Project site free of waste materials and debris.
3

4 Work Areas: Clean areas where Work is in progress to the level of cleanliness necessary for proper
5 execution of the Work.
6

7 Remove liquid spills promptly.

8 Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area,
9 as appropriate.
10

11 Installed Work: Keep installed work clean. Clean installed surfaces in accordance with written instructions
12 of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended.
13 If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health
14 or property and that will not damage exposed surfaces.
15

16 Concealed Spaces: Remove debris from concealed spaces before enclosing the space.
17

18 Exposed Surfaces: Clean exposed surfaces and protect as necessary to ensure freedom from damage and
19 deterioration at time of Substantial Completion.
20

21 Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or
22 into waterways. Comply with waste disposal requirements in Section 01 74 19 "Construction Waste
23 Management and Disposal."
24

25 During handling and installation, clean and protect construction in progress and adjoining materials already
26 in place. Apply protective covering where required to ensure protection from damage or deterioration at
27 Substantial Completion.
28

29 Clean and provide maintenance on completed construction as frequently as necessary through the
30 remainder of the construction period. Adjust and lubricate operable components to ensure operability
31 without damaging effects.
32

33 Limiting Exposures: Supervise construction operations to ensure that no part of the construction, completed
34 or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the
35 construction period.
36

37 **STARTING AND ADJUSTING**

38 Start equipment and operating components to confirm proper operation. Remove malfunctioning units,
39 replace with new units, and retest.
40

41 Adjust equipment for proper operation. Adjust operating components for proper operation without binding.
42

43 Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace
44 damaged and malfunctioning controls and equipment.
45

46 Manufacturer's Field Service: Comply with qualification requirements in Section 01 40 00 "Quality
47 Requirements."
48

49 **PROTECTION OF INSTALLED CONSTRUCTION**

50 Provide final protection and maintain conditions that ensure installed Work is without damage or
51 deterioration at time of Substantial Completion.
52

53 Protection of Existing Items: Provide protection and ensure that existing items to remain undisturbed by
54 construction are maintained in condition that existed at commencement of the Work.
55

1 Comply with manufacturer's written instructions for temperature and relative humidity.

2

3 **CORRECTION OF THE WORK**

4 Repair or remove and replace damaged, defective, or nonconforming Work. Restore damaged substrates
5 and finishes.

6

7 Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching
8 materials, and properly adjusting operating equipment.

9

10 Repair Work previously completed and subsequently damaged during construction period. Repair to like-
11 new condition.

12

13 Restore permanent facilities used during construction to their specified condition.

14

15 Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without
16 visible evidence of repair.

17

18 Repair components that do not operate properly. Remove and replace operating components that cannot be
19 repaired.

20

21 Remove and replace chipped, scratched, and broken glass or reflective surfaces.

22

23

END OF SECTION

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1
2 **SECTION 01 74 19**
3 **CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL**

4 **PART 1 - GENERAL**

5
6 **SUMMARY**

7 Section includes administrative and procedural requirements for the following:

- 8 Salvaging nonhazardous demolition and construction waste.
9 Recycling nonhazardous demolition and construction waste.
10 Disposing of nonhazardous demolition and construction waste.

11
12 **DEFINITIONS**

13 Construction Waste: Building, structure, and site improvement materials and other solid waste resulting
14 from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.

15
16 Demolition Waste: Building, structure, and site improvement materials resulting from demolition
17 operations.

18
19 Disposal: Removal of demolition or construction waste and subsequent salvage, sale, recycling, or deposit
20 in landfill, incinerator acceptable to authorities having jurisdiction, or designated spoil areas on Owner's
21 property.

22
23 Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.

24
25 Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.

26
27 Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the
28 Work.

29
30 **QUALITY ASSURANCE**

31 Waste Management Conference(s): Conduct conference(s) at Project site to comply with requirements in
32 Section 01 31 00 "Project Management and Coordination."
33

34 **WASTE MANAGEMENT PLAN**

35 General: Develop a waste management plan according to requirements in this Section.
36

37 **PART 2 - PRODUCTS**

38
39 **PERFORMANCE REQUIREMENTS**

40 General: Review with Owner and Architect what items will be salvaged, recycled, or disposed of.
41

42 **PART 3 - EXECUTION**

43
44 **PLAN IMPLEMENTATION**

45 General: Implement approved waste management plan. Provide handling, containers, storage, signage,
46 transportation, and other items as required to implement waste management plan during the entire duration
47 of the Contract.

48
49 Site Access and Temporary Controls: Conduct waste management operations to ensure minimum
50 interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

51
52 Designate and label specific areas on Project site necessary for separating materials that are to be
53 salvaged and recycled.

54 Comply with Section 01 50 00 "Temporary Facilities and Controls" for controlling dust and dirt,
55 environmental protection, and noise control.

1
2 **SALVAGING DEMOLITION WASTE**

3 Comply with requirements in Section 02 41 19 "Selective Demolition" for salvaging demolition waste.

4
5 Salvaged Items for Owner's Use:

6
7 Clean salvaged items.

8 Pack or crate items after cleaning. Identify contents of containers with label indicating elements, date
9 of removal, quantity, and location where removed.

10 Store items in a secure area until delivery to Owner.

11 Protect items from damage during transport and storage.
12

13 **RECYCLING WASTE, GENERAL**

14 General: Recycle paper and beverage containers used by on-site workers.

15
16 Preparation of Waste: Prepare and maintain recyclable waste materials according to recycling or reuse
17 facility requirements. Maintain materials free of dirt, adhesives, solvents, petroleum contamination, and
18 other substances deleterious to the recycling process.
19

20 Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable
21 waste by type at Project site to the maximum extent practical according to approved construction waste
22 management plan.
23

24 **RECYCLING DEMOLITION WASTE**

25 Asphalt Paving: Break up and transport paving to asphalt-recycling facility.
26

27 Concrete: Remove reinforcement and other metals from concrete and sort with other metals.
28

29 Masonry: Remove metal reinforcement, anchors, and ties from masonry and sort with other metals.
30

31 Wood Materials: Sort and stack members according to size, type, and length. Separate lumber, engineered
32 wood products, panel products, and treated wood materials.
33

34 Metals: Separate metals by type.

35
36 Structural Steel: Stack members according to size, type of member, and length.

37 Remove and dispose of bolts, nuts, washers, and other rough hardware.
38

39 Metal Suspension System: Separate metal members, including trim and other metals from acoustical panels
40 and tile, and sort with other metals.
41

42 Piping: Reduce piping to straight lengths and store by material and size. Separate supports, hangers, valves,
43 sprinklers, and other components by material and size.
44

45 Conduit: Reduce conduit to straight lengths and store by material and size.
46

47 Lamps: Separate lamps by type and store according to requirements in 40 CFR 273.
48

49 **RECYCLING CONSTRUCTION WASTE**

50 Packaging:

51
52 Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.

53 Polystyrene Packaging: Separate and bag materials.

54 Pallets: As much as possible, require deliveries using pallets to remove pallets from Project site. For
55 pallets that remain on-site, break down pallets into component wood pieces and comply with
56 requirements for recycling wood.

1 Crates: Break down crates into component wood pieces and comply with requirements for recycling
2 wood.

3

4 Wood Materials:

5 Clean Cut-Offs of Lumber: Grind or chip into small pieces.

6 Clean Sawdust: Bag sawdust that does not contain painted or treated wood.

7

8 **DISPOSAL OF WASTE**

9 General: Except for items or materials to be salvaged or recycled, remove waste materials from Project site
10 and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.

11

12 Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-
13 site.

14 Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

15

16 General: Except for items or materials to be salvaged or recycled, remove waste materials and legally
17 dispose of at designated spoil areas on Owner's property.

18

19 Burning: Do not burn waste materials.

20

21

END OF SECTION

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SECTION 01 77 00
CLOSEOUT PROCEDURES

PART 1 - GENERAL

SUMMARY

Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:

- Substantial Completion procedures.
- Final completion procedures.
- Warranties.
- Final cleaning.
- Repair of the Work.

ACTION SUBMITTALS

Product Data: For each type of cleaning agent.

Contractor's List of Incomplete Items: Initial submittal at Substantial Completion.

Certified List of Incomplete Items: Final submittal at final completion.

CLOSEOUT SUBMITTALS

Certificates of Release: From authorities having jurisdiction.

Certificate of Insurance: For continuing coverage.

Field Report: For pest control inspection.

SUBSTANTIAL COMPLETION PROCEDURES

Contractor's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Contractor's punch list), indicating the value of each item on the list and reasons why the Work is incomplete.

Submittals Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.

Certificates of Release: Obtain and submit releases from authorities having jurisdiction permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.

Submit closeout submittals specified in other Division 01 Sections, including project record documents, operation and maintenance manuals, damage or settlement surveys, property surveys, and similar final record information.

Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.

Submit maintenance material submittals specified in individual Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Architect. Label with manufacturer's name and model number.

Submit testing, adjusting, and balancing records.

Submit sustainable design submittals not previously submitted.

Submit changeover information related to Owner's occupancy, use, operation, and maintenance.

1 Procedures Prior to Substantial Completion: Complete the following a minimum of 10 days prior to
2 requesting inspection for determining date of Substantial Completion. List items below that are incomplete
3 at time of request.

- 4
- 5 Advise Owner of pending insurance changeover requirements.
- 6 Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of
7 changeover in security provisions.
- 8 Complete startup and testing of systems and equipment.
- 9 Perform preventive maintenance on equipment used prior to Substantial Completion.
- 10 Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and
11 systems. Submit demonstration and training video recordings specified in Section 01 79 00
12 "Demonstration and Training."
- 13 Advise Owner of changeover in utility services.
- 14 Participate with Owner in conducting inspection and walkthrough with local emergency responders.
- 15 Terminate and remove temporary facilities from Project site, along with mockups, construction tools,
16 and similar elements.
- 17 Complete final cleaning requirements.
- 18 Touch up paint and otherwise repair and restore marred exposed finishes to eliminate visual defects.
- 19

20 Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of 10
21 days prior to date the Work will be completed and ready for final inspection and tests. On receipt of
22 request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements.
23 Architect will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of
24 items, either on Contractor's list or additional items identified by Architect, that must be completed or
25 corrected before certificate will be issued.

26 **FINAL COMPLETION PROCEDURES**

27 Submittals Prior to Final Completion: Before requesting final inspection for determining final completion,
28 complete the following:
29

- 30
- 31 Submit a final Application for Payment according to Section 01 29 00 "Payment Procedures."
- 32 Certified List of Incomplete Items: Submit certified copy of Architect's Substantial Completion
33 inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect.
34 Certified copy of the list shall state that each item has been completed or otherwise resolved for
35 acceptance.
- 36 Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with
37 insurance requirements.
- 38 Submit pest-control final inspection report.
- 39

40 Inspection: Submit a written request for final inspection to determine acceptance a minimum of 10 days
41 prior to date the work will be completed and ready for final inspection and tests. On receipt of request,
42 Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will
43 prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must
44 be completed or corrected before certificate will be issued.

45 **LIST OF INCOMPLETE ITEMS (PUNCH LIST)**

46 Organization of List: Include name and identification of each space and area affected by construction
47 operations for incomplete items and items needing correction including, if necessary, areas disturbed by
48 Contractor that are outside the limits of construction.
49

- 50
- 51 Organize list of spaces in sequential order, starting with exterior areas first.
- 52 Organize items applying to each space by major element, including categories for ceiling, individual
53 walls, floors, equipment, and building systems.
- 54 Submit list of incomplete items in the following format:
55

1 PDF electronic file. Architect will return annotated file.

2
3 **SUBMITTAL OF PROJECT WARRANTIES**

4 Time of Submittal: Submit written warranties on request of Architect for designated portions of the Work
5 where warranties are indicated to commence on dates other than date of Substantial Completion, or when
6 delay in submittal of warranties might limit Owner's rights under warranty.

7
8 Organize warranty documents into an orderly sequence based on the table of contents of Project Manual.

9
10 Warranty Electronic File: Provide warranties and bonds in PDF format. Assemble complete warranty and
11 bond submittal package into a single electronic PDF file with bookmarks enabling navigation to each item.
12 Provide bookmarked table of contents at beginning of document.

13
14 Submit on digital media acceptable to Architect.

15
16 Warranties in Paper Form:

17
18 Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as
19 necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper.

20
21 Provide additional copies of each warranty to include in operation and maintenance manuals.

22
23 **PART 2 - PRODUCTS**

24
25 **MATERIALS**

26 Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the
27 surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that
28 might damage finished surfaces.

29
30 **PART 3 - EXECUTION**

31
32 **FINAL CLEANING**

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

35
36 Cleaning: Clean each surface or unit, comply with manufacturer's written instructions.

37
38 Complete the following cleaning operations before requesting inspection for certification of
39 Substantial Completion for entire Project or for a designated portion of Project:

40
41 Clean Project site, yard, and grounds, in areas disturbed by construction activities, including
42 landscape development areas, of rubbish, waste material, litter, and other foreign substances.

43 Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains,
44 films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces.

45 Restore reflective surfaces to their original condition.

46 Sweep concrete surfaces.

47 Clean light fixtures, lamps, globes, and reflectors to function with full efficiency.

48 Leave Project clean.

49
50 Pest Control: Comply with pest control requirements in Section 01 50 00 "Temporary Facilities and
51 Controls." Prepare written report.

52
53 Construction Waste Disposal: Comply with waste disposal requirements in Section 01 50 00 "Temporary
54 Facilities and Controls."

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REPAIR OF THE WORK

Complete repair and restoration operations, before requesting inspection for determination of Substantial Completion.

Repair, or remove and replace, defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.

END OF SECTION

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SECTION 01 78 23
OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

SUMMARY

Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:

- Operation and maintenance documentation directory manuals.
- Systems and equipment operation manuals.
- Systems and equipment maintenance manuals.
- Product maintenance manuals.

CLOSEOUT SUBMITTALS

Submit operation and maintenance manuals indicated. Provide content for each manual as specified in individual Specification Sections, and as reviewed and approved at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.

Format: Submit on digital media acceptable to Architect. Enable reviewer comments on draft submittals.

Final Manual Submittal: Submit (2) Two manuals in final form prior to requesting inspection for Substantial Completion before commencing demonstration and training.

Correct or revise each manual to comply with Architect's comments.

Comply with Section 01 77 00 "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

FORMAT OF OPERATION AND MAINTENANCE MANUALS

Manuals, Electronic File (1) One File: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.

Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.

File Names and Bookmarks: Bookmark individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.

Manuals, Paper Copies (2) Two Bound Books: Submit manuals in the form of hard-copy, bound and labeled volumes.

Binders: Heavy-duty, three-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.

Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.

If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.

If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

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SECTION 01 79 00
DEMONSTRATION AND TRAINING

PART 1 - GENERAL

SUMMARY

Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:

Instruction in operation and maintenance of systems, subsystems, and equipment.

QUALITY ASSURANCE

Preinstruction Conference: Conduct conference at Project site to comply with requirements in Section 01 31 00 "Project Management and Coordination."

COORDINATION

Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations and to ensure availability of Owner's personnel.

INSTRUCTION PROGRAM

Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.

INSTRUCTION

Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final Operation and Maintenance Manual.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

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SECTION 02 41 19
SELECTIVE DEMOLITION

PART 1 - GENERAL

SUMMARY

The Work of this Section Includes:

Demolition and removal of selected portions of the building interior.
Removal and salvage of existing items for delivery to Owner and removal of existing items for
reinstallation.

Related Requirements:

Section 01 10 00 "Summary" for restrictions on use of the premises, Owner-occupancy requirements,
and phasing requirements.

Section 01 56 39 "Temporary Tree and Plant Protection" for temporary protection of existing trees and
plants that are affected by selective demolition.

Section 01 73 00 "Execution" for cutting and patching procedures.

Section 01 35 16 "Alteration Project Procedures" for general protection and work procedures for
alteration projects.

MATERIALS OWNERSHIP

Unless otherwise indicated, demolition waste (items no being re-used) becomes property of Contractor.

Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their
contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be
uncovered during demolition remain the property of Owner.

Carefully salvage in a manner to prevent damage and promptly return to Owner.

PREINSTALLATION MEETINGS

Pre-demolition Conference: Conduct conference at Project site.

INFORMATIONAL SUBMITTALS

Survey of Existing Conditions: Submit survey.

Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for
protecting individuals and property, for dust control and, for noise control. Indicate proposed locations and
construction of barriers.

Schedule of selective demolition activities with starting and ending dates for each activity.

Statement of Refrigerant Recovery: Signed by refrigerant recovery technician. (Refrigerant may not be part
of this project)

CLOSEOUT SUBMITTALS

Inventory: Submit a list of items that have been removed and salvaged.

FIELD CONDITIONS

Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective
demolition so Owner's operations will not be disrupted.

Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.

Before selective demolition, Owner will remove the following items:

Furniture, not fixed in place.

Equipment like printers, computers, monitors, etc.

Ceiling hung TVs (3 total)

1 Microphones, video equipment shall be removed by CCAP, unless otherwise coordinated.
2

3 Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective
4 demolition.

5
6 **Hazardous Materials:**

7 It is not expected that hazardous materials will be encountered in the Work.

8 If materials suspected of containing hazardous materials are encountered, do not disturb;
9 immediately notify Architect and Owner. Hazardous materials will be removed by Owner under
10 a separate contract.

11
12 On-site sale of removed items or materials is not permitted.
13

14 **WARRANTY**

15 Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during
16 selective demolition, by methods and with materials and using approved contractors so as not to void existing
17 warranties. The roof above the Courtroom was recently replaced, verify warranty before installing or making
18 any openings on the roof.
19

20 **PART 2 - PRODUCTS**

21
22 **PERFORMANCE REQUIREMENTS**

23 Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective
24 demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
25

26 Standards: Comply with ANSI/ASSP A10.6 and NFPA 241.
27

28 **PART 3 - EXECUTION**

29
30 **EXAMINATION**

31 Survey of Existing Conditions: Record existing conditions by use of preconstruction photographs or video.

32 Inventory and record the condition of items to be removed for salvage or reinstallation. Photograph or
33 video conditions that might be misconstrued as damage caused by removal.

34 Photograph or video existing conditions of adjoining construction including finish surfaces, that might
35 be misconstrued as damage caused by selective demolition operations or removal of items for salvage
36 or reinstallation.
37

38 **PREPARATION**

39 Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people
40 and damage to adjacent buildings and facilities to remain.
41

42 Existing Items to Remain: Protect construction indicated to remain against damage and soiling during
43 selective demolition. When permitted by Owner, items may be removed to a suitable, protected storage
44 location and cleaned and reinstalled in their original locations after selective demolition operations are
45 complete.
46

47 Refrigerant: Before starting demolition, remove refrigerant from mechanical equipment in accordance with
48 40 CFR 82 and regulations of authorities having jurisdiction.
49

50 **UTILITY SERVICES AND BUILDING SYSTEMS**

51 Existing Services/Systems to Remain: Maintain utilities and building systems and equipment to remain and
52 protect against damage during selective demolition operations.
53

54 **SALVAGE/REINSTALL**

55 Removed and Salvaged Items:

- 1 Clean salvaged items.
- 2 Pack or crate items after cleaning. Identify contents of containers with label indicating elements, date of
- 3 removal, quantity, and location where removed.
- 4 Store items in a secure area until delivery to Owner.
- 5 Transport items to Owner's storage area on-site designated by Owner.
- 6 Protect items from damage during transport and storage.

7
8 **Removed and Reinstalled Items:**

- 9 Clean and repair items to functional condition adequate for intended reuse.
- 10 Pack or crate items after cleaning and repairing. Identify contents of containers.
- 11 Protect items from damage during transport and storage.
- 12 Reinstall items in locations indicated. Comply with installation requirements for new materials and
- 13 equipment. Provide connections, supports, and miscellaneous materials necessary to make item
- 14 functional for use indicated.

15
16 **SELECTIVE DEMOLITION, GENERAL**

17 General: Demolish and remove existing construction only to extent required by new construction and as
18 indicated. Use methods required to complete the Work within limitations of governing regulations and as
19 follows:

- 20 Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least
- 21 likely to damage construction to remain or adjoining construction. Use hand tools or small power tools
- 22 designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
- 23 Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished
- 24 surfaces.
- 25 Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such
- 26 as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting
- 27 operations. Maintain portable fire-suppression devices during flame-cutting operations.
- 28 Maintain fire watch during and for at least 2 hours after flame-cutting operations.
- 29 Locate selective demolition equipment and remove debris and materials so as not to impose excessive
- 30 loads on supporting walls, floors, or framing.

31
32 Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure
33 minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

34
35 **DISPOSAL OF DEMOLISHED MATERIALS**

- 36 Remove demolition waste materials from Project site and recycle or dispose of them in accordance with
- 37 Section 01 74 19 "Construction Waste Management and Disposal."
- 38 Do not allow demolished materials to accumulate on-site.
- 39 Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

40
41 Burning: Do not burn demolished materials.

42
43 **CLEANING**

44 Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition
45 operations. Return adjacent areas to condition existing before selective demolition operations began.

46
47 **END OF SECTION**

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SECTION 03 30 53
MISCELLANEOUS CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

SUMMARY

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

ACTION SUBMITTALS

Product Data: For each type of product.

Design Mixtures: For each concrete mixture.

QUALITY ASSURANCE

Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

PART 2 - PRODUCTS

CONCRETE, GENERAL

Comply with ACI 301.

Comply with ACI 117.

STEEL REINFORCEMENT

Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

Plain-Steel Welded-Wire Reinforcement: ASTM A 1064/A 1064M, plain, fabricated from as-drawn steel wire into flat sheets.

CONCRETE MATERIALS

Regional Materials: Concrete shall be manufactured within 500 miles of Project site.

Cementitious Materials:

Portland Cement: ASTM C 150/C 150M, Type I/II.

Fly Ash: ASTM C 618, Class C or F.

Slag Cement: ASTM C 989/C 989M, Grade 100 or 120.

Blended Hydraulic Cement: ASTM C 595/C 595M, Type IS, portland blast-furnace slag cement.

Normal-Weight Aggregate: ASTM C 33/C 33M, 1-1/2-inch nominal maximum aggregate size.

Air-Entraining Admixture: ASTM C 260/C 260M.

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

Water-Reducing Admixture: ASTM C 494/C 494M, Type A.

Retarding Admixture: ASTM C 494/C 494M, Type B.

Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.

High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.

High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.

Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

Water: ASTM C 94/C 94M.

1
2 **RELATED MATERIALS**

3 Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber, or ASTM D 1752, cork or self-
4 expanding cork.

5
6 **CURING MATERIALS**

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

9
10 Absorptive Cover: AASHTO M 182, Class 3, burlap cloth or cotton mats.

11
12 Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

13
14 **CONCRETE MIXTURES**

15 Normal-Weight Concrete:

16
17 Minimum Compressive Strength: 4000 psi at 28 days.

18 Maximum W/C Ratio: 0.45.

19 Cementitious Materials: Use fly ash, pozzolan, slag cement, and silica fume as needed to reduce the total
20 amount of portland cement, which would otherwise be used, by not less than 40 percent.

21 Slump Limit: 4 inches, plus or minus 1 inch.

22 Air Content: Maintain within range permitted by ACI 301. Do not allow air content of trowel-finished
23 floor slabs to exceed 3 percent.

24
25 Synthetic Fiber: Uniformly disperse in concrete mix at manufacturer's recommended rate, but not less than a
26 rate of 1.0 lb/cu. yd..

27
28 **CONCRETE MIXING**

29 Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and
30 ASTM C 1116/C 1116, and furnish batch ticket information.

31
32 When air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

33
34 **PART 3 - EXECUTION**

35
36 **FORMWORK INSTALLATION**

37 Design, construct, erect, brace, and maintain formwork according to ACI 301.

38
39 **EMBEDDED ITEM INSTALLATION**

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

43
44 **STEEL REINFORCEMENT INSTALLATION**

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

46
47 Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

48
49 **CONCRETE PLACEMENT**

50 Before test sampling and placing concrete, water may be added at Project site, subject to limitations of
51 ACI 301.

52
53 Do not add water to concrete during delivery, at Project site, or during placement.

1 **FINISHING FORMED SURFACES**

2 Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly
3 and symmetrical manner with a minimum of seams. Repair and patch tie holes and defective areas. Remove
4 fins and other projections exceeding 1/8 inch.

5
6 Apply to concrete surfaces to be covered with a coating or covering material applied directly to concrete
7 (Carpet).

8
9 **FINISHING UNFORMED SURFACES**

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

12
13 Screenshot surfaces with a straightedge and strike off. Begin initial floating using bull floats or darbies to form a
14 uniform and open-textured surface plane before excess moisture or bleedwater appears on surface.

15
16 Do not further disturb surfaces before starting finishing operations.

17
18 Float Finish: Apply float finish to surfaces indicated, to surfaces to receive trowel finish, and to floor and
19 slab surfaces to be covered with fluid-applied or sheet waterproofing, fluid-applied or direct-to-deck-applied
20 membrane roofing, or sand-bed terrazzo.

21
22 **CONCRETE PROTECTING AND CURING**

23 General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
24 Comply with ACI 306.1 for cold-weather protection and with ACI 305.1 for hot-weather protection during
25 curing.

26
27 Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

28
29 Curing Methods: Cure formed and unformed concrete for at least seven days by one or a combination of the
30 following methods:

31
32 Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing
33 concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed
34 by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or
35 tears during curing period, using cover material and waterproof tape.

36 Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation
37 by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to
38 heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a
39 second coat. Maintain continuity of coating and repair damage during curing period.

40
41 **FIELD QUALITY CONTROL**

42 Testing Agency: Engage a qualified testing agency to perform tests and inspections.

43
44 Tests: Perform according to ACI 301.

45
46 Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding
47 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.

48 Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each
49 concrete mixture placed each day.

50
51 **END OF SECTION**

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SECTION 05 40 00
COLD-FORMED METAL FRAMING

PART 1 - GENERAL

SUMMARY

Section Includes: Interior non-load-bearing wall framing.

PREINSTALLATION MEETINGS

Preinstallation Conference: Conduct conference at Project site.

ACTION SUBMITTALS

Product Data: For the following:

- Cold-formed steel framing materials.
- Interior non-load-bearing wall framing.
- Vertical deflection clips.
- Single deflection track.
- Drift clips.
- Post-installed anchors.

Shop Drawings:

- Include layout, spacings, sizes, thicknesses, and types of cold-formed steel framing; fabrication; and fastening and anchorage details, including mechanical fasteners.
- Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.

INFORMATIONAL SUBMITTALS

- Welding certificates.
- Product certificates.
- Product test reports.
- Research Reports:

- For post-installed anchors, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

QUALITY ASSURANCE

Product Tests: Mill certificates or data from a qualified independent testing agency.

Welding Qualifications: Qualify procedures and personnel according to the following:

- AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

PART 2 - PRODUCTS

PERFORMANCE REQUIREMENTS

Cold-Formed Steel Framing Standards: Unless more stringent requirements are indicated, framing shall comply with AISI S100, AISI S200, and the following:

- Wall Studs: AISI S211.
- Headers: AISI S212.
- Lateral Design: AISI S213.

1 **COLD-FORMED STEEL FRAMING MATERIALS**

2 Steel Sheet: ASTM A1003/A1003M, Structural Grade, Type H, metallic coated, of grade and coating
3 designation as follows:

4
5 Grade: ST33H or As required by structural performance.

6 Coating: G60, A60, AZ50, or GF30.

7
8 Steel Sheet for Vertical Deflection Clips: ASTM A653/A653M, structural steel, zinc coated, of grade and
9 coating as follows:

10
11 Grade: 33 or As required by structural performance.

12 Coating: G60.

13
14 **INTERIOR NON-LOAD-BEARING WALL FRAMING**

15 Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened
16 flanges, and as follows:

17
18 Minimum Base-Metal Thickness: 0.0428 inch.

19 Flange Width: 1-5/8 inches.

20
21 Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with
22 unstiffened flanges, and matching minimum base-metal thickness of steel studs.

23
24 Vertical Deflection Clips: Manufacturer's standard bypass or head clips, capable of accommodating upward
25 and downward vertical displacement of primary structure through positive mechanical attachment to stud
26 web.

27
28 Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with
29 unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges
30 designed to support horizontal loads and transfer them to the primary structure.

31
32 Drift Clips: Manufacturer's standard bypass or head clips, capable of isolating wall stud from upward and
33 downward vertical displacement and lateral drift of primary structure through positive mechanical
34 attachment to stud web and structure.

35
36 **FRAMING ACCESSORIES**

37 Fabricate steel-framing accessories from ASTM A1003/A1003M, Structural Grade, Type H, metallic
38 coated steel sheet, of same grade and coating designation used for framing members.

39
40 Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated.

41
42 **ANCHORS, CLIPS, AND FASTENERS**

43 Steel Shapes and Clips: ASTM A36/A36M, zinc coated by hot-dip process according to
44 ASTM A123/A123M.

45
46 Anchor Bolts: ASTM F1554, Grade 36, threaded carbon-steel hex-headed bolts, carbon-steel nuts, and flat,
47 hardened-steel washers; zinc coated by hot-dip process according to ASTM A153/A153M, Class C.

48
49 Post-Installed Anchors: Fastener systems with bolts of same basic metal as fastened metal, if visible, unless
50 otherwise indicated; with working capacity greater than or equal to the design load, according to an
51 evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01, ICC-ES AC193,
52 ICC-ES AC58 or ICC-ES AC308 as appropriate for the substrate.

53
54 Uses: Securing cold-formed steel framing to structure.

55 Type: Adhesive anchor.

1 Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or
2 ASTM F1941, Class Fe/Zn 5, unless otherwise indicated.

3
4 Power-Actuated Anchors: Fastener systems with working capacity greater than or equal to the design load,
5 according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

6
7 Mechanical Fasteners: ASTM C1513, corrosion-resistant-coated, self-drilling, self-tapping, steel drill
8 screws.

9
10 Head Type: Low-profile head beneath sheathing; manufacturer's standard elsewhere.

11
12 **MISCELLANEOUS MATERIALS**

13 Galvanizing Repair Paint: ASTM A780/A780M, MIL-P-21035B or SSPC-Paint 20.

14
15 Cement Grout: Portland cement, ASTM C150/C150M, Type I; and clean, natural sand, ASTM C404. Mix
16 at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and
17 hydration.

18
19 Nonmetallic, Nonshrink Grout: Factory-packaged, nonmetallic, noncorrosive, nonstaining grout, complying
20 with ASTM C1107/C1107M, and with a fluid consistency and 30-minute working time.

21
22 Shims: Load-bearing, high-density, multimonomer, nonleaching plastic; or cold-formed steel of same grade
23 and metallic coating as framing members supported by shims.

24
25 **PART 3 - EXECUTION**

26
27 **INSTALLATION, GENERAL**

28 Cold-formed steel framing may be shop or field fabricated for installation, or it may be field assembled.

29
30 Install cold-formed steel framing according to AISI S200, AISI S202, and manufacturer's written
31 instructions unless more stringent requirements are indicated.

32
33 Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections
34 securely fastened.

35
36 Install framing members in one-piece lengths unless splice connections are indicated for track or tension
37 members.

38
39 Install temporary bracing and supports to secure framing and support loads equal to those for which
40 structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated
41 supporting structure has been completed and permanent connections to framing are secured.

42
43 Install sound batts, specified in Section 07 21 01 "Sound Attenuation Batt" in framing-assembly members,
44 such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of
45 framing work.

46
47 Fasten hole-reinforcing plate over web penetrations that exceed size of manufacturer's approved or standard
48 punched openings.

49
50 **INSTALLATION OF INTERIOR NON-LOAD-BEARING WALL FRAMING**

51 Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting
52 structure.

53
54 Fasten both flanges of studs to top and bottom track unless otherwise indicated. Space studs as follows:
55

1 Stud Spacing: 16 inches.

2
3 Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces
4 and similar requirements.

5
6 Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while
7 providing lateral support.

8
9 Install single deep-leg deflection tracks and anchor to building structure.

10 Connect vertical deflection clips to studs and anchor to building structure.

11 Connect drift clips to cold-formed steel metal framing and anchor to building structure.

12
13 Install horizontal bridging in wall studs, spaced vertically in rows indicated but not more than 48 inches
14 apart. Fasten at each stud intersection.

15
16 Channel Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched
17 studs.

18 Strap Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-
19 track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and
20 secure solid blocking to stud webs or flanges.

21 Bar Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.

22
23 Top Bridging for Single Deflection Track: Install row of horizontal bridging within 18 inches of single
24 deflection track. Install a combination of bridging and stud or stud-track solid blocking of width and
25 thickness matching studs, secured to stud webs or flanges.

26
27 Install solid blocking at 96-inch centers.

28
29 Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles,
30 continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

31 32 **INSTALLATION TOLERANCES**

33 Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation
34 of 1/8 inch in 10 feet and as follows:

35
36 Space individual framing members no more than plus or minus 1/8 inch from plan location.

37 Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing
38 materials.

39 40 **REPAIRS**

41 Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-
42 formed steel framing with galvanized repair paint according to ASTM A780/A780M and manufacturer's
43 written instructions.

44
45 **END OF SECTION**

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SECTION 05 50 00
METAL FABRICATIONS

PART 1 – GENERAL

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SUMMARY

Section Includes:

- Miscellaneous framing and supports.
- Metal floor plate.
- Miscellaneous steel trim.

Products furnished, but not installed, under this Section include the following:

- Loose steel lintels.
- Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
- Steel weld plates and angles for casting into concrete.

ACTION SUBMITTALS

Product Data: For the following:

- Fasteners.
- Shop primers.
- Shrinkage-resisting grout.
- Slotted channel framing.
- Abrasive metal nosings, treads, and thresholds.

Shop Drawings: Show fabrication and installation details.

PART 2 – PRODUCTS

METALS

Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

Steel Plates, Shapes, and Bars: ASTM A36/A36M.

Stainless Steel Bars and Shapes: ASTM A276/A276M, Type 304.

Rolled-Steel Floor Plate: ASTM A786/A786M, rolled from plate complying with ASTM A36/A36M or ASTM A283/A283M, Grade C or D.

Rolled-Stainless Steel Floor Plate: ASTM A793.

Steel Tubing: ASTM A500/A500M, cold-formed steel tubing.

Steel Pipe: ASTM A53/A53M, Standard Weight (Schedule 40) unless otherwise indicated.

Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.

Size of Channels: 1-5/8 by 1-5/8 inches.

Material: Cold-rolled steel, ASTM A1008/A1008M, commercial steel, Type B; 0.0677-inch minimum thickness; coated with rust-inhibitive, baked-on, acrylic enamel or hot-dip galvanized after fabrication.

1
2 **FASTENERS**

3 General: Unless otherwise indicated, provide Type 304 stainless steel fasteners for exterior use and zinc-
4 plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, at
5 exterior walls. Select fasteners for type, grade, and class required.

6
7 Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors.

8 Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or
9 ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.

10 Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless steel
11 bolts, ASTM F593, and nuts, ASTM F594.

12
13 Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with
14 MFMA-4, 1-5/8 by 7/8 inches by length indicated with anchor straps or studs not less than 3 inches long at
15 not more than 8 inches o.c. Provide with temporary filler and tee-head bolts, complete with washers and nuts,
16 all zinc-plated to comply with ASTM B633, Class Fe/Zn 5, as needed for fastening to inserts.

17
18 **MISCELLANEOUS MATERIALS**

19 Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying
20 with MPI#79 and compatible with topcoat.

21 Use primer that contains pigments that make it easily distinguishable from zinc-rich primer.

22
23 Water-Based Primer: Emulsion type, anticorrosive primer for mildly corrosive environments that is resistant
24 to flash rusting when applied to cleaned steel, complying with MPI#107 and compatible with topcoat.

25
26 Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.

27
28 Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible
29 with finish paint systems indicated.

30
31 Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with
32 paints specified to be used over it.

33
34 Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

35 Shrinkage-Resistant Grout: Factory-packaged, nonmetallic, nonstaining, noncorrosive, nongaseous grout
36 complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for
37 interior and exterior applications.

38
39 **FABRICATION, GENERAL**

40 Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as
41 necessary for shipping and handling limitations. Use connections that maintain structural value of joined
42 pieces. Clearly mark units for reassembly and coordinated installation.

43
44 Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately
45 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

46
47 Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing
48 work.

49
50 Form exposed work with accurate angles and surfaces and straight edges.

51
52 Weld corners and seams continuously to comply with the following:

53 Use materials and methods that minimize distortion and develop strength and corrosion resistance of
54 base metals.

55 Obtain fusion without undercut or overlap.

1 Remove welding flux immediately.
2 At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows
3 after finishing.
4
5 Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where
6 possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless
7 otherwise indicated. Locate joints where least conspicuous.
8
9 Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide
10 weep holes where water may accumulate.
11
12 Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel
13 strap anchors, not less than 8 inches from ends and corners of units and 24 inches o.c.
14
15 **MISCELLANEOUS FRAMING AND SUPPORTS**
16 General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.
17
18 Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated.
19 Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.
20
21 **METAL FLOOR PLATE**
22 Fabricate from rolled-steel floor plate of thickness indicated below:
23 Thickness: 3/16 inch.
24
25 Provide steel angle supports as indicated.
26
27 **MISCELLANEOUS STEEL TRIM**
28 Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with
29 continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where
30 possible.
31
32 Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.
33 Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.
34
35 **LOOSE BEARING AND LEVELING PLATES**
36 Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill
37 plates to receive anchor bolts and for grouting.
38
39 Galvanize bearing and leveling plates.
40
41 Prime plates with zinc-rich primer.
42
43 **LOOSE STEEL LINTELS**
44 Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in
45 masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless
46 otherwise indicated. Weld adjoining members together to form a single unit where indicated.
47
48 Galvanize loose steel lintels located in exterior walls.
49
50 Prime loose steel lintels located in exterior walls with zinc-rich primer.
51
52 **STEEL WELD PLATES AND ANGLES**
53 Provide steel weld plates and angles not specified in other Sections, for items supported from concrete
54 construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded
55 steel strap anchors for embedding in concrete.

1
2 **GENERAL FINISH REQUIREMENTS**

3 Finish metal fabrications after assembly.
4

5 **STEEL AND IRON FINISHES**

6 Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron
7 hardware and with ASTM A123/A123M for other steel and iron products.

8 Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
9

10 Shop prime iron and steel items unless they are to be embedded in concrete, sprayed-on fireproofing, or
11 masonry, or unless otherwise indicated.

12 Shop prime with universal shop primer unless indicated.
13

14 Preparation for Shop Priming: Prepare surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast
15 Cleaning."
16

17 Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop,
18 Field, and Maintenance Painting of Steel," for shop painting.
19

20 **PART 3 - EXECUTION**
21

22 **INSTALLATION, GENERAL**

23 Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal
24 fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces
25 level, plumb, true, and free of rack; and measured from established lines and levels.
26

27 Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left
28 as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade
29 surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed
30 field connections.
31

32 Field Welding: Comply with the following requirements:

33 Use materials and methods that minimize distortion and develop strength and corrosion resistance of
34 base metals.

35 Obtain fusion without undercut or overlap.

36 Remove welding flux immediately.

37 At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows
38 after finishing and contour of welded surface matches that of adjacent surface.
39

40 Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are
41 required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry
42 inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.
43

44 Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or
45 similar construction.
46

47 **INSTALLATION OF MISCELLANEOUS FRAMING AND SUPPORTS**

48 Install framing and supports to comply with requirements of items being supported, including manufacturers'
49 written instructions and requirements indicated on Shop Drawings.
50

51 Anchor shelf angles securely to existing construction with anchor bolts.
52

53 **INSTALLATION OF METAL FLOOR PLATE**

54 Install metal floor plates flush with finished surface. Adjust as required to avoid lippage that could present a
55 tripping hazard.

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INSTALLATION OF MISCELLANEOUS STEEL TRIM

Anchor to concrete construction to comply with manufacturer's written instructions.

INSTALLATION OF LOOSE BEARING AND LEVELING PLATES

Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.

Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with shrinkage-resistant grout. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

REPAIRS

Touchup Painting:

Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

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SECTION 05 52 13
PIPE AND TUBE RAILINGS

PART 1 - GENERAL

SUMMARY

Section Includes: Aluminum railings.

ACTION SUBMITTALS

Product Data:

- Manufacturer's product lines of mechanically connected railings.
- Handrail brackets.
- Shop primer.
- Intermediate coats and topcoats.
- Bituminous paint.
- Nonshrink, nonmetallic grout.
- Anchoring cement.
- Metal finishes.
- Paint products.

Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

Samples: For each type of exposed finish.

INFORMATIONAL SUBMITTALS

Welding certificates.

Product Test Reports: For tests on railings performed by a qualified testing agency, in accordance with ASTM E894 and ASTM E935.

QUALITY ASSURANCE

Welding Qualifications: Qualify procedures and personnel in accordance with the following:
AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."

PART 2 - PRODUCTS

PERFORMANCE REQUIREMENTS

Structural Performance: Railings, including attachment to building construction, withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

Handrails and Top Rails of Guards:

- Uniform load of 50 lbf/ ft. applied in any direction.
- Concentrated load of 200 lbf applied in any direction.
- Uniform and concentrated loads need not be assumed to act concurrently.

Infill of Guards:

- Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft..
- Infill load and other loads need not be assumed to act concurrently.

METALS, GENERAL

Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.

Provide type of bracket with flange tapped for concealed anchorage to threaded hanger bolt and that provides 1-1/2-inch clearance from inside face of handrail to finished wall surface.

1
2 **ALUMINUM RAILINGS**

3 Aluminum, General: Provide alloy and temper recommended by aluminum producer and finisher for type
4 of use and finish indicated, and with not less than the strength and durability properties of alloy and temper
5 designated below for each aluminum form required.

6
7 Extruded Tubing: ASTM B221, Alloy 6063-T5/T52.

8
9 Extruded Structural Round Tubing: ASTM B429/B429M, Alloy 6063-T6.
10 Provide Standard Weight (Schedule 40) pipe unless otherwise indicated.

11
12 Drawn Seamless Tubing: ASTM B210/B210M, Alloy 6063-T832.

13
14 Plate and Sheet: ASTM B209, Alloy 6061-T6.

15
16 Die and Hand Forgings: ASTM B247, Alloy 6061-T6.

17
18 Castings: ASTM B26/B26M, Alloy A356.0-T6.

19
20 **FASTENERS**

21 Fastener Materials:

22 Aluminum Railing Components: Type 304 stainless steel fasteners.

23
24 Post-Installed Anchors: Fastener systems with working capacity greater than or equal to the design load,
25 according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193 or
26 ICC-ES AC308.

27 Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B633 or
28 ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.

29
30 **MISCELLANEOUS MATERIALS**

31 Welding Rods and Bare Electrodes: Select in accordance with AWS specifications for metal alloy welded.

32 For aluminum railings, provide type and alloy as recommended by producer of metal to be welded and
33 as required for color match, strength, and compatibility in fabricated items.

34
35 Etching Cleaner for Galvanized Metal: Complying with MPI#25.

36
37 Galvanizing Repair Paint: High-zinc-dust-content paint, complying with SSPC-Paint 20 and compatible
38 with paints specified to be used over it.

39
40 Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying
41 with MPI#79 and compatible with topcoat.

42 Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

43
44 Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.

45
46 Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and
47 compatible with finish paint systems indicated.

48
49 Epoxy Intermediate Coat: Complying with MPI #77 and compatible with primer and topcoat.

50
51 Polyurethane Topcoat: Complying with MPI #72 and compatible with undercoat.

52
53 Bituminous Paint: Cold-applied asphalt emulsion, complying with ASTM D1187/D1187M.

1 Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout, complying
2 with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and
3 exterior applications.
4

5 Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement
6 formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting
7 compound.
8

9 **FABRICATION**

10 Cut, drill, and punch metals cleanly and accurately.
11 Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated.
12 Remove sharp or rough areas on exposed surfaces.
13

14 Form work true to line and level with accurate angles and surfaces.
15

16 Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this
17 purpose. Weld all around at connections, including at fittings.
18 Use materials and methods that minimize distortion and develop strength and corrosion resistance of
19 base metals.
20 Obtain fusion without undercut or overlap.
21 Remove flux immediately.
22 At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish
23 Standards" for Finish #1 welds; ornamental quality with no evidence of a welded joint.
24

25 Welded Connections for Aluminum Pipe: Fabricate railings to interconnect members with concealed
26 internal welds that eliminate surface grinding, using manufacturer's standard system of sleeve and socket
27 fittings.
28

29 Nonwelded Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate
30 members and fittings to produce flush, smooth, rigid, hairline joints.
31

32 Form changes in direction as follows:
33 By bending or by inserting prefabricated elbow fittings.
34

35 Bend members in jigs to produce uniform curvature for each configuration required. Maintain cross section
36 of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed
37 surfaces of components.
38

39 Close exposed ends of hollow railing members with prefabricated cap and end fittings of same metal and
40 finish as railings.
41

42 Close ends of returns unless clearance between end of rail and wall is 1/4 inch or less.
43

44 Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and
45 anchors to interconnect railing members to other work unless otherwise indicated.
46 At brackets and fittings fastened to plaster or gypsum board partitions, provide crush-resistant fillers or
47 other means to transfer loads through wall finishes to structural supports and prevent bracket or
48 fitting rotation and crushing of substrate.
49

50 Provide inserts and other anchorage devices for connecting railings to concrete or masonry work.
51 Fabricate anchorage devices capable of withstanding loads imposed by railings.
52 Coordinate anchorage devices with supporting structure.
53

54 Toe Boards: Where indicated, provide toe boards at railings around openings and at edge of open-sided
55 floors and platforms. Fabricate to dimensions and details indicated.

1
2 **ALUMINUM FINISHES**

3 Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if
4 they are within one-half of the range of approved Samples. Noticeable variations in the same piece are
5 unacceptable. Variations in appearance of other components are acceptable if they are within the range of
6 approved Samples and are assembled or installed to minimize contrast.

7
8 Mill Finish: AA-M12, nonspecular as fabricated.

9
10 Clear Anodic Finish: AAMA 611.

11
12 **PART 3 - EXECUTION**

13
14 **INSTALLATION, GENERAL**

15 Perform cutting, drilling, and fitting required for installing railings.

16 Fit exposed connections together to form tight, hairline joints.

17 Install railings level, plumb, square, true to line; without distortion, warp, or rack.

18 Set railings accurately in location, alignment, and elevation; measured from established lines and
19 levels.

20 Do not weld, cut, or abrade surfaces of railing components that are coated or finished after fabrication
21 and that are intended for field connection by mechanical or other means without further cutting or
22 fitting.

23 Set posts plumb within a tolerance of 1/16 inch in 3 feet.

24 Align rails so variations from level for horizontal members and variations from parallel with rake of
25 steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.

26
27 **ANCHORING POSTS**

28 Use stainless steel pipe sleeves anchored into concrete for installing posts. After posts are inserted into
29 sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout or anchoring cement,
30 mixed and placed to comply with anchoring material manufacturer's written instructions.

31
32 Anchor posts to metal surfaces with flanges, angle type, or floor type, as required by conditions, connected
33 to posts and to metal supporting members.

34
35 **CLEANING**

36 Clean aluminum by washing thoroughly with clean water and soap and rinsing with clean water.

37
38 Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas, and repair galvanizing to
39 comply with ASTM A780/A780M.

40
41 **END OF SECTION**

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SECTION 06 10 53
MISCELLANEOUS ROUGH CARPENTRY

PART 1 - GENERAL

SUMMARY

Section Includes:

- Framing with dimension lumber.
- Rooftop equipment bases and support curbs.
- Wood blocking and nailers.
- Wood furring.
- Wood sleepers.

ACTION SUBMITTALS

Product Data: For each type of process and factory-fabricated product.

PART 2 - PRODUCTS

WOOD PRODUCTS, GENERAL

Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

- Factory mark each piece of lumber with grade stamp of grading agency.
- Dress lumber, S4S, unless otherwise indicated.

Maximum Moisture Content of Lumber: 15 percent unless otherwise indicated.

DIMENSION LUMBER FRAMING

Non-Load-Bearing Interior Partitions: Standard, Stud, or No. 3 grade of any species.

Other Framing: Construction, Stud, or No. 3 grade of any of the following species:

- Hem-fir (north); NLGA.
- Southern pine; SPIB.
- Douglas fir-larch; WCLIB or WWPA.
- Southern pine or mixed southern pine; SPIB.
- Spruce-pine-fir; NLGA.
- Douglas fir-south; WWPA.
- Hem-fir; WCLIB or WWPA.
- Douglas fir-larch (north); NLGA.
- Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.

STRUCTURAL COMPOSITE LUMBER

Laminated-Veneer Lumber (LVL): Structural composite lumber made from wood veneers with grain primarily parallel to member lengths, evaluated and monitored in accordance with ASTM D5456, and manufactured with exterior-type adhesive complying with ASTM D2559.

Allowable Stresses:

- Extreme Fiber Stress in Bending, Edgewise (Fb): 2400 psi for 12-inch nominal-depth members.
- Modulus of Elasticity, Edgewise (E): 2,000,000 psi.

1
2 **MISCELLANEOUS LUMBER**

3 General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction,
4 including the following:

- 5 Blocking.
- 6 Nailers.
- 7 Rooftop equipment bases and support curbs.
- 8 Furring.

9
10 Dimension Lumber Items: Standard, Stud, or No. 3 grade lumber of any species.

11
12 **FASTENERS**

13 General: Provide fasteners of size and type indicated that comply with requirements specified in this article
14 for material and manufacture.

15
16 Screws for Fastening to Metal Framing: ASTM C1002, length as recommended by screw manufacturer for
17 material being fastened.

18
19 Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having
20 jurisdiction, based on ICC-ES AC70.

21
22 Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having
23 jurisdiction, based on ICC-ES AC01, ICC-ES AC58, ICC-ES AC193 or ICC-ES AC308 as appropriate for
24 the substrate.

25
26 **MISCELLANEOUS MATERIALS**

27 Adhesives for Gluing Furring and Sleepers to Concrete or Masonry: Formulation complying with
28 ASTM D3498 that is approved for use indicated by adhesive manufacturer.

29
30 **PART 3 - EXECUTION**

31
32 **INSTALLATION**

33 Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction,"
34 unless otherwise indicated.

35
36 Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry
37 accurately to other construction. Locate furring, nailers, blocking, and similar supports to comply with
38 requirements for attaching other construction.

39
40 Do not splice structural members between supports unless otherwise indicated.

41
42 Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the
43 following:

- 44 Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
- 45 ICC-ES evaluation report for fastener.

46
47
48 **PROTECTION**

49 Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic
50 boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying
51 to comply with EPA-registered label.

52
53 **END OF SECTION**

1
2 **WOOD STRUCTURAL PANEL INSTALLATION**
3 General: Comply with applicable recommendations in APA Form No. E30, "Engineered Wood Construction
4 Guide," for types of structural-use panels and applications indicated.

5
6 Fastening Methods: Fasten panels as indicated below:

7 Combination Subfloor-Underlayment:
8 Glue and nail to wood framing.
9 Screw to cold-formed metal framing.
10 Space panels 1/8 inch apart at edges and ends.

11
12 Subflooring:
13 Glue and nail to wood framing.
14 Screw to cold-formed metal framing.
15 Space panels 1/8 inch apart at edges and ends.

16
17 Underlayment:
18 Nail or staple to subflooring.
19 Space panels 1/32 inch apart at edges and ends.
20 Fill and sand edge joints of underlayment receiving resilient flooring immediately before installing
21 flooring.

22
23 **CEMENTITIOUS BACKER UNIT INSTALLATION**
24 Install panels and treat joints in accordance with ANSI A108.11 and manufacturer's written instructions for
25 type of application indicated.

26
27 **PARTICLEBOARD UNDERLAYMENT INSTALLATION**
28 Comply with CPA's recommendations for type of subfloor indicated. Fill and sand gouges, gaps, and chipped
29 edges. Sand uneven joints flush.

30
31 Fastening Method: Glue and nail underlayment to subflooring.

32
33 **HARDBOARD UNDERLAYMENT INSTALLATION**
34 Comply with CPA's recommendations and hardboard manufacturer's written instructions for preparing and
35 applying hardboard underlayment.

36
37 Fastening Method: Nail underlayment to subflooring.

38
39 **END OF SECTION**

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SECTION 06 40 23
INTERIOR ARCHITECTURAL WOODWORK

PART 1 - GENERAL

SUMMARY

Section Includes:

- Interior standing and running trim.
- Interior hardboard paneling.
- Interior railings.
- Miscellaneous materials.
- Shop finishing of interior architectural woodwork.

PREINSTALLATION MEETINGS

Preinstallation Conference: Conduct conference at Project site.

ACTION SUBMITTALS

Product Data: For the following:

- Anchors.
- Adhesives.
- Shop finishing materials.

Shop Drawings:

- Include the following:
 - Dimensioned plans, elevations, and sections.
 - Show large-scale details.
 - Show locations and sizes of furring, blocking, and hanging strips, including blocking and reinforcement concealed by construction and specified in other Sections.

Samples: For each exposed product and for each shop-applied color and finish specified.

INFORMATIONAL SUBMITTALS

Qualification Data: For architectural woodwork manufacturer.

Product Certificates: For the following:

- Composite wood products.
- Adhesives.

PART 2 - PRODUCTS

ARCHITECTURAL WOODWORK, GENERAL

Quality Standard: Unless otherwise indicated, comply with the Architectural Woodwork Standards for grades of interior architectural woodwork indicated for construction, finishes, installation, and other requirements.

INTERIOR STANDING AND RUNNING TRIM FOR TRANSPARENT FINISH

Architectural Woodwork Standards Grade: Custom.

Hardwood Lumber:

- Wood Species and Cut: Match species and cut indicated for other types of transparent-finished architectural woodwork located in same area of building unless otherwise indicated.
- Species: Red oak.
- Cut: Plain sliced/plain sawn.
- Wood Moisture Content: 8 to 13 percent.

1 Provide split species on trim that faces areas with different wood species, matching each face of
2 woodwork to species and cut of finish wood surfaces in areas finished.

3
4 For trim items other than base wider than available lumber, use veneered construction. Do not glue for
5 width.

6
7 For veneered base, use hardwood lumber core, glued for width.

8
9 For base wider than available lumber, glue for width. Do not use veneered construction.

10
11 For rails thicker than available lumber, use veneered construction. Do not glue for thickness.

12 13 **PANELING**

14 Board Paneling, MMPA: Interior wood-board paneling complying with MMPA WM 9.

15
16 Species: Red Oak, or species with similar grain pattern.

17 Grade: Clear No. 2.

18 Maximum Moisture Content: 15 percent with at least 85 percent of shipment at 12 percent or less.

19 Pattern: Smooth.

20 Net Coverage Width: Not less than 5-1/16 inches.

21 22 **INTERIOR WOOD RAILINGS**

23 Architectural Woodwork Standards Grade: Custom.

24 Wood for Transparent Finish:

25 Species and Cut:

26 Railings: Red oak, plain sawn.

27 Wood Moisture Content: 8 to 13 percent.

28
29 Handrail Brackets: Cast nickel-silver with wall flange drilled for exposed anchor and with support arm for
30 screwing to underside of rail. Size to provide 1-1/2-inch clearance between handrail and face of wall.

31 32 **HARDWOOD SHEET MATERIALS**

33 Composite Wood Products: Provide materials that comply with requirements of the Architectural Woodwork
34 Standards for each type of interior architectural woodwork and quality grade specified unless otherwise
35 indicated.

36
37 Veneer-Faced Panel Products (Hardwood Plywood): HPVA HP-1.

38 39 **MISCELLANEOUS MATERIALS**

40 Furring, Blocking, Shims, and Nailers: Softwood or hardwood lumber, kiln-dried to less than 15 percent
41 moisture content.

42
43 Provide self-drilling screws for metal-framing supports, as recommended by metal-framing manufacturer.

44 Anchors: Select material, type, size, and finish required for each substrate for secure anchorage.

45
46 Provide metal expansion sleeves or expansion bolts for post-installed anchors.

47 Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at
48 floors.

49
50 Installation Adhesive: Product recommended by fabricator for each substrate for secure anchorage.

51 52 **FABRICATION**

53 Complete fabrication, including assembly, to maximum extent possible before shipment to Project site.

54
55 Disassemble components only as necessary for shipment and installation.

1 Where necessary for fitting at site, provide allowance for scribing, trimming, and fitting.
2 Trial fit assemblies at fabrication shop that cannot be shipped completely assembled.
3
4 Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial
5 fitting.
6
7 Verify that parts fit as intended, and check measurements of assemblies against field measurements
8 indicated on approved Shop Drawings before disassembling for shipment.
9

10 **SHOP FINISHING**

11 Finish interior architectural woodwork with transparent finish at fabrication shop. Defer only final touchup,
12 cleaning, and polishing until after installation.
13

14 Preparation for Finishing: Comply with Architectural Woodwork Standards, Section 5 for sanding, filling
15 countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing interior architectural
16 woodwork, as applicable to each unit of work.
17

18 Backpriming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of
19 interior architectural woodwork. Apply two coats to end-grain surfaces.
20

21 Transparent Finish:

- 22 Architectural Woodwork Standards Grade: Custom.
- 23 Finish System - 1: Lacquer, Nitrocellulose.
- 24 Finish System - 2: Lacquer, Pre Catalyzed.
- 25 Finish System - 3: Lacquer, Post Catalyzed.
- 26 Finish System - 4: Latex Acrylic, Water Based.
- 27 Finish System - 5: Varnish, Conversion.
- 28 Finish System - 6: Oil, Synthetic Penetrating.
- 29 Finish System - 7: Vinyl, Catalyzed.
- 30 Finish System - 8: Acrylic Cross Linking, Water Based.
- 31 Finish System - 9: UV Curable, Acrylated Epoxy, Polyester, or Urethane.
- 32 Finish System - 10: UV Curable, Water Based.
- 33 Finish System - 11: Polyurethane, Catalyzed.
- 34 Finish System - 12: Polyurethane, Water Based.
- 35 Finish System - 13: Polyester, Catalyzed.

36
37 Wash Coat for Closed-Grain Woods: Apply wash-coat sealer to woodwork made from closed-grain
38 wood before staining and finishing.
39

40 Staining: Match approved sample for color or Match Architect's sample.
41

42 Open Finish for Open-Grain Woods: Do not apply filler to open-grain woods.
43

44 Filled Finish for Open-Grain Woods: After staining, apply wash-coat sealer and allow to dry. Apply
45 paste wood filler and wipe off excess. Tint filler to match stained wood.

46 Sheen: Satin, 31-45 gloss units measured on 60-degree gloss meter in accordance with ASTM D523.
47

48 **PART 3 - EXECUTION**

49
50 **PREPARATION**

51 Before installation, condition interior architectural woodwork to humidity conditions in installation areas for
52 not less than 72 hours prior to beginning of installation.
53

54 Before installing interior architectural woodwork, examine shop-fabricated work for completion and
55 complete work as required, including removal of packing and backpriming of concealed surfaces.

1
2 **INSTALLATION**

3 Grade: Install interior architectural woodwork to comply with same grade as item to be installed.

4
5 Assemble interior architectural woodwork and complete fabrication at Project site to the extent that it was
6 not completed during shop fabrication.

7
8 Install interior architectural woodwork level, plumb, true in line, and without distortion.

9 Shim as required with concealed shims.

10 Install level and plumb to a tolerance of 1/8 inch in 96 inches.

11
12 Scribe and cut interior architectural woodwork to fit adjoining work, refinish cut surfaces, and repair damaged
13 finish at cuts.

14
15 Fire-Retardant-Treated Wood: Install fire-retardant-treated wood to comply with chemical treatment
16 manufacturer's written instructions, including those for adhesives used to install woodwork.

17 Anchor interior architectural woodwork to anchors or blocking built in or directly attached to substrates.

18
19 Secure with countersunk, concealed fasteners and blind nailing.

20 Use fine finishing nails for exposed fastening, countersunk and filled flush with interior architectural
21 woodwork.

22 For shop-finished items, use filler matching finish of items being installed.

23
24 Standing and Running Trim:

25 Install with minimum number of joints possible, using full-length pieces (from maximum length of
26 lumber available) to greatest extent possible.

27 Do not use pieces less than [**36 inches**] [**60 inches**] [**96 inches**] long, except where shorter single-length
28 pieces are necessary.

29 Scarf running joints and stagger in adjacent and related members.

30 Fill gaps, if any, between top of base and wall with [**plastic wood filler; sand smooth; and finish same**
31 **as wood base if finished**] [**latex sealant, painted to match wall**].

32 Install standing and running trim with no more variation from a straight line than 1/8 inch in 96 inches.

33
34 Railings:

35 Install rails with no more than 1/8 inch in 96-inch variation from a straight line.

36 Stair Rails: Glue and dowel or pin balusters to treads and railings, and railings to newel posts.

37
38 Secure with countersunk, concealed fasteners and blind nailing.

39 Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with
40 wood surface.

41
42 Wall Rails: Support rails on wall brackets securely fastened to wall framing.

43
44
45 **INSTALLATION OF PANELING**

46 Board Paneling: Install according to manufacturer's written instructions.

47
48 Arrange in random-width pattern suggested by manufacturer unless boards or planks are of uniform
49 width.

50 Install in full lengths without end joints.

51 Stagger end joints in random pattern to uniformly distribute joints on each wall.

52 Install with uniform end joints with only end-matched (tongue-and-groove) joints within each field of
53 paneling.

54 Install with uniform end joints. Locate end joints only over furring or blocking.

- 1 Select and arrange boards on each wall to minimize noticeable variations in grain character and color
- 2 between adjacent boards.
- 3 Install with uniform tight joints between boards.
- 4 Fasten paneling by face nailing, setting nails, and filling over nail heads.
- 5 Fasten paneling with trim screws, set below face and filled.
- 6 Fasten paneling by blind nailing through tongues.
- 7 Fasten paneling with paneling system manufacturer's concealed clips.
- 8 Fasten paneling to gypsum wallboard with panel adhesive.
- 9
- 10

END OF SECTION

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SECTION 07 21 01
SOUND ATTENUATION BATT

PART 1 - GENERAL

SUMMARY

Section Includes: Sound batt.

ACTION SUBMITTALS

Product Data: For each type of product.

INFORMATIONAL SUBMITTALS

Product test reports and Research reports.

PART 2 - PRODUCTS

PERFORMANCE REQUIREMENTS

Surface-Burning Characteristics: Maximum flame-spread and smoke-developed indexes less than Class A, 25 and 450 when tested in accordance with ASTM E84.

Fire-Resistance Ratings: Comply with ASTM E119 or UL 263; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

Indicate design designations from UL's "Fire Resistance Directory" or from listings of another qualified testing agency.

Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.

Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches and wider in width.

SOUND ATTENUATION BATT INSULATION

Unfaced, for interior partitions: ASTM C665, Type I (blankets without membrane facing); consisting of fibers; passing ASTM E136 for combustion characteristics.

Thickness: 3 inches minimum

Noise Reduction Coefficient (NRC): 0.8 or better

Acceptable materials include: Flexible Fiber Glass Insulation, Mineral Wool Batt, or High-density Cotton

A thermal resistance (R) identification mark shall be applied by the manufacturer to each piece of building envelope insulation.

PART 3 - EXECUTION

INSTALLATION, GENERAL

Comply with insulation manufacturer's written instructions applicable to products and applications.

Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.

Extend insulation to envelop entire area to be insulated. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

1 Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths.
2 Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total
3 thickness.

4

5 **INSTALLATION OF INSULATION IN FRAMED CONSTRUCTION**

6 Blanket Insulation: Install in cavities formed by framing members according to the following requirements:

7

8 Use insulation widths and lengths that fill the cavities formed by framing members. If more than one
9 length is required to fill the cavities, provide lengths that will produce a snug fit between ends.

10 Place insulation in cavities formed by framing members to produce a friction fit between edges of
11 insulation and adjoining framing members.

12 Maintain 3-inch clearance of insulation around recessed lighting fixtures not rated for or protected from
13 contact with insulation.

14

15

END OF SECTION

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6 **SECTION 07 84 43**
7 **JOINT FIRESTOPPING**

8
9
10 **PART 1 - GENERAL**

11
12 **SUMMARY**

13 Section Includes:

- 14 Joints in or between fire-resistance-rated construction.
15 Joints at exterior curtain-wall/floor intersections.
16 Joints in smoke barriers.

17
18 **PREINSTALLATION MEETINGS**

19 Preinstallation Conference: Conduct conference at Project site.

20
21 **ACTION SUBMITTALS**

22 Product data.

23
24 **INFORMATIONAL SUBMITTALS**

25 Qualification Data: For Installer.

26 Listed System Designs: For each joint firestopping system, for tests performed by a qualified testing agency.

27
28 **CLOSEOUT SUBMITTALS**

29 Installer Certificates: From Installer indicating that joint firestopping systems have been installed in compliance with requirements and manufacturer's written installation instructions.

30
31 **QUALITY ASSURANCE**

32 Installer Qualifications: A firm that has been approved by FM Approvals in accordance with FM Approvals 4991 or been evaluated by UL and found to comply with UL's "UL Solutions Qualified Firestop Contractor Program."

33
34 **PART 2 - PRODUCTS**

35
36 **PERFORMANCE REQUIREMENTS**

37 Fire-Test-Response Characteristics:

- 38 A qualified testing agency, acceptable to authorities having jurisdiction, will perform joint firestopping system tests.
39 Test in accordance with testing standards referenced in "Joint Firestopping Systems" Article.

40
41 **JOINT FIRESTOPPING SYSTEM TYPES**

42 General: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which joint firestopping systems are installed. Joint firestopping systems must accommodate building movements without impairing their ability to resist the passage of fire and hot gases.

43 Joint firestopping systems that are compatible with one another, with the substrates forming openings, and with penetrating items, if any.

44 Provide products that, upon curing, do not re-emulsify, dissolve, leach, break down, or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water or other forms of moisture.

45 Provide firestop products that do not contain ethylene glycol.

46
47 Joints in or between Fire-Resistance-Rated Construction: Provide joint firestopping systems with ratings determined in accordance with ASTM E1966 or UL 2079, with published L-Ratings for ambient and elevated temperatures as evidence of the ability of the fire-resistive joint system to restrict the movement of smoke.

48 Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of the wall, floor, or roof in or between which it is installed.

1
2 Joints at Exterior Curtain-Wall/Floor Intersections: Provide joint firestopping systems with rating determined
3 in accordance with ASTM E2307.

4 F-Rating: Equal to or exceeding the fire-resistance rating of the floor assembly.
5

6 Joints in Smoke Barriers: Provide joint firestopping systems with ratings determined in accordance with
7 UL 2079 based on testing at a positive pressure differential of 0.30 inch wg.

8 L-Rating: Not exceeding 5.0 cfm/ft. of joint at both ambient and elevated temperatures.
9

10 Exposed Joint Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450,
11 respectively, as determined in accordance with ASTM E84.
12

13 **ACCESSORIES**

14 Provide components of joint firestopping systems, including primers and forming materials, that are needed
15 to install elastomeric fill materials and to maintain ratings required. Use only components specified by joint
16 firestopping system manufacturer and approved by the qualified testing agency for conditions indicated.
17

18 **PART 3 - EXECUTION**

19 **PREPARATION**

20 **Surface Cleaning:** Before installing joint firestopping systems, clean joints in accordance with fire-resistive
21 joint system manufacturer's written installation instructions and the following requirements:
22

23 Remove foreign materials from substrate surfaces that could interfere with adhesion of elastomeric fill
24 materials or compromise fire-resistive rating.

25 Clean joint substrates to produce clean, sound surfaces capable of developing optimum bond with
26 elastomeric fill materials. Remove loose particles remaining from cleaning operation.

27 Remove laitance and form-release agents from concrete.
28

29 Prime substrates in accordance with joint firestopping system manufacturer's written installation instructions,
30 using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not
31 allow spillage and migration onto exposed surfaces.
32

33 Apply a suitable bond breaker to prevent three-sided adhesion in applications where condition occurs.
34

35 **INSTALLATION**

36 **General:** Install joint firestopping systems in accordance with manufacturer's written installation instructions
37 and published drawings for products and applications indicated.
38

39 Install forming materials and other accessories of types required to support elastomeric fill materials during
40 their application and in position needed to produce cross-sectional shapes and depths required to achieve fire
41 ratings indicated.

42 After installing elastomeric fill materials and allowing them to fully cure, remove combustible forming
43 materials and other accessories not indicated as permanent components of fire-resistive joint system.
44

45 **IDENTIFICATION**

46 **Wall Identification:** Permanently label walls containing firestopping systems with the words "FIRE AND/OR
47 SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches high and with
48 minimum 0.375-inch strokes.

49 Locate in accessible concealed floor, floor-ceiling, or attic space at 15 ft. from end of wall and at intervals
50 not exceeding 30 ft.
51

52 **Joint Identification:** Identify joint firestopping systems with legible metal or plastic labels. Attach labels
53 permanently to surfaces adjacent to and within 6 inches of joint edge, so labels are visible to anyone seeking
54 to remove joint firestopping system. Use mechanical fasteners or self-adhering-type labels with adhesives

1 capable of permanently bonding labels to surfaces on which labels are placed. Include the following
2 information on labels:
3 The words "Warning - Joint Firestopping - Do Not Disturb. Notify Building Management of Any
4 Damage."
5 Contractor's name, address, and phone number.
6 Designation of applicable testing agency.
7 Date of installation.
8 Manufacturer's name.
9 Installer's name.

10
11 **CLEANING AND PROTECTION**

12 Clean off excess elastomeric fill materials adjacent to joints as the Work progresses by methods and with
13 cleaning materials that are approved in writing by joint firestopping system manufacturers and that do not
14 damage materials in which joints occur.

15
16 Provide final protection and maintain conditions during and after installation that ensure joint firestopping
17 systems are without damage or deterioration at time of Substantial Completion. If damage or deterioration
18 occurs despite such protection, cut out and remove damaged or deteriorated joint firestopping systems
19 immediately and install new materials to produce joint firestopping systems complying with specified
20 requirements.

21
22 **END OF SECTION**

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1
2 **PART 2 - PRODUCTS**
3

4 **JOINT SEALANTS, GENERAL**

5 Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one
6 another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant
7 manufacturer, based on testing and field experience.
8

9 Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.
10

11 **SILICONE JOINT SEALANTS**

12 Silicone, S, NS, 100/50, NT: Single-component, nonsag, plus 100 percent and minus 50 percent movement
13 capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS,
14 Class 100/50, Use NT.
15

16 Silicone, S, NS, 100/50, T, NT: Single-component, nonsag, plus 100 percent and minus 50 percent movement
17 capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS,
18 Class 100/50, Uses T and NT.
19

20 **NONSTAINING SILICONE JOINT SEALANTS**

21 Nonstaining Joint Sealants: No staining of substrates when tested in accordance with ASTM C1248.
22

23 Silicone, Nonstaining, S, NS, 100/50, NT: Nonstaining, single-component, nonsag, plus 100 percent and
24 minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920,
25 Type S, Grade NS, Class 100/50, Use NT.
26

27 Silicone, Nonstaining, S, NS, 100/50, T, NT: Nonstaining, single-component, nonsag, plus 100 percent and
28 minus 50 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant;
29 ASTM C920, Type S, Grade NS, Class 100/50, Uses T and NT.
30

31 **URETHANE JOINT SEALANTS**

32 Urethane, S, NS, 100/50, T, NT: Single-component, nonsag, plus 100 percent and minus 50 percent
33 movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade NS,
34 Class 100/50, Uses T and NT.
35

36 **LATEX JOINT SEALANTS**

37 Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C834, Type OP, Grade NF.
38

39 **JOINT-SEALANT BACKING**

40 Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and
41 other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience
42 and laboratory testing.
43

44 Cylindrical Sealant Backings: ASTM C1330, Type C (closed-cell material with a surface skin) or any of the
45 preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated, and of
46 size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
47

48 Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for
49 preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint.
50 Provide self-adhesive tape where applicable.
51

52 **MISCELLANEOUS MATERIALS**

53 Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint
54 substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
55

1 Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant
2 backing materials, free of oily residues or other substances capable of staining or harming joint substrates
3 and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to
4 joint substrates.

5
6 Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to
7 joints.

8 9 **PART 3 - EXECUTION**

10 11 **PREPARATION**

12 Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-
13 sealant manufacturer's written instructions and the following requirements:

14
15 Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant,
16 including dust, paints (except for permanent, protective coatings tested and approved for sealant
17 adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing,
18 water repellents, water, surface dirt, and frost.

19 Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of
20 these methods to produce a clean, sound substrate capable of developing optimum bond with joint
21 sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing
22 out joints with oil-free compressed air. Porous joint substrates include the following:

23 Concrete.

24 Masonry.

25
26 Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by
27 preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant
28 manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or
29 migration onto adjoining surfaces.

30
31 Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining
32 surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods
33 required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

34 35 **INSTALLATION OF JOINT SEALANTS**

36 General: Comply with joint-sealant manufacturer's written installation instructions for products and
37 applications indicated, unless more stringent requirements apply.

38
39 Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as
40 applicable to materials, applications, and conditions indicated.

41 Install sealant backings of type indicated to support sealants during application and at position required to
42 produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum
43 sealant movement capability.

44
45 Do not leave gaps between ends of sealant backings.

46 Do not stretch, twist, puncture, or tear sealant backings.

47 Remove absorbent sealant backings that have become wet before sealant application, and replace them
48 with dry materials.

49
50 Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of
51 joints.

52
53 Install sealants using proven techniques that comply with the following and at the same time backings are
54 installed:

1 Place sealants so they directly contact and fully wet joint substrates.
2 Completely fill recesses in each joint configuration.
3 Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant
4 movement capability.

5
6 Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool
7 sealants in accordance with requirements specified in subparagraphs below to form smooth, uniform beads
8 of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides
9 of joint.

10 Remove excess sealant from surfaces adjacent to joints.
11 Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants
12 or adjacent surfaces.
13 Provide concave joint profile in accordance with Figure 8A in ASTM C1193 unless otherwise indicated.

14
15
16 Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with
17 cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints
18 occur.

19
20 Protect joint sealants during and after curing period from contact with contaminating substances and from
21 damage resulting from construction operations or other causes so sealants are without deterioration or damage
22 at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out,
23 remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas
24 are indistinguishable from original work.

25
26

END OF SECTION

1 Joint Compound for Interior Gypsum Board: For each coat, use formulation that is compatible with other
2 compounds applied on previous or for successive coats.

3 Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type
4 taping compound.

5 Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use
6 drying-type, all-purpose compound.

7 Use setting-type compound for installing paper-faced metal trim accessories.

8 Fill Coat: For second coat, use drying-type, all-purpose compound.

9 Finish Coat: For third coat, use drying-type, all-purpose compound.

10 Skim Coat: For final coat of Level 5 finish, use drying-type, all-purpose compound.

11 12 **AUXILIARY MATERIALS**

13 Provide auxiliary materials that comply with referenced installation standards and manufacturer's written
14 instructions.

15
16 Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to
17 continuous substrate.

18
19 Steel Drill Screws: ASTM C1002 unless otherwise indicated.

20 Use screws complying with ASTM C954 for fastening panels to steel members from 0.033 to 0.112 inch
21 thick.

22 For fastening cementitious backer units, use screws of type and size recommended by panel
23 manufacturer.

24 25 **PART 3 - EXECUTION**

26 27 **INSTALLATION OF PANELS**

28 Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

29
30 Comply with ASTM C840.

31
32 Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide
33 1/4- to 1/2-inch-wide spaces at these locations and trim edges with edge trim where edges of panels are
34 exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

35
36 For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels.
37 Otherwise, attach trim according to manufacturer's written instructions.

38 39 **FINISHING OF GYPSUM BOARD**

40 Prefill open joints, rounded or beveled edges, and damaged surface areas.

41
42 Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to
43 receive tape.

44
45 Gypsum Board Finish Levels: Finish panels to levels indicated below and in accordance with ASTM C840:

46 Level 1: Ceiling plenum areas, concealed areas, and where indicated.

47 Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.

48 Primer and its application to surfaces are specified in Section 09 91 23 "Interior Painting."
49

50 **PROTECTION**

51 Protect installed products from damage from weather, condensation, direct sunlight, construction, and other
52 causes during remainder of the construction period.

53 Remove and replace panels that are wet, moisture damaged, and mold damaged.
54

55 **END OF SECTION**

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SECTION 09 51 23
ACOUSTICAL TILE CEILINGS

PART 1 - GENERAL

SUMMARY

Section Includes:

- Acoustical tiles.
- Metal suspension system.
- Accessories.
- Metal edge moldings and trim.

PREINSTALLATION MEETINGS

Preinstallation Conference: Conduct conference at Project site.

ACTION SUBMITTALS

Product Data: For each type of product.

Samples: For each exposed product and for each color and texture specified.

INFORMATIONAL SUBMITTALS

Coordination Drawings: Reflected ceiling plans, drawn to scale, and coordinated with each other, using input from installers of the items involved.

Product test reports.

Research reports.

CLOSEOUT SUBMITTALS

Maintenance data.

PART 2 - PRODUCTS

PERFORMANCE REQUIREMENTS

Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

Flame-Spread Index: Class A in accordance with ASTM E1264.

Smoke-Developed Index: 50 or less.

ACOUSTICAL TILES (ACT-1)

Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Armstrong World Industries.
2. USG Corporation.

Acoustical Tile Standard: Manufacturer's standard tiles of configuration indicated that comply with ASTM E1264.

Classification, Basis of Design: USG Radar Ceiling Panels.

Color: White.

Light Reflectance (LR): 0.84.

Ceiling Attenuation Class (CAC): 33.

Noise Reduction Coefficient (NRC): 0.55.

1
2 Edge/Joint Detail: Beveled, kerfed, and rabbeted; tongue and grooved; or butt.

3
4 Thickness: 5/8 inch.

5
6 Modular Size: 24 by 24 inches.

7
8 **METAL SUSPENSION SYSTEM**

9 Metal Suspension-System Standard: Manufacturer's standard, direct-hung, fully concealed, metal suspension
10 system that complies with applicable requirements in ASTM C635/C635M.

11
12 **ACCESSORIES**

13 Attachment Devices: Size for five times the design load indicated in ASTM C635/C635M, Table 1, "Direct
14 Hung," unless otherwise indicated. Comply with seismic design requirements.

15
16 **PART 3 - EXECUTION**

17
18 **PREPARATION**

19 Measure each ceiling area and establish layout of acoustical tiles to balance border widths at opposite edges
20 of each ceiling. Avoid using less-than-half-width tiles at borders unless otherwise indicated.

21
22 Layout openings for penetrations centered on the penetrating items.

23
24 **INSTALLATION OF SUSPENDED ACOUSTICAL TILE CEILINGS**

25 Install suspended acoustical tile ceilings in accordance with ASTM C636/C636M and manufacturer's written
26 instructions.

27
28 Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary
29 to conceal edges of acoustical tiles.

30 Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before
31 they are installed.

32 Do not use exposed fasteners, including pop rivets, on moldings and trim.

33
34 Arrange directionally patterned acoustical tiles as indicated on reflected ceiling plans.

35
36 **END OF SECTION**

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SECTION 09 65 13
RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

SUMMARY

Section Includes: Thermoset-rubber base.

ACTION SUBMITTALS

Product Data: For each type of product.

Samples: For each exposed product and for each color and texture specified.

PART 2 - PRODUCTS

THERMOSET-RUBBER BASE

Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Tarkett USA.

Product Standard: ASTM F 1861, Type TS (rubber, vulcanized thermoset), Group I (solid, homogeneous).

Style and Location:

Style, Coved with Toe: Provide in areas with carpet.

Thickness: 0.125 inch.

Height: 4 inches.

Lengths: Cut lengths 48 inches long or Coils in manufacturer's standard length.

Outside Corners: Job formed or preformed.

Inside Corners: Job formed or preformed.

Colors: Black

INSTALLATION MATERIALS

Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by resilient-product manufacturer for applications indicated.

Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.

Floor Polish: Provide protective, liquid floor-polish products recommended by resilient stair-tread manufacturer.

PART 3 - EXECUTION

PREPARATION

Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.

Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.

1
2 Do not install resilient products until materials are the same temperature as space where they are to be
3 installed.

4
5 Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

6
7 **RESILIENT BASE INSTALLATION**

8 Comply with manufacturer's written instructions for installing resilient base.

9
10 Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent
11 fixtures in rooms and areas where base is required.

12
13 Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces
14 aligned.

15
16 Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact
17 with horizontal and vertical substrates.

18
19 Do not stretch resilient base during installation.

20
21 On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with
22 manufacturer's recommended adhesive filler material.

23
24 Preformed Corners: Install preformed corners before installing straight pieces.

25
26 Job-Formed Corners:

27 Outside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3
28 inches in length.

29 Form without producing discoloration (whitening) at bends.

30
31 Inside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3
32 inches in length.

33 Miter or cope corners to minimize open joints.

34
35 **CLEANING AND PROTECTION**

36 Comply with manufacturer's written instructions for cleaning and protecting resilient products.

37
38 Floor Polish: Remove soil, adhesive, and blemishes from resilient stair treads before applying liquid floor
39 polish.

40 Apply two coat(s).

41
42
43 Cover resilient products subject to wear and foot traffic until Substantial Completion.

44
45 **END OF SECTION**

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SECTION 09 68 13
TILE CARPETING

PART 1 - GENERAL

SUMMARY

Section Includes: Carpet tile.

PREINSTALLATION MEETINGS

Preinstallation Conference: Conduct conference at Project site.

ACTION SUBMITTALS

Product data.

Shop Drawings: For carpet tile installation.

Samples: Manufacturer's standard color sheets, showing full range of available colors for each type of carpet tile.

INFORMATIONAL SUBMITTALS

Product test reports.

Sample warranties.

CLOSEOUT SUBMITTALS

Maintenance data.

WARRANTY

Special Warranty for Carpet Tiles: Manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.

Warranty Period: 10 years minimum from date of Substantial Completion.

PART 2 - PRODUCTS

CARPET TILE or PLANKS (CPT-1)

Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Patcraft
2. Mohawk
3. Tarkett

Color: As selected by Owner, Cream/Grey color; basis of design Patcraft Wellbeing Pebble and Inclusion Granite.

Pattern: Match color sample listed above.

Fiber Content: 100 percent nylon.

Fiber Type: Manufactures Standard.

Pile Characteristic: Level-loop pile.

Surface Pile Weight: around 16 oz./sq. yd..

Primary Backing/Backcoating: Manufacturer's standard composite materials.

Secondary Backing: Manufacturer's standard material.

Size: 24 by 24 inches or 18 by 36 inches.

Applied Treatments:

Soil-Resistance Treatment: Manufacturer's standard treatment.

1 Performance Characteristics:

2 Texture Appearance Retention Rating (TARR): Moderate traffic, 2.5 minimum in accordance with
3 ASTM D7330.

4 Dry Breaking Strength: Not less than 100 lbf in accordance with ASTM D2646.

5 Tuft Bind: Not less than 3 lbf in accordance with ASTM D1335.

6 Delamination: Not less than 3.5 lbf/in. in accordance with ASTM D3936.

7 Dimensional Tolerance: Within 1/32 inch of specified size dimensions, as determined by physical
8 measurement.

9
10 **INSTALLATION ACCESSORIES**

11 Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation
12 provided or recommended in writing by carpet tile manufacturer.

13
14 Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive types to suit products and
15 subfloor conditions indicated, that comply with flammability requirements for installed carpet tile, and that
16 are recommended in writing by carpet tile manufacturer for releasable installation.

17
18 **PART 3 - EXECUTION**

19
20 **EXAMINATION**

21 Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for
22 maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet tile
23 performance.

24
25 Examine carpet tile for type, color, pattern, and potential defects.

26
27 Concrete Slabs: Verify that surfaces are free of cracks, ridges, depressions, scale, and foreign deposits.

28
29 Wood Subfloors: Verify the following:

30 Underlayment over subfloor complies with requirements specified in Section 06 16 00 "Sheathing."

31 Underlayment surface is free of irregularities and substances that may interfere with adhesive bond or
32 show through surface.

33
34 Access Flooring Systems: Verify the following:

35 Access floor substrate is compatible with carpet tile and adhesive if any.

36
37 Proceed with installation only after unsatisfactory conditions have been corrected.

38
39 **PREPARATION**

40 General: Comply with CRI 104 and with carpet tile manufacturer's written installation instructions for
41 preparing substrates.

42
43 Use trowelable leveling and patching compounds, in accordance with manufacturer's written instructions, to
44 fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions
45 1/8 inch wide or wider, and protrusions more than 1/32 inch unless more stringent requirements are required
46 by manufacturer's written instructions.

47
48 Concrete Substrates: Remove coatings, including curing compounds, and other substances that are
49 incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use
50 mechanical methods recommended in writing by adhesive and carpet tile manufacturers.

51
52 Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

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INSTALLATION

General: Comply with CRI 104, Section 10, "Carpet Tile," and with carpet tile manufacturer's written installation instructions.

Installation Method: As recommended in writing by carpet tile manufacturer.

Maintain dye-lot integrity. Do not mix dye lots in same area.

Maintain pile-direction patterns recommended in writing by carpet tile manufacturer, verify with Owner.

Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended in writing by carpet tile manufacturer.

Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.

Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on carpet tile as marked on subfloor. Use nonpermanent, nonstaining marking device.

Install pattern parallel to walls and borders.

Access Flooring: Stagger joints of carpet tiles so carpet tile grid is offset from access flooring panel grid. Do not fill seams of access flooring panels with carpet adhesive; keep seams free of adhesive.

CLEANING AND PROTECTION

Perform the following operations immediately after installing carpet tile:

Remove excess adhesive and other surface blemishes using cleaner recommended by carpet tile manufacturer.

Remove yarns that protrude from carpet tile surface.

Vacuum carpet tile using commercial machine with face-beater element.

Protect installed carpet tile to comply with CRI 104, Section 13.7.

Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

END OF SECTION

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SECTION 09 84 33
SOUND-ABSORBING WALL UNITS

PART 1 - GENERAL

SUMMARY

Section includes shop-fabricated, sound-absorbing acoustical panel.

PREINSTALLATION MEETINGS

Preinstallation Conference: Conduct conference at Project site.

ACTION SUBMITTALS

Product Data: For each type of product.

Shop Drawings: For unit assembly and installation.

Samples: For each exposed product and for each color and texture specified.

INFORMATIONAL SUBMITTALS

Product certificates.

CLOSEOUT SUBMITTALS

Maintenance data.

PART 2 - PRODUCTS

SOUND-ABSORBING WALL UNITS

Sound-Absorbing Wall Panel: Manufacturer's standard panel construction consisting of facing material.

Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Woody Walls, Basis of Design: Solid Wood Slate Wall Panels

Mounting: Back mounted with manufacturer's standard adhesive, secured to substrate.

Backing: Manufacturer's standard felt or material.

Reveals between Panels: Recessed reveals, black.

Core Materials: Manufacturer's standard.

Wood: Manufacturer's standard hardwood.

Mounting Devices: glue and screws per manufactures written instructions.

FABRICATION

Standard Construction: Use manufacturer's standard construction unless otherwise indicated; with facing material applied to face, edges, and back border of dimensionally stable core; and with rigid edges to reinforce panel perimeter against warpage and damage.

Backing: manufactures standard belt, material backing.

Facing Material: Hardwood, color Walnut

1 **PART 3 - EXECUTION**

2
3 **INSTALLATION**

4 Install units in locations indicated. Unless otherwise indicated, install units with vertical surfaces and edges
5 plumb, top edges level and in alignment with other units, faces flush, and scribed to fit adjoining work
6 accurately at borders and at penetrations.

7
8 Comply with manufacturer's written instructions for installation of units using type of mounting devices
9 indicated. Mount units securely to supporting substrate.

10
11 Align fabric pattern and grain with adjacent units.

12
13 **CLEANING**

14 Clip loose threads; remove pills and extraneous materials.

15
16 Clean panels on completion of installation to remove dust and other foreign materials according to
17 manufacturer's written instructions.

18
19 **END OF SECTION**

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SECTION 09 91 23
INTERIOR PAINTING

PART 1 - GENERAL

SUMMARY

Section Includes: Primers and Water-based finish coatings.

ACTION SUBMITTALS

Product Data: For each type of product.

Samples: For each type of topcoat product.

Product Schedule: Use same designations indicated on Drawings and in the Interior Painting Schedule to cross-reference paint systems specified in this Section. Include color designations.

QUALITY ASSURANCE

Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

PART 2 – PRODUCTS

MANUFACTURERS

Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Sherwin-Williams, basis of design
2. Benjermin More
3. PPG

PAINT PRODUCTS, GENERAL

Material Compatibility:

Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.

For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.

Colors: As selected by Owner, basis of design Sherwin-Williams Bauhaus and Mega Greige.

PRIMERS

Interior Latex Primer Sealer: Water-based latex sealer used on new interior plaster, concrete, and gypsum wallboard surfaces.

Alkyd Quick-Dry Primer for Metal: Corrosion-resistant, solvent-based, modified-alkyd primer; lead and chromate free; formulated for quick-drying capabilities and for use on cleaned, interior steel surfaces.

Cementitious Galvanized Primer: Solvent-based primer composed of linseed oil/alkyd resin and portland cement for cleaned galvanized metal prior to finish coating.

Quick-Drying Aluminum Primer: Corrosion-resistant, solvent-based, alkyd or modified-alkyd primer formulated for quick-drying capabilities and for use on prepared exterior aluminum.

1 **WATER-BASED FINISH COATS**

2 Interior, Latex, Satin: Pigmented, water-based paint for use on primed/sealed interior plaster and gypsum
3 board, and on primed wood and metals.

4 Gloss and Sheen Level: Manufacturer's standard low-sheen finish.

5
6 **SOLVENT-BASED FINISH COATS**

7 Aluminum Paint: Aliphatic, solvent-based coating consisting of varnish or alkyd binder combined with
8 aluminum pigment that is formulated for use as a stain-blocking coating and sealer on wood, metal,
9 bituminous-coated, and prepared masonry surfaces and to be able to be recoated with conventional alkyd and
10 latex paints.

11
12 **PART 3 - EXECUTION**

13
14 **EXAMINATION**

15 Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and
16 primers.

17
18 Proceed with coating application only after unsatisfactory conditions have been corrected.

19 Application of coating indicates acceptance of surfaces and conditions.

20
21 **PREPARATION**

22 Comply with manufacturer's written instructions and recommendations applicable to substrates and paint
23 systems indicated.

24
25 Remove hardware, covers, plates, and similar items already in place that are removable and are not to be
26 painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied
27 protection before surface preparation and painting.

28
29 After completing painting operations, use workers skilled in the trades involved to reinstall items that were
30 removed. Remove surface-applied protection if any.

31
32 **INSTALLATION**

33 Apply paints according to manufacturer's written instructions.

34
35 Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller
36 tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

37
38 Painting Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work exposed to
39 view:

40 Paint the following work where exposed in Courtroom or Jury Room:

41 Plastic conduit.

42 Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are
43 visible from occupied spaces.

44
45 **CLEANING AND PROTECTION**

46 After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping,
47 or other methods. Do not scratch or damage adjacent finished surfaces.

48
49 Protect work of other trades against damage from paint application. Correct damage to work of other trades
50 by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged
51 condition.

52
53 At completion of construction activities of other trades, touch up and restore damaged or defaced painted
54 surfaces.

- 1
- 2 **INTERIOR PAINTING SCHEDULE**
- 3 Steel Substrates:
 - 4 Latex over Shop-Applied Quick-Drying Shop Primer System:
 - 5 Prime Coat: Quick-dry primer for shop application.
 - 6 Intermediate Coat: Matching topcoat.
 - 7 Topcoat: Interior, latex, satin.
- 8
- 9 Galvanized-Metal Substrates:
 - 10 Latex System:
 - 11 Prime Coat: Cementitious galvanized primer.
 - 12 Intermediate Coat: Matching topcoat.
 - 13 Topcoat: Interior, latex, satin.
- 14
- 15 Finish Carpentry: to be stained see section 09 93 00.
- 16
- 17 Gypsum Board Substrates:
 - 18 Latex over Latex Sealer System:
 - 19 Prime Coat: Interior latex primer sealer.
 - 20 Intermediate Coat: Matching topcoat.
 - 21 Topcoat: Interior, latex, satin.
- 22
- 23 **END OF SECTION**

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SECTION 09 93 00
STAINING AND TRANSPARENT FINISHING

PART 1 - GENERAL

SUMMARY

Section Includes:

- Primers
- Wood stains.
- Transparent finishes.

ACTION SUBMITTALS

Product Data: For each type of product.

Samples: For each type of finish system and in each color and gloss of finish required.

Product List: Cross-reference to finish system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.

MOCKUPS

Apply mockups of each finish system indicated and each color selected to verify preliminary selections made under Sample submittals.

PART 2 - PRODUCTS

MANUFACTURERS

MANUFACTURERS

Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Sherwin-Williams, basis of design
2. Benjermin More
3. PPG

MATERIALS, GENERAL

Material Compatibility:

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.

Stain Colors: As selected by Owner, match samples.

Stain 1: Match Woody Walls Walnut (refer to section 09 84 33)

Stain 2: Darker than Stain 1, Espresso or something similar.

PRIMERS

Alkyd Sanding Sealer, Interior, Solvent Based, Clear: Solvent-based, quick-drying, clear, sandable alkyd sealer used on new interior wood surfaces that are to be top-coated with an alkyd varnish.

WOOD STAINS

Stain, Interior, Semitransparent, for Interior Wood: Solvent-based, oil or oil/alkyd, semitransparent, pigmented stain for new interior wood surfaces that are to be finished with a clear varnish.

TRANSPARENT FINISHES

Varnish, Interior, Water Based, Clear, Satin: Water-based clear satin coating for interior wood trim, frames, doors, paneling and cabinetry.

1 **PART 3 - EXECUTION**

2
3 **EXAMINATION**

4 Maximum Moisture Content of Interior Wood Substrates: 15 percent, when measured with an electronic
5 moisture meter.

6
7 **PREPARATION**

8 Remove hardware, covers, plates, and similar items already in place that are removable. If removal is
9 impractical or impossible because of size or weight of item, provide surface-applied protection before surface
10 preparation and finishing.

11 After completing finishing operations, use workers skilled in the trades involved to reinstall items that
12 were removed. Remove surface-applied protection if any.

13
14 Clean and prepare surfaces to be finished according to manufacturer's written instructions for each substrate
15 condition and as specified.

16 Remove dust, dirt, oil, and grease by washing with a detergent solution; rinse thoroughly with clean
17 water and allow to dry. Remove grade stamps and pencil marks by sanding lightly. Remove loose
18 wood fibers by brushing.

19 Remove mildew by scrubbing with a commercial wash formulated for mildew removal and as
20 recommended by stain manufacturer.

21
22 **APPLICATION**

23 Apply finishes according to manufacturer's written instructions.

24
25 Apply finishes to produce surface films without cloudiness, holidays, lap marks, brush marks, runs, ropiness,
26 or other surface imperfections.

27
28 **CLEANING AND PROTECTION**

29 Protect work of other trades against damage from finish application. Correct damage by cleaning, repairing,
30 replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

31
32 At completion of construction activities of other trades, touch up and restore damaged or defaced finished
33 wood surfaces.

34
35 **INTERIOR WOOD-FINISH-SYSTEM SCHEDULE**

36 Wood Substrates, Wood Trim, Architectural Woodwork, and Wood Board Paneling:

37 Water-Based Varnish over Stain System:

38 Stain Coat: Stain, semitransparent, for interior wood.

39 First Intermediate Coat: Water-based varnish matching topcoat.

40 Second Intermediate Coat: Water-based varnish matching topcoat.

41 Topcoat: Varnish, water based, clear, satin.

42
43 **END OF SECTION**

**SECTION 10 26 41
FIBERGLASS PANELS**

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Bullet Resistant Fiberglass.

1.2 REFERENCES

- A. Underwriters Laboratory UL 752-Standard for Bullet Resisting Equipment.
- B. ASTM C 1172 - Standard Specification for Laminated Architectural Flat Glass.
- C. ASTM E119-98-Standard Test Methods for Fire Tests of Building Construction and Materials,
- D. MIL-P-46593A-Numerical simulation of ballistic impact on composite laminates,
- E. MIL-STD-622F-V50 Ballistic Test for Armor.

1.3 ACTION SUBMITTALS

- A. Product Data: Including manufacturer recommended installation instructions.
- B. Shop Drawings: Include plans, elevations, sections, details, attachment to other work.
- C. Samples: For each exposed glazing type.

1.4 INFORMATION SUBMITTALS

- A. Product Test Reports: Indicating compliance with requirements
- B. Warranty: Sample of warranty

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials to the project site with the manufacturer's UL Listed Labels intact and legible. Handle the materials with care to prevent damage. Store materials inside and under cover, stack flat and off floor. Project conditions (temperature, humidity, and ventilation) shall be within the maximum limit recommendations provided by

manufacturer. Do not install products stored in conditions outside manufacturer's recommended limits.

1.7 WARRANTY

- A. Workmanship Warranty: All materials shall be warranted against defects for a period of 1 year for the date of receipt at the project site. Provide certificates of manufacturer's standard limited warranty with closeout documents.
- B. Finish Warranty: Manufacturer's warranty against deterioration of factory finishes for the period of 1 year from the date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

- A. Subject to compliance with requirements, other manufacturers of products of equivalent design may be acceptable.
- B. Basis of Design:
 - 1. Total Security Solutions, Inc., 935 Garden Lane, Fowlerville, MI 48836, 866 734-6277. Attn: Sales Department, sales@tssbulletproof.com. Web: www.tssbulletproof.com.
UL Level 2

2.2 BULLET RESISTANT ALL GLASS GLAZING

- A. Through the design, manufacturing techniques and material application, the TSS Total Armor Bullet Resistant Fiberglass panels shall be made of multiple layers of woven roving ballistic grade fiberglass cloth impregnated with a thermoset polyester resin and compressed into flat rigid sheets.
- B. TSS Total Armor Bullet Resistant Fiberglass will be rated and tested for UL 752 and NIJ—0108.01 at the Level indicated by the product selected.

2.3 FABRICATION

- A. Tolerances: All joints and connections shall be tight, providing hairline joints and true alignment of adjacent members.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Prior to beginning installation, verify that areas have been prepared as required by the Contract Documents and architectural drawings, and Shop Drawings have been approved.

- B. Notify Architect of any unsatisfactory preparation that is responsibility of others.
- C. Clean and prepare all surfaces per manufacturers recommendations as required for achieving the best results for the substrate under the project conditions.
- D. Do not begin installation of material until all unsatisfactory conditions have been resolved and approved by Architect.

3.2 INSTALLATION

- A. Do not begin installation until areas have been verified and surfaces properly prepared in accordance with Drawings.
- B. Install in accordance with manufacturer's instructions and UL 752. Set all equipment plumb.
- C. Apply sealant in accordance with manufacturer's recommendations as indicated in installation instructions.
- D. Remove excess sealant and leave exposed surfaces clean and smooth

3.3 PROTECTION

- A. Clean and protect material from damage during ongoing construction operations. If damage occurs, remove and replace as required to provide voice ports in their original, undamaged condition.
- B. Inspection and Cleaning: Verify installation is complete and complies with manufacturer's requirements.
- C. Provide final cleaning of product and accessories, removing excess sealant, labels and protective covers.
- D. Touch-up, repair or replace damaged products prior to Substantial Completion.

END OF SECTION

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1
2 Exposed Materials:

3 Plastic-Laminate Grade: HGS.

4 Colors and Patterns: basis of design Formica Prestige Walnut.

5
6 Edgebanding: Plastic laminate matching adjacent surfaces.

7
8 Semiexposed Materials:

9 Plastic Laminate: Grade VGS unless otherwise indicated. Provide plastic laminate for semiexposed
10 surfaces unless otherwise indicated.

11 Colors and Patterns: basis of design Formica Prestige Walnut..

12 Provide plastic laminate of same grade as exposed surfaces for interior faces of doors and drawer
13 fronts and other locations where opposite side of component is exposed.

14
15 Thermally Fused Laminate (TFL) Panels: Provide thermally fused laminate panels for semiexposed
16 surfaces unless otherwise indicated.

17
18 Provide plastic laminate of same grade as exposed surfaces for interior faces of doors and drawer
19 fronts and other locations where opposite side of component is exposed.

20
21 Hardboard: Use only for cabinet backs where exterior side of back is not exposed.

22 Metal for Steel Drawer Pans: Cold-rolled, carbon-steel sheet complying with ASTM A1008/A1008M;
23 matte finish; suitable for exposed applications.

24 Unless otherwise indicated, provide specified edgebanding on all semiexposed edges.

25
26
27 Concealed Materials:

28 Solid Wood: With no defects affecting strength or utility.

29 Plywood: Hardwood plywood.

30 Plastic Laminate: Grade VGS.

31 Particleboard.

32 MDF.

33 Hardboard.

34
35 **MATERIALS**

36 Maximum Moisture Content for Lumber: 7 percent for hardwood and 12 percent for softwood.

37
38 Hardwood Plywood: HPVA HP-1, particleboard core except where veneer core is indicated.

39
40 Softwood Plywood: DOC PS 1.

41
42 Particleboard: ANSI A208.1, Grade M-2.

43
44 MDF: Medium-density fiberboard, ANSI A208.2, Grade 130.

45
46 Hardboard: ANSI A135.4, Class 1 tempered.

47
48 Plastic Laminate: High-pressure decorative laminate complying with ISO 4586-3.

49
50 PVC Edgebanding for Plastic Laminate: Rigid PVC extrusions, through color with satin finish, 3.0 mm thick
51 at doors and drawer fronts, 1.0 mm thick elsewhere.

52
53 Thermally Fused Laminate (TFL) Panels: Particleboard or MDF finished with thermally fused, melamine-
54 impregnated decorative paper.

1 Edgbanding for Thermally Fused Laminate (TFL) Panels: PVC or polyester edgbanding matching
2 thermally fused laminate panels.
3

4 **HARDWARE AND ACCESSORIES**

5 Hardware, General: Unless otherwise indicated, provide manufacturer's standard satin-finish, commercial-
6 quality, heavy-duty hardware.
7

8 Use threaded metal or plastic inserts with machine screws for fastening to particleboard except where
9 hardware is through-bolted from back side.
10

11 Butt Hinges: Stainless steel, semiconcealed, five-knuckle hinges complying with ANSI/BHMA A156.9,
12 Grade 1, with antifriction bearings and rounded tips.
13

14 Door and Drawer Bumpers: Self-adhering, clear silicone rubber.
15

16 Drawer Slides: Manufacturer's standard; complying with ANSI/BHMA A156.9.
17

18 Drawer and Hinged-Door Locks (for casework at Judges Bench): Cylindrical (cam) type, five-pin tumbler,
19 brass with chrome-plated finish, and complying with ANSI/BHMA A156.11, Grade 1.
20

21 Provide a minimum of two keys per lock.
22

23 Adjustable Shelf Supports:

24 Adjustable Shelf Supports: Pin-type, single-pin metal shelf rests complying with ANSI/BHMA A156.9,
25 Type B04013.
26

27 **PART 3 - EXECUTION**

28
29 **INSTALLATION**

30 Grade: Install casework to comply with same quality standard grade as item to be installed.
31

32 Install casework level, plumb, and true in line; shim as required using concealed shims. Where casework
33 abuts other finished work, apply filler strips and scribe for accurate fit, with fasteners concealed where
34 practical.
35

36 Base Cabinets: Set cabinets straight, level, and plumb. Adjust subtops within 1/16 inch of a single plane.
37 Align similar adjoining doors and drawers to a tolerance of 1/16 inch. Bolt adjacent cabinets together with
38 joints flush, tight, and uniform.
39

40 Fasten casework to adjacent units and to masonry, framing, wood blocking, or reinforcements in walls and
41 partitions to comply with the AWI/AWMAC/WI's "Architectural Woodwork Standards."
42

43 Install hardware uniformly and precisely. Set hinges snug and flat in mortises unless otherwise indicated.
44 Adjust and align hardware so moving parts operate freely and contact points meet accurately. Allow for final
45 adjustment after installation.
46

47 Adjust operating hardware so doors and drawers operate smoothly without warp or bind. Lubricate operating
48 hardware as recommended by manufacturer.
49

50 Clean finished surfaces, touch up as required, and remove or refinish damaged or soiled areas to match
51 original factory finish, as approved by Architect.
52

53 **END OF SECTION**

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SECTION 12 36 23
PLASTIC-LAMINATE-CLAD COUNTERTOPS

27
28

PART 1 - GENERAL

29
30

SUMMARY

Section Includes:

Plastic-laminate-clad countertops.

Accessories.

31
32
33

ACTION SUBMITTALS

Product Data: For each type of product.

Shop Drawings: For plastic-laminate-clad countertops.

Samples: Plastic laminates in each type, color, pattern, and surface finish required.

34
35
36
37

INFORMATIONAL SUBMITTALS

Product Certificates: For the following:

Composite wood products.

High-pressure decorative laminate.

Adhesives.

38
39
40
41

QUALITY ASSURANCE

Fabricator Qualifications: Shop that employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.

Installer Qualifications: A representative who is trained and has experience installing casework.

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PART 2 - PRODUCTS

BASIS OF DESIGN

Counter in Jury Room: Formica Paloma Polar

Work surfaces in Courtroom (witness stand and Judges Bench): solid color selected by Owner

PLASTIC-LAMINATE-CLAD COUNTERTOPS

Quality Standard: Unless otherwise indicated, comply with the "Architectural Woodwork Standards" for grades of plastic-laminate-clad countertops indicated for construction, finishes, installation, and other requirements.

Grade: Custom.

High-Pressure Decorative Laminate: ISO 4586-3, Grade HGS.

Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:

As indicated by manufacturer's designations.

Match Architect's sample.

As selected by Architect from manufacturer's full range in the following categories:

Solid colors, matte finish.

Solid colors with core same color as surface, matte finish.

Wood grains, matte finish with grain running parallel to length of countertop.

Edge Treatment: Same as laminate cladding on horizontal surfaces.

Core Material: As selected by fabricator to comply with quality standard.

1
2 Core Material at Sinks: Particleboard made with exterior glue.

3
4 Core Thickness: 1-1/8 inch.

5
6 Build up countertop thickness to 1-1/2 inches at front, back, and ends with additional layers of core
7 material laminated to top.

8
9 Backer Sheet: Provide plastic-laminate backer sheet, ISO 4586-3, grade to match exposed surface, on
10 underside of countertop substrate.

11
12 Paper Backing: Provide paper backing on underside of countertop substrate.

13 14 **WOOD MATERIALS**

15 Wood Products: Provide materials that comply with requirements of referenced quality standard unless
16 otherwise indicated.

17
18 Wood Moisture Content: 8 to 13 percent.

19
20 Composite Wood Products: Provide materials that comply with requirements of referenced quality standard
21 for each type of countertop and quality grade specified unless otherwise indicated.

22
23 MDF: Medium-density fiberboard, ANSI A208.2, Grade 130.

24 Particleboard: ANSI A208.1, Grade M-2.

25 Softwood Plywood: DOC PS 1.

26 27 **ACCESSORIES**

28 Wire-Management Grommets at Judges Bench: Circular, molded-plastic grommets and matching plastic caps
29 with slot for wire passage.

30
31 Outside Diameter: 2 inch.

32 Color: Black,

33 34 **MISCELLANEOUS MATERIALS**

35 Adhesive for Bonding Plastic Laminate: Type II water-resistant type as selected by fabricator to comply
36 with requirements.

37
38 Adhesive for Bonding Edges: Hot-melt adhesive or adhesive specified above for faces.

39 40 **FABRICATION**

41 Fabricate countertops to dimensions, profiles, and details indicated. Provide front and end overhang of 1 inch
42 over base cabinets. Ease edges to radius indicated for the following:

43
44 Solid-Wood (Lumber) Members: 1/16 inch unless otherwise indicated.

45
46 Complete fabrication, including assembly, to maximum extent possible before shipment to Project site.
47 Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site,
48 provide ample allowance for scribing, trimming, and fitting.

49 50 **PART 3 - EXECUTION**

51 52 **INSTALLATION**

53 Grade: Install countertops to comply with same grade as item to be installed.

54 Assemble countertops and complete fabrication at Project site to the extent that it was not completed in the
55 shop.

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Provide cutouts for appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately, and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.
Seal edges of cutouts by saturating with varnish.

Field Jointing: Where possible, make in the same manner as shop jointing, using dowels, splines, adhesives, and fasteners recommended by manufacturer. Prepare edges to be joined in shop so Project-site processing of top and edge surfaces is not required. Locate field joints where shown on Shop Drawings.

Secure field joints in countertops with concealed clamping devices located within 6 inches of front and back edges and at intervals not exceeding 24 inches. Tighten in accordance with manufacturer's written instructions to exert a constant, heavy-clamping pressure at joints.

Scribe and cut countertops to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.

Countertop Installation: Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop.

Install countertops level and true in line. Use concealed shims as required to maintain not more than a 1/8-inch-in-96-inches variation from a straight, level plane.

Secure backsplashes to tops with concealed metal brackets at 16 inches o.c. and to walls with adhesive. Seal joints between countertop and backsplash, if any, and joints where countertop and backsplash abut walls with mildew-resistant silicone sealant or another permanently elastic sealing compound recommended by countertop material manufacturer.

Protection: Provide Kraft paper or other suitable covering over countertop surfaces, taped to underside of countertop at a minimum of 48 inches o.c. Remove protection at Substantial Completion.

END OF SECTION

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SECTION 22 05 00

COMMON WORK RESULTS FOR PLUMBING

PART 1 GENERAL

1.01 SCOPE

- A. Applicable provisions of Division 1 shall govern work under this section. The contractor shall provide all items, articles, materials, operations, or methods listed, mentioned, or scheduled on the drawings and/or herein specified, including all materials, equipment, and incidentals necessary to produce a complete and operating system.

1.02 INDEX

- A. General
 - 1. Scope
 - 2. Index
 - 3. System Description
 - 4. Related Sections
 - 5. Submittals
- B. General Provisions
 - 1. Codes and Standards
 - 2. Permits
 - 3. Drawings, Coordination, Existing Conditions
 - 4. Materials
 - 5. Substitution
 - 6. Execution
 - 7. Sleeves and Inserts
 - 8. Escutcheons
 - 9. Horizontal Sanitary Lines
 - 10. Traps
 - 11. Penetrations of Fire Resistive Assemblies
 - 12. Requirements for Substantial Completion
 - 13. Tests and Adjustments
 - 14. Certification of Tests and Adjustments - Plumbing
 - 15. Guarantee

1.03 SYSTEM DESCRIPTION

- A. Demolition. Disconnect existing fixtures and related piping as indicated on documents. Remove all unnecessary piping above ceiling and below floor as necessary to complete new work.
- B. Provide and install fixtures, specialties, equipment, and all related piping as shown on floor plans, scheduled, and/or specified for a complete working system.

Clark County Courthouse, Branch 1 & 2 Courtroom Remodel
Neillsville, WI

- C. Provide and install all necessary sanitary waste, vent, water piping, gas piping, and air piping as shown on floor plans, scheduled, and/or specified for a complete working system.

1.04 RELATED SECTIONS

- A. Applicable provisions of Division 1 govern work under this section.
 - 1. Division 6 - Rough Carpentry.
 - 2. Division 23 - Mechanical.
 - 3. Division 26 - Electrical.
- B. This section applies to all Division 22 00 00 Sections of Plumbing.

1.05 SUBMITTALS

- A. The Plumbing Contractor shall review all shop drawings and mark each item with their approval before submitting to Architect/Engineer.
- B. The Plumbing Contractor shall provide shop drawings for review in accordance with the requirements of the General Conditions.
- C. Shop drawings shall contain complete dimensional, operational, material quality and manufacturer information on all fixture, specialty, and equipment items. Drawings shall also include title sheet with plumbing contractor's and supplier's name, address, phone number and email address.
- D. Shop drawings shall have each piece of equipment, fixture, and specialty items identified in correlation with drawings and specifications, all accessories shall be checked or identified as being provided, index sheets alone are not acceptable. Shop drawings shall be submitted electronically in pdf format, or in booklet form. Each fixture, specialty, and equipment along with accessories be grouped together. Failure to do so, will result in shop drawings being returned to the sender marked "Incomplete" or "Revise and Resubmit."
- E. The Plumbing Contractor shall be responsible for transmitting copies of the reviewed shop drawings to all affected trades, such as the Electrical Contractor for wiring connections, Heating Contractor for piping connections and General Contractor for supports, drains and equipment bases, etc. If submitting in booklet form, provide sufficient copies for all trades listed above along with contractors' own needs and a copy to be retained by Architect and Engineer.
- F. Shop drawings are required on the following items:
 - 1. Fixtures and Trim
 - 2. Valves
 - 3. Pipe Insulation

PART 2 GENERAL PROVISIONS

2.01 CODES AND STANDARDS

- A. All work specified in this section and applicable provisions of Division 1 shall conform to all applicable codes and to the standards for materials and workmanship of the nationally recognized approval agencies and trade associations such as the American Society of Mechanical Engineers, the American Society for Testing and Materials, The American Standards Association, National Fire Protection Association.
- B. Comply with requirements of Wisconsin Administrative Code.
- C. Standards. Abbreviations of standards organizations referenced in this, and other sections are as follows:
 - 1. ABMA - American Boiler Manufacturers Association
 - 2. ACPA - American Concrete Pipe Association
 - 3. AGA - American Gas Association
 - 4. AMCA - Air Movement and Control Association
 - 5. ANSI - American National Standards Institute
 - 6. ARI - Air Conditioning and Refrigeration Institute
 - 7. ASME - American Society of Mechanical Engineers
 - 8. ASPE - American society of Plumbing Engineers
 - 9. ASSE - American Society of Sanitary Engineering
 - 10. ASTM - American Society for Testing and Materials
 - 11. AWWA - American Water Works Association
 - 12. AWS - American Welding Society
 - 13. CISPI - Cast Iron Soil Pipe Institute
 - 14. CGA - Compressed Gas Association
 - 15. CS - Commercial Standards, Products Standards Sections, Office of Eng. Standards Service, NBS
 - 16. EPA - Environmental Protection Agency
 - 17. FS - Federal Specifications, Superintendent of Documents, U.S. Government Printing Office
 - 18. GAMA - Gas Appliance Manufacturers Association
 - 19. IAPMO - International Association of Plumbing & Mechanical Officials
 - 20. IEEE - Institute of Electrical and Electronics Engineers
 - 21. ISA - Instrument Society of America
 - 22. MCA - Mechanical Contractors Association
 - 23. MICA - Midwest Insulation Contractors Association
 - 24. MSS - Manufacturer's Standardization Society of the Valve & Fitting Industry, Inc.
 - 25. NBS - National Bureau of Standards
 - 26. NEC - National Electric Code
 - 27. NEMA - National Electrical Manufacturers Association
 - 28. NFPA - National Fire Protection Association
 - 29. NSF - National Sanitation Foundation
 - 30. PDI - Plumbing and Drainage Institute
 - 31. SMACNA - Sheet Metal and Air Conditioning Contractors' National Association. Inc.
 - 32. STI - Steel Tank Institute
 - 33. UL - Underwriters Laboratories Inc.

D. Standards referenced in this section:

1. ACI 614 - Recommended Practice for Measuring, Mixing and Placing of Concrete
2. ASTM D1557 - Standard Test Method for Moisture-Density Relations of Soils
3. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Fire Stops
4. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials
5. D.O.T. - Standard Specifications for Road and Bridge Construction, State of Wisconsin, Dept. of Transportation
6. UL1479 - Fire Tests of Through-Penetration Firestops
7. UL723 - Surface Burning Characteristics of Building Materials

2.02 PERMITS

- A. All permits and fees required by regulatory agencies or utilities for plumbing work shall be secured and paid for by the Plumbing Contractor.

2.03 DRAWINGS, COORDINATION, EXISTING CONDITIONS

- A. Plans of piping and fixtures shown on scale drawings, are diagrammatic only. They are intended to indicate size and/or capacity where stipulated, approximate location and/or direction and approximate general arrangement of one phase of work to another, but not to the exact detail or arrangement of construction. Plans are based on equipment scheduled. Plumbing Contractor shall be responsible for changes resulting from equipment other than scheduled.
- B. If it is found before installation, that a more convenient, suitable or workable arrangement for any or all phases of the project would result by varying or altering the arrangement indicated on the drawings, the Plumbing Contractor may change the location or arrangement of their work without additional cost to the owner but only after obtaining a written approval by the Architect/Engineer.
- C. Mechanical systems are shown on drawings that were closely coordinated with the Architectural drawings; however, minor variations may occur. Plumbing Contractor shall verify dimensions, heights, door swings, window locations, and any other information critical to the placement of devices, with the architectural drawings to assure proper installation. Field measurements shall take precedence over drawing dimensions and shall be verified. Plans shall not be scaled to locate equipment.
- D. All piping installations shall closely match the drawings as approved by the Department of Safety and Professional Services. Any variation from or additions to the piping arrangement will require a revision or be resubmitted to the Department of Safety and Professional Services at the Plumbing Contractor's expense.
- E. It shall be the contractor's responsibility to visit the existing project site, become acquainted with all existing conditions, and ascertain the extent of work involved. The contractor shall provide all labor, materials, etc., required for the complete, new installation required for the completion of the project. By the act of submitting a price; or in the case of time and material project, begin work, the contractor shall be deemed to have performed such an examination, to have accepted such conditions, and to have made allowances therefore preparing their price and resolving questions regarding work required.

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- F. The contractor installing material and equipment shall coordinate the installation with all other trades prior to installation. Additional project cost is not justified due to lack of coordination or due to material fabrication without field measurements. Any coordination problems shall be brought to the attention of the engineer before installation or fabrication. Any work installed that is not coordinated and that interferes with other contractor's work shall be removed or relocated at installing contractor's expense.
- G. All project conditions shall be verified prior to performing any work. All accessible elevations and inverts shall be immediately verified. Hidden or inaccessible elevations or inverts important to the installation of plumbing systems shall be investigated after obtaining approval from the owner to excavate or demolish surfaces or structure required for such investigation, but prior to performing any related work. Promptly report findings to the engineer who shall assist the contractor in determining if revisions, if any, are required to the scope of the contractor work.
- H. It is the Plumbing Contractor's responsibility to become acquainted with fixtures/equipment installation manuals before proceeding with the installation of that fixture/equipment. Any variation from drawing conditions and manufacturer's installation instructions shall be reported to the engineer before installing equipment.

2.04 MATERIALS

- A. Each major component of the equipment shall have the manufacturer's name, address, catalog, and serial number permanently attached in a conspicuous place.
- B. The same brand or manufacturer shall be used for each specific application of fixtures, pumps, valves, fittings, controls, and other equipment.
- C. All materials shall be new and of the quality specified and meet approval as per SPS 384.10 (2).
- D. All products must be lead free as required by the lead-free law "Federal Safe Drinking Water Act."
- E. All equipment shall be listed, approved, or rated by a nationally recognized testing and rating bureau or the recognized manufacturers association responsible for setting industry standards. All electrical equipment and apparatus shall be U.L. listed. Examples of recognized associations are:
 - 1. American Concrete Pipe Association
 - 2. American Gas Association
 - 3. American Pipe Fitting Institute
 - 4. American Water Works Association
 - 5. Plastic Pipe Institute
 - 6. Thermal Insulation Manufacturers Association

2.05 SUBSTITUTIONS

- A. It is the intent of this specification to permit the use of the materials of any nationally recognized manufacturer so long as they are fully equal to the quality and performance of the named item in the opinion of the engineer. Materials or equipment of other manufacturers may be used upon the following conditions:
1. The proposed substitute is equal in design, materials, construction, and performance in the opinion of the engineer. No compromise in quality level will be allowed.
 2. The service capabilities, availability of service parts and stability of the manufacturer are adequate in the opinion of the engineer.
 3. The Plumbing Contractor assumes responsibility for any modifications required for the installation of substitute equipment and for the accommodation of such substitution by work of other contractors. Any additional expense on the part of other contractors or to the owner due to substitution of equipment shall be borne by the Plumbing Contractor making such substitution.
 4. Substitute equipment/products shall fit into the space provided with adequate provisions for service and maintenance and must meet product approval as per SPS 384.10 (2). Any substitute equipment that causes variation of or deviation from original piping arrangement may require a revision to be submitted to the Department of Safety and Professional Services at the Plumbing Contractor's expense.
- B. The Plumbing Contractor may submit catalog data on material proposed for substitution to the engineer for evaluation up to 10 days prior to the date for opening bids. The engineer will render an opinion on whether the material can be bid as a substitute based on the information received. Final approval for the use of substitute equipment will not be given until complete shop drawings, samples or other information deemed necessary by the engineer has been submitted.
- C. Where several manufacturer's names are specified for a given item the product of these manufacturers only will be accepted. Requests for substitutions will not be granted. Materials by the first manufacturer named are used in design and scheduled. Materials by the other name manufacturers shall be of equal quality, capacity, design, and function and shall be adaptable into the system without alteration to the system.

2.06 EXECUTION

- A. Workmanship. All work shall be done by qualified licensed plumbers that are knowledgeable and experienced in the operations they are performing. Fabrications and installation methods, procedures and materials shall be in accordance with accepted industry practice and with the standard of manufacturing and contracting associations applicable to the work. All work shall be neatly done with special emphasis on the appearance of work exposed to view. All piping shall be run plumb and square unless otherwise required for a functional reason. Gradients of pitched lines shall be continuous.
- B. Painting. Furnish all equipment completely finished unless specifically noted otherwise. Touch up all abrasions, nicks, scratches, or other paint defects to restore equipment to its original condition. Severely marred equipment shall be factory refinished if so desired by Architect/Engineer. All surfaces shall be clean, rust free, and suitable for painting, on all piping and equipment furnished which are to be painted. All roof and/or wall piping penetrations that are visible shall be primed and painted. All painting of plumbing related items is responsibility of Plumbing Contractor, who may use project Painting Contractor as their subcontractor for this work. Coordinate color with Architect.
- C. Cutting and Patching. Skilled tradesmen shall be employed to do cutting and patching. Each Contractor shall be responsible for cutting and patching new openings for their use, in existing or previously constructed walls, ceilings, floors, roofs, etc., unless otherwise designated. Provide personnel protection under coring operations in occupied areas. Submit methods of supporting and sealing floor sleeves for approval. Holes cut in roof and exterior wall shall be weatherproofed immediately. Provide temporary dust barriers for cutting operations in occupied spaces. Refer to Architectural drawings for lintels provided by General Contractor. When lintels are not indicated in other divisions of the work, they shall be provided by the contractor requiring the opening. All piping penetrations through masonry structure shall be drilled or core drilled. All penetrations for access panels, etc. shall be saw cut before removal. Jack hammering without saw cutting is prohibited.
- D. Access. All plumbing fixtures and/or equipment shall be located so that parts requiring service and/or adjustment, fixture traps and valves shall be readily accessible. Provide access doors or panels to make service convenient. Doors by Acudor, Milcor or as per architectural specifications. Provide by Plumbing Contractor unless designated otherwise.
- E. Plumbing piping and equipment located between finish floor and 7'-6" shall have a resilient material (foam rubber, etc.) attached to all potentially dangerous edges.
- F. Blocking. Plumbing Contractor is responsible for any additional blocking materials required for the attachment or suspending of plumbing related piping, components, fixtures, equipment related to plumbing work. Reference Division 06 - Rough Carpentry.

2.07 SLEEVES AND INSERTS

- A. At all fire rated penetrations only use UL listed, tested, and approved materials and methods that meet Department of Safety and Professional Services Plumbing Approval. (Division 07 - Fire stopping.)
- B. All pipes passing through masonry walls, floors, ceilings, or partitions shall be provided with sleeves having internal diameters at least 1/4" greater than the outside diameter of un-insulated pipes and/or outside diameter of the insulation of insulated piping. Sleeves for pipes passing through fire rated floor slabs and fire rated walls shall be schedule 40 steel pipes extending 1" above the finished slab and sealed. If holes must be cut through finished construction, they must be core drilled to avoid damage to construction. Exterior wall sleeves shall be caulked weather tight. Sleeves through equipment room also shall be filled with glass fiber insulation. Where chases are formed for passage of several pipes, they shall have a 1" high curb above finished slab and sealed. Whenever sleeves occur as penetrations of rated construction, the void space shall be sealed with U.L. rated sealant similar to Bio Fireshield Firestop Products; Chase Foam, CTC PR855; 3M Fire Barrier Caulk CP25 and putty 303; Dow Corning Fire Stop 2000 or Specified Technologies, Inc. Spec Seal Firestop Products installed in strict accordance with the manufacturer's instructions. Use sealant thickness as required to provide the full fire protection rating of the structure. Insulation shall not pass through rated assemblies. Insulation shall butt tight against the rated assembly after the sealant is installed and inspected. Refer to section SPS 351.049 (1)(3) of the Wisconsin Building Heating, Ventilating and Air Conditioning Code.
- C. Inserts in floor slabs shall be galvanized individual type with accommodation for removable nuts and threaded rods up to 3/4" diameter, permitting lateral adjustment. Any fastener in a beam shall be midway above the bottom of the beam.
- D. Piping that passes through outside walls below grade and above grade shall be permanently sealed with watertight rubber compression seal between the pipe and the sleeve equal to Link-Seal modular wall and casing seal as manufacturer by Thunderline Corporation. The pipe sleeve and seal must meet UL listed, tested, and approved materials and methods that meet Department of Safety and Professional Services Plumbing Approval.
- E. Sleeves through equipment room walls shall be filled with pre-compressed, self-expanding, polyurethane acoustic foam equal to Illbruck insulation.

2.08 ESCUTCHEONS

- A. Escutcheons shall be installed on all exposed pipes wherever they pass through floors, ceilings, walls, or partitions.
- B. Escutcheons for pipes passing through floors in unfinished areas shall be split hinged type designed to fit the pipe and to cover the projecting pipe sleeve. Escutcheons for pipes exposed to view in finished areas shall be chrome-plated brass.
- C. Escutcheons shall be properly sized to fit snugly around the pipe and shall be sized to completely cover the wall or floor opening.

2.09 HORIZONTAL SANITARY PIPING

- A. Lines shall pitch down a minimum of 1/8" per foot in the direction of flow, or as indicated on the drawings. Soil and waste branch piping shall pitch down 1/4" per foot. All vent piping shall drip back into waste piping. Stacks shall be run vertically. Changes of direction 45° or more from vertical to horizontal shall be made with long sweep elbows. Horizontal changes in direction shall be made with "Y" or "Y" and 1/8 bend combination fitting.

2.10 TRAPS

- A. Every fixture and floor drain shall be provided with a proper trap placed near the outlet and properly vented. Traps shall be cast iron hub and spigot when used in soil pipe or no hub with approved stainless-steel couplings. Traps for threaded pipe shall be screwed drainage pattern cast iron "P" traps. Where approved, PVC traps with adjustable compression fittings may be used. All exposed traps for sinks, lavatories and similar fixtures shall be chrome plated "P" traps, or as specified with the fixture trim. All traps shall have a minimum seal of 2".

2.11 PENETRATIONS OF FIRE RESISTIVE ASSEMBLIES

- A. Plumbing piping systems that penetrate fire rated assemblies shall be installed in accordance with SPS 351.049 or current acceptable methods. Also refer to requirements for sleeves.
- B. SPS 351.049 Miscellaneous Openings in Fire-rated Construction.
 - 1. Service Openings. Openings around plumbing pipes, sleeves, conduit or other service installations penetrating required fire-resistive rated floor, wall and roof assemblies shall be protected by an approved penetration fire stop system installed as tested in accordance with ASTM E814 and shall have F rating of not less than the required fire resistance rating of the construction assembly. The system shall be tested and listed for the specific application regarding the size of the opening, the size and type of the penetrating objects and the type of assembly penetrated, and the size of the annular space to be fire stopped.
 - 2. Plastic Piping and Electrical System Components. Penetration of required fire-resistive rated floor, wall, ceiling and roof assemblies by plastic piping and electrical system components shall be in accordance with one of the following:
 - a. A device or system tested and listed by an approved testing laboratory.
 - b. For plastic piping, conduits, or raceways, substitute a steel or cast-iron pipe or conduit in the penetration of the fire-rated assembly to a distance of at least 10ft beyond both faces of the assembly.
 - 3. Plumbing contractor shall verify all fire rated areas, walls, and floors on architectural plans and with general contractor.

2.12 REQUIREMENTS FOR SUBSTANTIAL COMPLETION

A. Cleaning Equipment and Premises

1. Thoroughly clean all parts of the piping, valves, and fixtures. Exposed parts which are to be painted shall be thoroughly cleaned of cement, plaster and other materials and all oil and grease spots removed. Such surfaces shall be carefully wiped and all cracks and corners scraped out. Exposed metal work shall be carefully brushed down with steel brushes to remove rust and other spots and left smooth and clean.
2. Remove all construction debris, excess materials, and equipment.
3. Caulk around all plumbing fixtures at walls and around base of water closets, service sinks, etc.

B. Operating and Maintenance Manuals

1. The Plumbing Contractor shall furnish to the Engineer a pdf file format or two operating manuals of furnished plumbing equipment. Information sheets shall be bound in standard 3-ring binders labeled to show the contractor's name, address, regular business phone number, emergency phone number, email address, and date. Operating manuals shall be submitted prior to completion of the work to allow time for review.
2. The manual shall contain the following information:
 - a. Provide a warranty letter on the plumbing contractor's letterhead stating that, *"All material and workmanship shall be guaranteed for a period of one year after substantial completion."*
 - b. The Certification of Tests and Adjustments completed and signed.
 - c. Completed and signed plumbing punch lists.
 - d. A copy of the stamped reviewed shop drawings for each fixture, equipment and plumbing specialties installed.
 - e. Provide installation and service manuals for all plumbing specialties, equipment, and fixtures, with all model numbers and options highlighted.
 - f. A complete operating and maintenance manual with parts listed, wiring diagrams, lubrication requirements, and service instructions for each major item including faucet and mixing valve repair.
 - g. Properly executed and registered manufacturer's warranties for all products installed.
 - h. A copy of valve chart.
 - i. Provide a signed letter by plumbing contractor and owner maintenance staff on contractor's letter head stating completion of a minimum of two hours training on operating and maintenance of major equipment.

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- j. Provide Record Drawings: Accurately record locations of field changes on a set of drawings and deliver to Architect/Engineer upon substantial completion. State approved plumbing plans are not to be used for Record Drawings!

2.17 TESTS AND ADJUSTMENTS

- A. The Plumbing Contractor shall conduct tests of systems as required by codes, regulatory agencies, and this specification. Tests shall be made with the medium and under pressure as stated in the test requirements. Notify the Engineer and/or regulatory agencies prior to conducting tests. The Plumbing Contractor shall complete the attached certification form and submit to the Engineer when tests have been completed and include in O&M Manuals.
- B. Testing Requirements:
 - 1. Building sanitary, storm and clear water piping system.
 - a. Water test – Minimum of 10-foot head on each joint for a minimum of 15 minutes with no head loss.
 - b. Air test – Uniform gauge pressure of 3 psig for a minimum of 15 minutes without adding air.
 - 2. Water Service and Building Distribution Piping.
 - a. Water test – 100 psi gauge pressure for a two-hour period.
 - 3. The pressure in pounds per square inch, or inches of vacuum, gauge, are given as an initial pressure to be applied to lines being tested, together with test medium. Tests are to be applied for a minimum period of four (4) hours and until tests are complete. Final pressures at the end of test period may vary only by that caused by expansion of the test medium due to temperature changes.
 - 4. Check of systems during application of test pressures should include visual check for water medium leakage, soap bubble or similar for air and nitrogen medium.
 - 5. Start-Up of Piping Systems. Potable water system shall be cleaned and disinfected in accordance with state and local codes or in the absence of such codes shall be treated by accepted methods to provide a system free of harmful contaminants and acceptance to regulatory agencies. All lines shall be thoroughly flushed to remove dirt and construction debris. See SPS 382.40(8) (I).

2.18 CERTIFICATION OF TESTS AND ADJUSTMENTS - PLUMBING

- A. Project Name: _____
- B. Project Number: _____
- C. Plumbing Contractor Name: _____

The Plumbing Contractor named above certifies that the tests and adjustments indicated below have been completed in accordance with the specifications on the date indicated. Also include attachments of all test reports.

	TESTS	DATE
D.	Building Sanitary Sewers, Branches, Drains, Stacks and Vent Piping.	_____
E.	Building Water Distribution Piping.	_____

Contract _____

Signed By Plumbing Contractor _____

Date _____

Signed By Project Manager _____

Date _____

2.19 GUARANTEE

- A. All material and workmanship shall be guaranteed for a period of one year after substantial completion. Where warranties are required, they shall be provided by the manufacturer or contractor as specified.

END OF SECTION

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SECTION 22 05 53

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Nameplates.
- B. Tags.
- C. Pipe Markers.

1.02 REFERENCES

- A. ASME A13.1 - Scheme for the Identification of Piping Systems; The American Society of Mechanical Engineers; 2007.

1.03 SUBMITTALS

- A. See Section 22 05 00 - Submittals.
- B. List: Submit list of wording, symbols, letter size, and color-coding for plumbing identification.
- C. Product Data: Provide manufacturer's catalog literature for each product required.
- D. Manufacturer's Installation Instructions: Indicate special procedures, and installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Brady Inc: www.bradyid.com.
- B. Brimar Inc: www.brimar.com.
- C. Kolbi Pipe Marker Co.: www.kolbipipemarkers.com.
- D. Marking Services, Inc.: www.markerv.com.
- E. Seton Identification Products: www.seton.com/aec.
- F. Substitutions: See Section 22 05 00 Substitutions.

2.02 NAMEPLATES

- A. Description: Laminated three-layer plastic with engraved letters.
 - 1. Letter Color: White.
 - 2. Letter Height: 1/2".
 - 3. Background Color: Black.

2.03 TAGS

- A. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2" diameter.
- B. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2" diameter with smooth edges.
- C. Chart: Typewritten letter size list in anodized aluminum frame.
- D. Chart: Copy of valve chart included in O&M manuals.

2.04 PIPE MARKERS

- A. Comply with ASME A13.1. and ASME Pipe Marker Guidelines for proper identification including, but not limited to, letter heights, marker size, color, wording legend, flow direction arrows, and proper placement.
- B. Snap-on Plastic Pipe Markers: Factory fabricated, flexible, cylindrical self-coiling semi-rigid plastic, preformed to fit around pipe or pipe covering held tightly in place without the use of adhesive, tape or straps; information indicating flow direction arrow and identification of fluid being conveyed.
- C. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure-sensitive adhesive backing and printed markings.
- D. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6" wide by 4 mil thick, manufactured for direct burial service.

2.05 CEILING TACKS

- A. Description: Steel pushpin with color-coded head.
- B. Color code as follows:
 - 1. Green - Plumbing valves
 - 2. Silver - Plumbing equipment
 - 3. Yellow - HVAC equipment
 - 4. Red - Fire dampers/smoke dampers
 - 5. Blue - Heating/cooling valves

PART 3 EXECUTION

3.01 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.

3.02 INSTALLATION

- A. Install plastic nameplates with corrosive-resistant mechanical fasteners in lieu of adhesive whenever possible. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- B. Install tags with corrosion resistant chain and/or S-hook.
- C. Install plastic pipe markers in accordance with manufacturer's instructions.
- D. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
- E. Identify valves in main and branch piping with tags.
- F. Valve tags shall state valve number, valve location, and describe valve function.
- G. Identify piping, concealed or exposed, with pipe markers. Identify service, flow direction, and, if required, pressure. Install in clear view and align with axis of piping. Locate identification in each room, or open area, not to exceed 20ft on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction. Installation of pipe identification shall be after piping is clean or required painting is performed, and before installation of finish ceiling.
- H. Domestic hot water piping distributing 125° and higher hot water, or if there is multiple temperature hot water piping systems, the piping shall be labeled with distributing temperature.
- I. Domestic hot water with a hot water return system shall be marked with directional arrows to indicate flow.
- J. Abandoned Piping: Provide Snap-On pipe markers for abandoned piping. Marker to be white with black lettering and include a black border. If abandoned piping is pressurized, or contains hazardous materials, the legend should indicate such.
- K. Valve tag chart shall be mounted in mechanical room in a place as directed by Architect.
- L. Provide ceiling tacks to locate valves and plumbing equipment above T-bar type panel ceilings. Locate in corner of panel closest to valves and equipment.
- M. Coordinate with owner on use and location of ceiling tacks.
- N. Coordinate equipment and piping labels, and valve tag types with existing piping identifications. Valve tags shall be coordinated with existing tag numbers and the numbering shall be of continuation.

3.03 SCHEDULES

- A. Identification Symbols:
1. Condensate drain
 2. Domestic Cold Water
 3. Domestic Hot Water
 4. Domestic Hot Water Recirculation
 5. Sanitary Sewer
 6. Sanitary Vent

END OF SECTION

SECTION 22 07 19

PLUMBING PIPING INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Piping insulation.
- B. Jackets and accessories.

1.02 RELATED SECTIONS

- A. Section 07 84 00 - Firestopping.
- B. Section 09 90 00 - Painting and Coating: Painting insulation jacket.
- C. Section 22 05 00 - Common Work Results for Plumbing
- D. Section 22 10 05 - Plumbing Piping: Placement of hangers and hanger inserts.

1.03 REFERENCES

- A. ASTM A 666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless-Steel Sheet, Strip, Plate, and Flat Bar; 2003.
- B. ASTM B 209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2006.
- C. ASTM C 177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot Plate Apparatus; 2004.
- D. ASTM C 195 - Standard Specification for Mineral Fiber Thermal Insulating Cement; 2000.
- E. ASTM C 449/C 449M - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement; 2000.
- F. ASTM C 518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2004.
- G. ASTM C 533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation; 2007.
- H. ASTM C 534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2005.
- I. ASTM C 547 - Standard Specification for Mineral Fiber Pipe Insulation; 2006.
- J. ASTM C 552 - Standard Specification for Cellular Glass Thermal Insulation; 2003.
- K. ASTM C 578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation; 2006.

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- L. ASTM C 585 - Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System); 1990 (Reapproved 2004).
- M. ASTM C 591 - Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation; 2005.
- N. ASTM C 610 - Standard Specification for Molded Expanded Perlite Block and Pipe Thermal Insulation; 2005.
- O. ASTM C 795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel; 2003.
- P. ASTM D 1056 - Standard Specification for Flexible Cellular Materials--Sponge or Expanded Rubber; 2000.
- Q. ASTM D 2842 - Standard Test Method for Water Absorption of Rigid Cellular Plastics; 2006.
- R. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2007.
- S. ASTM E 96/E 96M - Standard Test Methods for Water Vapor Transmission of Materials; 2005.
- T. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials; National Fire Protection Association; 2006.
- U. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Underwriters Laboratories Inc.; 2003.

1.04 SUBMITTALS

- A. See Section 22 05 00 - Submittals.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
- C. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than five years of documented experience.
- B. Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum five years of documented experience.

- C. Install all insulation in accordance with the latest edition of MICA (Midwest Insulation Contractors Association) Standard and manufacturer's installation instructions. Exceptions to these standards will only be accepted where specifically modified in these specifications, or where prior written approval has been obtained from the Project Engineer.

1.06 DELIVERY, STORAGE, AND PROTECTION

- A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.07 ENVIRONMENTAL REQUIREMENTS

- A. Maintain ambient conditions required by manufacturers of each product.
- B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 PRODUCTS

2.01 REQUIREMENTS FOR ALL PRODUCTS OF THIS SECTION

- A. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E 84, NFPA 255, or UL 723.
- B. General Requirements. The work covered by this specification consists in furnishing all labor, equipment, accessories and materials and in performing all operations necessary for the installation of all insulation for the plumbing piping systems in strict accordance with the insulation for the plumbing piping systems in strict accordance with the insulation section of this specification and applicable drawings, subject to the terms and conditions of the contract. All insulation shall be installed in a skillful manner by skilled workers regularly engaged in this type of work.
 - 1. All insulation shall have composite (insulation, jacket, or facing, and adhesive used to adhere the facing or jacket to the insulation) fire and smoke hazard ratings as tested by procedure ASTM E84, NFPA 255, and UL 723 not exceeding: Flame spread 25; Smoke developed 50; fuel contributed 50; UL fire hazard classification 1. Accessories, such as adhesives, plastics, cements, taps or glass fabric for fittings shall be the same component ratings as listed above.
 - 2. Insulation thickness specified herein is based on a conductivity of .22 BTU/SQ.Ft>/Deg. F/HR. at 75° F. mean temperature. If insulating materials with substantially different thermal properties are used the thickness of insulation shall be adjusted to provide the overall insulating efficiency of the material specified.

2.02 GLASS FIBER

- A. Manufacturers:
 - 1. Knauf Fiber Glass: www.knaufusa.com.
 - 2. Johns Manville Corporation: www.jm.com.
 - 3. Owens Corning Corp: www.owenscorning.com.
 - 4. CertainTeed Corporation: www.certainteed.com.
 - 5. Substitutions: See Section 22 05 00 Substitutions.

- B. Insulation: ASTM C 547; rigid molded, noncombustible.
 - 1. 'K' value: ASTM C 177, 0.24 at 75° F.
 - 2. Maximum service temperature: 850° F.
 - 3. Maximum moisture absorption: 0.2% by volume.

- C. Insulation: ASTM C 547; semi-rigid, noncombustible, end grain adhered to jacket.
 - 1. 'K' value: ASTM C 177, 0.24 at 75° F.
 - 2. Maximum service temperature: 650° F.
 - 3. Maximum moisture absorption: 0.2% by volume.
 - 4. Preformed pipe insulation shall be two-piece or one-piece fiberglass composite with vinyl coated embossed vapor barrier laminate and pressure sealing lap. The insulation systems shall be suitable for piping operating between 50°F to 450°F. The insulation system shall be vermin-proof, rot-free, non-shrinking with a moisture absorption not exceeding .2% by volume after 96 hours at 120°F and 95% RH. Jacket permanence shall not exceed .2% perms and shall have a Beach puncture rating of at least 50 units.
 - 5. Fittings, valve bodies and flanges for pipe sizes 6" and smaller shall be finished with fiberglass inserts and PVC fitting covers. One (1) insert to be used for pipe insulation of 1" thickness. An additional insert to be used for each additional 1" or fraction thereof for pipe insulation above 1" thickness.

- D. Vapor Barrier Jacket: White kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E 96/E 96M of 0.02 perm-inches.

- E. Tie Wire: 0.048" stainless steel with twisted ends on maximum 12" centers.

- F. Vapor Barrier Lap Adhesive:
 - 1. Compatible with insulation.

- G. Fibrous Glass Fabric:
 - 1. Cloth: Untreated; 9 oz/sq yd weight.
 - 2. Blanket: 1.0 lb/cu ft density.
 - 3. Weave: 5x5.

- H. Indoor Vapor Barrier Finish:
 - 1. Cloth: Untreated; 9 oz/sq yd weight.
 - 2. Vinyl emulsion type acrylic, compatible with insulation, white color.

2.03 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

- A. Manufacturer:
 - 1. Armacell International: www.armacell.com.
 - 2. Aeroflex: www.aeroflexusa.com.
 - 3. Substitutions: See Section 22 05 00 Substitutions.
- B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C 534 Grade 3; use molded tubular material wherever possible.
 - 1. Minimum Service Temperature: -40° F.
 - 2. Maximum Service Temperature: 220° F.
 - 3. Connection: Waterproof vapor barrier adhesive.

2.04 JACKETS

- A. PVC Plastic.
 - 1. Manufacturers:
 - a. Johns Manville Corporation: www.jm.com.
 - b. Sproule Mfg. Co.: www.sroule-mfg.com.
 - c. Substitutions: See Section 22 05 00 Substitutions.
 - 2. Jacket: One-piece molded type fitting covers and sheet material, off-white color.
 - a. Minimum Service Temperature: 0° F.
 - b. Maximum Service Temperature: 150° F.
 - c. Moisture Vapor Permeability: 0.002 perm inch, maximum, when tested in accordance with ASTM E 96/E 96M.
 - d. Thickness: 10 mil.
 - e. Connections: Brush on welding adhesive.
 - 3. Covering Adhesive Mastic:
 - a. Compatible with insulation.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that piping has been tested before applying insulation materials.
- B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with NAIMA National Insulation Standards.
- C. Exposed Piping: Locate insulation and cover seams in least visible locations.
- D. Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.

- E. Glass fiber insulated pipes conveying fluids below ambient temperature:
 - 1. Provide vapor barrier jackets, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
 - 2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.
- F. For hot piping conveying fluids 140° F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
- G. For hot piping conveying fluids over 140° F, insulate flanges and unions at equipment.
- H. Glass fiber insulated pipes conveying fluids above ambient temperature:
 - 1. Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples.
 - 2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC covers.
- I. Inserts and Shields:
 - 1. Application: Piping 1" diameter or larger.
 - 2. Shields: Galvanized steel between pipe hangers or pipe hangers, rolls, and inserts. Stainless steel shall be used in a high corrosive area.
 - 3. Insert location: Between support shield and piping and under the finish jacket.
 - 4. Insert configuration: Minimum 6" long, of same thickness and contour as adjoining insulation; may be factory fabricated.
 - 5. Insert material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
- J. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Section 07 84 00.
- K. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10ft above finished floor): Finish with PVC jacket covers.
- L. All exposed insulated piping located 10ft or less above finish floor shall be finished with PVC jacket covers.
- M. Insulation on all cold surfaces where vapor barrier jackets are used shall be applied with a continuous, unbroken vapor seal. Hangers, supports, anchor, etc. that is secured directly to cold surfaces must be adequately insulated and vapor sealed to prevent condensation.
- N. All insulation shall be continuous through walls and ceiling openings and sleeves where applicable.
- O. Make adequate provisions for expansion of piping. Unions to be left uncovered and clean. Finished surfaces of insulation are to be suitable for painting.

- P. At no point taping of joints with duct tape, electrical tape, or other materials not designed for the insulation system be an acceptable method of attaching insulation; only use proper adhesives rated for that systems type of insulation material.
- Q. Circulated or self-regulating electric heating cable - domestic hot water piping. Water distribution piping conveying circulated water or served by a self-regulating electric heating cable shall be insulated to limit the heat loss at the external surface of the pipe insulation to a maximum of 25 BTUs per hour per square foot for above ground piping and 35 BTUs per hour per square foot for underground piping. The maximum heat loss shall be determined at a temperature differential, T, equal to the maximum water temperature minus a design ambient temperature no higher than 65° F. Refer to Hot Water Maintenance Manufacturer's recommended insulation thickness.
- R. All exposed insulation shall be clean and free of tears, holes, dirt, oil, grease, fingerprints, etc. at time of completion of project.
- S. Pipe insulation shall be protected with insulation saddles at pipe hangers or similar supports.

3.03 SCHEDULES

- A. Insulation Protection
 - 1. Insulation exposed to high moisture of interior areas shall be encased with 15 mil. vinyl film.
 - 2. Insulation exposed above food processing areas shall be protected with 30 mil. vinyl film.
 - 3. Insulation exposed to weather shall be encased with 20 mil. vinyl film.
 - 4. All joints sealed as recommended by manufacturer.
- B. Domestic Water Piping
 - 1. Cold water above ground shall be insulated with 1" thick fiberglass insulation with ASJ jacket.
 - 2. Hot water above ground shall be insulated with 1" thick fiberglass for sizes through 3" pipe and 1-1/2" thick fiberglass for sizes greater than 3" and with ASJ jacket.
 - 3. Hot water return above ground shall be insulated with 1" thick fiberglass for sizes through 2" pipe with ASJ jacket.
 - 4. Hot and cold-water branch piping concealed in walls or pipe chases may be insulated with 1/2" thick plastic foam.
 - 5. Circulated hot water and hot water return piping concealed in walls or pipe chase shall be insulated with 1" fiberglass or 1" foam insulation.

END OF SECTION

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SECTION 22 10 05
PLUMBING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Sanitary and vent.
- B. Domestic water.
- C. Pipe hangers and supports.
- D. Valves.

1.02 RELATED SECTIONS

- A. Section 07 84 00 – Firestopping.
- B. Section 08 31 00 – Access Doors and Panels.
- C. Section 09 90 00 – Painting and Coating.
- D. Section 22 05 00 – Common Work Results for Plumbing.
- E. Section 22 05 53 – Identification for Plumbing Piping and Equipment.
- F. Section 22 07 19 – Plumbing Piping Insulation.

1.03 REFERENCES

- A. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers; 2001 (R2005).
- B. ASTM B 32 - Standard Specification for Solder Metal; 2004.
- C. ASTM B 88 - Standard Specification for Seamless Copper Water Tube; 2003.
- D. ASTM B 302 - Standard Specification for Threadless Copper Pipe, Standard Sizes; 2002.
- E. ASTM D1784 Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
- F. ASTM D 1785 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120; 2006.
- G. ASTM D 2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40; 2006.

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- H. ASTM D 2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems; 2004.
- I. ASTM D 2665 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings; 2007.
- J. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications; Cast Iron Soil Pipe Institute; Latest Revision.
- K. MSS SP-58 - Pipe Hangers and Supports - Materials, Design and Manufacture; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2002.
- L. MSS SP-69 - Pipe Hangers and Supports - Selection and Application; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2003.
- M. MSS SP-89 - Pipe Hangers and Supports - Fabrication and Installation Practices; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2003.
- N. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 1996.

1.04 SUBMITTALS

- A. See Section 22 05 00 - Submittals.
- B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturer's catalog information. Indicate valve data and ratings.
 - 1. Grooved joint couplings and fittings shall be referred to on drawings and product submittals and shall be identified by the manufacturer's style or series designation. Trade names and abbreviations are not acceptable.

1.05 QUALITY ASSURANCE

- A. Perform Work in accordance with State of Wisconsin plumbing codes.
 - 1. Maintain one copy of approved plumbing plans on project site.
- B. Valves: Manufacturer's name and pressure rating marked on valve body.
- C. Welding Materials and Procedures: Conform to ASME (BPV IX) and applicable state labor regulations.
- D. Welders Certification: In accordance with ASME (BPV IX).
- E. All grooved joint couplings, fittings, valves, and specialties shall be of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
 - 1. All castings used for fittings, couplings, valve bodies, etc., shall include a cast date stamp for quality assurance and traceability.

- F. Identify pipe with marking including size, ASTM material classification, ASTM specification, potable water certification, water pressure rating.
- G. All piping, fittings, pipe hangers and all other related materials shall be manufactured in the USA.

1.06 REGULATORY REQUIREMENTS

- A. Perform work in accordance with State of Wisconsin plumbing code.
- B. Conform to Wisconsin plumbing code for installation of backflow prevention devices.
- C. Provide certificate of compliance from authority having jurisdiction indicating approval of installation of backflow prevention devices.

1.07 DELIVERY, STORAGE, AND PROTECTION

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary protective coating on cast iron and steel valves.
- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.08 FIELD CONDITIONS

- A. Do not install underground piping when bedding is wet or frozen.

1.09 EXTRA MATERIALS

- A. See Section 01 60 00 - Project Requirements for additional provisions.

PART 2 PRODUCTS

2.01 SANITARY SEWER AND VENT PIPING, ABOVE GRADE

- A. Cast Iron Pipe and Fittings: ASTM A74, ASTM A888, CISPI 301, Cast iron Waste and Vent lines service weight. Pipe and fittings shall be marked with the above listings and listed by NSF. Acceptable: AB&I, Charlotte, Tyler Pipe.
 - 1. Hub and Spigot Compression Gaskets ASTM C564, ASTM C1563, one piece compression neoprene elastomeric gasket.
 - a. AB&I, Charlotte, Tyler Pipe.
 - 2. Joint Seals: ASTM C-564, ASTM C1540, Standard duty neoprene sleeve gasket with 304 stainless steel shield minimum thickness of 0.015 and a minimum of four screw 304 stainless steel bands. Bands to be torqued to 80-inch pounds.
 - a. Husky SD 4000 series, Clamp-All 125, MG Products.
- B. Cast Iron to PVC piping transitions: ASTM C1460, ASTM C654, Heavy duty neoprene sleeve gasket with 316 stainless steel shield minimum thickness of 0.015 and a minimum of four screw 304 stainless steel bands. Bands to be torqued to 80-inch pounds.
 - 1. Husky SD 4200
- C. PVC solid wall plastic pipe, Schedule 40, Class 12454, per ASTM D1784, iron pipe size (IPS) conforming to NSF 14, ASTM D1785; PVC plastic drain, waste and vent pipe and fittings ASTM D2665; socket fitting patterns, ASTM D3311 and ASTM F1866; primer ASTM F656; solvent cement ASTM D2564. Acceptable Charlotte, Crestline, Spears.

2.02 WATER PIPING, ABOVE GRADE

- A. Copper seamless water tube H (drawn) temper, type 'L' copper in accordance with ASTM B88 and ANSI/NSF 61. Acceptable: Cerrotube, JMF, Mueller Streamline, Wheatland tube.
 - 1. Wrought copper pressure fittings in accordance with ANSI B16.22 and ANSI/NSF 61.
 - a. Lead free flux in accordance ASTM B813, and lead free solder with less than 0.2% lead in accordance ASTM B32.
 - 2. Lead free copper and copper alloy press fittings with EPDM seal element in accordance with ASME 16.51, NSF 61, UPC, NSF/ANSI 372. Acceptable: Apollo Press, Nibco Presssystem, Viega ProPress.
 - 3. Copper mechanical grooved fittings and couplings on roll grooved pipe NSF/ANSI 61. Ductile iron couplings with copper colored alkyd enamel with offsetting angle-pattern bold pads ASTM A-536 Grade 65-45-12, and EPDM coupling gasket. Acceptable: Victaulic.
- B. UL classified in accordance with NSF-61 for potable water service. The system shall meet the low-lead requirements of NSF-372.

2.03 PIPE HANGERS AND SUPPORTS

- A. Manufacturers:
1. Anvil International: www.anvilintl.com.
 2. Champion Fiberglass : www.championfiberglass.com.
 3. Cooper B-Line: www.cooperblin.com.
 4. Elite Components: www.elitecomponents.com.
 5. Mason Industries: www.mason-ind.com.
 6. Substitutions: See Section 22 05 00 Substitutions.
- B. Pipe Hangers - General
1. Furnish and install suitable hangers and supports for all horizontal lines. Pipe sizes of 3" and larger shall be carried by pipe hangers supported by rods secured to structure. No piping shall be hung from other piping or ductwork. In no case shall hangers be supported by means of vertical expansion bolts. At no point shall hangers and pipe clamps break the insulation vapor barrier. Always provide proper saddle support and hanger/clamp support system for insulation materials.
 2. Support Spacing. Piping shall be supported at distances not to exceed those specified:
 - a. Cast Iron: Horizontal Max - 5ft (a); Vertical Max - 15ft.
 - b. Copper or Copper-Alloy Tubing
 - 1) Less than or equal to 1-1/4" diameter: Horizontal Max - 6ft; Min - 10ft.
 - 2) Greater than or equal to 1-1/2" diameter: Horizontal Max - 10ft; Min - 10ft.
- NOTES: (a) is the maximum horizontal spacing for supports may be increase to 10ft when 10-foot lengths of pipe are employed. (b) is mid-story guide to be employed.
- C. Plumbing Piping - Drain, Waste, and Vent:
1. Conform to ASME B31.9 or MSS SP-69.
 2. Hangers for Pipe Sizes 1/2" to 1-1/2": Malleable iron, adjustable swivel, split ring.
 3. Hangers for Pipe Sizes 2" and Over: Carbon steel, adjustable, clevis.
 4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
 5. Wall Support for Pipe Sizes to 3": Cast iron hook.
 6. Wall Support for Pipe Sizes 4" and Over: Welded steel bracket and wrought steel clamp.
 7. Vertical Support: Steel riser clamp.
 8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 9. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
- D. Plumbing Piping - Water:
1. Conform to ASME B31.9 or MSS SP-69.
 2. Hangers for Pipe Sizes 1/2" to 1-1/2": Malleable iron, adjustable swivel, split ring.
 3. Hangers for Cold Pipe Sizes 2" and Over: Carbon steel, adjustable, clevis.

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4. Multiple or Trapeze Hangers: Steel channels with welded supports or spacers and hanger rods.
5. Wall Support for Pipe Sizes to 3": Cast iron hook.
6. Wall Support for Pipe Sizes 4" and Over: Welded steel bracket and wrought steel clamp.
7. Vertical Support: Steel riser clamp.
8. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
9. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

2.04 VALVES - GENERAL

- A. Manufacturers:
 1. Apollo Valve: www.apollovalves.com.
 2. Jomar International: www.jomar.com.
 3. Kitz Valves: www.kitzus-kca.com.
 4. Nibco, Inc: www.nibco.com.
 5. Milwaukee Valve Company: www.milwaukeevalve.com.
 6. Red-White Valve Corp. (RWV): www.redwhitevalvecorp.com.
 7. Shurjoint: www.shurjoint.com.
 8. Smith Cooper Valves: www.smithcooper.com.
 9. Victaulic Company: www.victaulic.com.
 10. Watts Water Technologies Inc.: www.watts.com.
 11. Spears Manufacturing Company: www.spearsmfg.com.
 12. Substitutions: See Section 22 05 00 Substitutions.
- B. Valves shall be suitable for 125 PSIG working pressure unless otherwise specified.
- C. A control valve for water supply piping 3/4" through 4" in diameter which serves 2 or more plumbing fixtures shall have a nominal diameter at least equal to the piping.
- D. Valves for water supplies shall be lead free, as required by the Lead-Free Law.

2.05 BALL VALVES

- A. Water Systems
 1. MSS SP-110, 3" and smaller: Two-piece bronze body; sweat, threaded, press or ASTM F1960 joint connection ends, full port stainless steel ball and stem; glass filled Teflon seat; Teflon packing and threaded packing nut; blowout-proof stem; 600 psig CWP, WOG. Provide valve stem extensions for valves installed in all piping with insulation.
 - a. Apollo 70LF-100 series
 - b. Jomar T-200 series
 - c. Milwaukee UPBA-100S series

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that excavations are to required grade, dry, and not over-excavated.

3.02 PREPARATION

- A. Ream pipe and tube ends. Remove burrs.
- B. Remove scale and dirt, on inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.
- D. Unions and flanges for servicing or disconnect are not required on installations using grooved joint couplings. The couplings shall serve as disconnect points.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. All piping materials and related hangers etc. installed in plenum rated ceilings shall be plenum rated. Plenum wrap over non-plenum material is not acceptable. Plumbing Contractor shall coordinate with Mechanical and General Contractor on location of plenum rated ceilings before performing any work.
- C. All sanitary waste and storm piping that are located over offices, conference rooms etc. where sound needs to be at a minimum, all piping shall be cast iron or insulated PVC piping. coordinate with General Contractor.
- D. All sanitary waste piping serving mop sink or similar fixtures shall be epoxy coated cast iron or PVC piping.
- E. Provide non-conducting dielectric connections wherever joining dissimilar metals.
- F. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
- G. Install piping to maintain headroom, conserve space, and not interfere with use of space.
- H. Group piping whenever practical at common elevations.
- I. Install piping to allow for expansion and contraction without stressing pipes, joints, or connected equipment.
- J. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
- K. Provide access where valves and fittings are not exposed.
- L. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

- M. Provide support for utility meters in accordance with requirements of utility companies.
- N. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Section 22 05 00 - Execution.
- O. Install bell and spigot pipe with bell end upstream.
- P. Install valves with stems upright or horizontal, not inverted.
- Q. Install water piping to ASME B31.9.
- R. PVC Pipe: Make solvent-welded joints in accordance with ASTM D 2855.
- S. Sleeve pipes passing through partitions, walls, and floors.
- T. Inserts:
 - 1. Provide inserts for placement in concrete formwork.
 - 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4".
 - 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 - 5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above, flush with top of slab.
- U. Pipe Hangers and Supports:
 - 1. Install in accordance with ASME B31.9, ASTM F 708; and MSS SP-89.
 - 2. Support horizontal piping as scheduled.
 - 3. Install hangers to provide minimum 1/2" space between finished covering and adjacent work.
 - 4. Place hangers within 12" of each horizontal elbow.
 - 5. Use hangers with 1-1/2" minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 - 6. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.
 - 7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 - 8. Provide copper plated hangers and supports for copper piping.
 - 9. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
 - 10. Provide hangers adjacent to motor driven equipment with vibration isolation; refer to Section 22 05 48.
 - 11. Support cast iron drainage piping at every joint.

3.04 APPLICATION

- A. Use grooved mechanical couplings and fasteners in accessible locations.
 - 1. Grooved joint couplings and fittings shall be installed in accordance with the manufacturer's written installation instructions. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. Gaskets shall be verified as suitable for the intended service prior to installation. Gaskets shall be molded and produced by the coupling manufacturer. The grooved coupling manufacturer's factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and installation of grooved joint products. The manufacturer's representative shall periodically visit the jobsite and review installation. Contractor shall remove and replace any joints deemed improperly installed.
- B. Install unions downstream of valves and at equipment or apparatus connections.
- C. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.
- D. Install ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- E. Install ball valves for throttling, bypass, or manual flow control services.

3.05 ERECTION TOLERANCES

- A. Drainage Piping: Establish invert elevations within 1/2" vertically of location indicated and slope to drain at minimum of 1/8" per foot slope.
- B. Water Piping: Slope at minimum of 1/32" per foot and arrange to drain at low points.

3.06 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

- A. Disinfect water distribution system in accordance with Section 33 13 00.
- B. Prior to starting work, verify system is complete, flushed, and clean.
- C. Ensure Ph of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).
- D. Inject disinfectant, free chlorine in liquid, powder, tablet, or gas form, throughout system to obtain 50 to 80 mg/L residual.
- E. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15% of outlets.
- F. Maintain disinfectant in system for 24 hours.
- G. If final disinfectant residual tests less than 25 mg/L, repeat treatment.

- H. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.
- I. Take samples no sooner than 24 hours after flushing, from 10% of outlets and from water entry, and analyze in accordance with AWWA C651.

3.07 SCHEDULES

- A. Pipe Hanger Spacing:
 - 1. Metal Piping:
 - a. Pipe size: 1/2" to 1-1/4":
 - 1) Maximum hanger spacing: 6.5 ft.
 - 2) Hanger rod diameter: 3/8".
 - b. Pipe size: 1-1/2" to 2":
 - 1) Maximum hanger spacing: 10 ft.
 - 2) Hanger rod diameter: 3/8".
 - c. Pipe size: 2-1/2" to 3":
 - 1) Maximum hanger spacing: 10 ft.
 - 2) Hanger rod diameter: 1/2".
 - 2. Plastic Piping:
 - a. All Sizes:
 - 1) Maximum hanger spacing: 6 ft.
 - 2) Hanger rod diameter: 3/8".

END OF SECTION

SECTION 22 10 06
PLUMBING PIPING SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Access panels.

1.02 RELATED SECTIONS

- A. Section 22 05 00 - Common Work Results for Plumbing.
- B. Section 22 10 05 - Plumbing Piping.
- C. Section 22 40 00 - Plumbing Fixtures.
- D. Section 26 27 17 - Equipment Wiring: Electrical characteristics and wiring connections.

1.03 SUBMITTALS

- A. See Section 22 05 00 - Submittals.
- B. Product Data: Provide component sizes, rough-in requirements, service sizes, and finishes.
- C. Shop Drawings: Indicate dimensions, weights, and placement of openings and holes.
- D. Manufacturer's Instructions: Indicate Manufacturer's Installation Instructions: Indicate assembly and support requirements.
- E. Project Record Documents: Record actual locations of equipment, cleanouts, backflow preventers, and water hammer arrestors.
- F. Operation Data: Indicate frequency of treatment required for interceptors.
- G. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years documented experience.

1.05 DELIVERY, STORAGE, AND PROTECTION

- A. Accept specialties on site in original factory packaging. Inspect for damage.

1.06 EXTRA MATERIALS

- A. See Section 22 05 00 – Extra Materials, for additional provisions.

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PART 2 PRODUCTS

2.01 ACCESS DOORS

- A. Manufacturers:
 - 1. Acudor Product, Inc.: www.acudor.com.
 - 2. Elmdor/Stoneman: www.elmdorstoneman.com.
 - 3. Mifab, Inc.: www.mifab.com.
 - 4. Substitutions: See Section 22 05 00 Substitutions.

- B. AD-1 Access Door.
 - 1. Fire rated 1½ hour "B" label Underwriters Laboratories (UL) listed and tested access door in fire rated walls with stack cleanouts. Use 12" x 12" size for cleanouts up to 6 inch in size. Use 16" x 16" size for clean outs 8 to 12 inches in size.
 - a. Acudor FB-5060
 - b. Elmdor FR Series

- C. AD-2 Access Door.
 - 1. Non-Fire rated access door in walls with stack cleanouts or water piping with control valves or system draining points. Use 12" x 12" size for cleanouts up to 6 inch in size. Use 16" x 16" size for clean outs 8 to 12 inches in size. Use appropriate size access door to allow for ease of access to valves and/or drain points. Provide access doors with gaskets where required. Coordinate with General Contractor.
 - a. Acudor ED-2002 or AS-9000 Series
 - b. Elmdor ES or GD Series

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install equipment where shown on plan drawings and as scheduled.

- B. Install in accordance with manufacturer's instructions.

- C. Install air chambers on hot and cold water supply piping to each fixture or group of fixtures (each washroom). Fabricate same size as supply pipe or ¾ inch minimum, and minimum 18 inches long.

END OF SECTION

SECTION 22 40 00
PLUMBING FIXTURES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Sinks.

1.02 RELATED REQUIREMENTS

- A. Section 01 10 00 - Summary: Product requirements for owners furnished fixtures.
- B. Section 06 41 00 - Architectural Wood Casework: Preparation of counters for sinks; lavatory tops.
- C. Section 07 90 05 - Joint Sealers: Seal fixtures to walls and floors.
- D. Section 22 05 00 - Common Work Results for Plumbing.
- E. Section 22 10 05 - Plumbing Piping.
- F. Section 22 30 00 - Plumbing Equipment.

1.03 REFERENCE STANDARDS

- A. ASME A112.6.1M - Supports for Off-the-Floor Plumbing Fixtures for Public Use; The American Society of Mechanical Engineers; 1997 (Reaffirmed 2002).
- B. ASME A112.18.1 - Plumbing Supply Fittings; The American Society of Mechanical Engineers; 2005.
- C. ASME A112.19.3 - Stainless Steel Plumbing Fixtures (Designed for Residential Use); The American Society of Mechanical Engineers; 2001 (R2004).
- D. ASME A112.19.4M - Porcelain Enameled Formed Steel Plumbing Fixtures; The American Society of Mechanical Engineers; 1994 (R2004).

1.04 SUBMITTALS

- A. See Section 22 05 00 - Submittals.
- B. Product Data: Provide catalog illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.
- C. Manufacturer's Instructions: Indicate installation methods and procedures.
- D. Maintenance Data: Include fixture trim exploded view and replacement parts lists.
- E. Warranty: Submit manufacturer warranty and ensure forms have been completed in owners name and registered with manufacturer.

Clark County Courthouse, Branch 1 & 2 Courtroom Remodel
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1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.06 REGULATORY REQUIREMENTS

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Accept fixtures on site in factory packaging. Inspect for damage.
- B. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.08 WARRANTY

- A. See Section 22 05 00 - Closeout Submittals, for additional warranty requirements.

1.09 EXTRA MATERIALS

- A. See Section 01 60 00 - Project Requirements, for additional provisions.

1.10 FIXTURES AND TRIM

- A. This section of the work includes plumbing fixtures furnished and installed by the Plumbing Contractor.
- B. All vitreous china fixtures shall be of the best quality conforming in all respects to classification "Regulation Selection" in accord with the uniform grading rules of "Vitreous China."
- C. All products must be lead free as required by the lead free law "Federal Safe Drinking Water Act."
- D. All similar fixtures, faucets, and trim shall be of same manufacturer throughout project.
- E. Fixtures and trim of equal quality as listed by other manufacturers may be submitted.
- F. Fixture support. Provide and install proper supports and carriers for plumbing fixtures as scheduled or required for the application. Carriers shall be set in accordance with manufacturer's recommendations with adequate anchors and fasteners to provide required support. Wall hung water closet outlets shall be fully grouted for support in masonry walls.

1.11 PLUMBING FIXTURES LIST

A. Manufacturers: Fixture descriptions establish fixture type, quality, materials, features and size. Products of the following manufacturers determined to be equal by the Architect/Engineer will be accepted. For substitutions, see Section 22 05 00 Substitutions.

1. Faucets

- a. American Standard Inc: www.americanstandard.com.
- b. Bradley Corporation: www.bradleycorp.com.
- c. Chicago Faucet Company: www.chicagofaucets.com.
- d. Elkay Manufacturing Company: www.elkay.com.
- e. Kohler Company: www.kohlerco.com.
- f. Sloan Valve Company: www.sloanvalve.com.
- g. Speakman Company: www.speakmancompany.com.
- h. Symmons Industries: www.symmons.com.
- i. T&S Brass Inc.: www.tsbrass.com.
- j. Union Brass Manufacturing Company: www.unionbrass.com.
- k. Zurn Industries, Inc: www.zurn.com.

2. Sinks

- a. Acorn Engineering Company: www.acorneng.com.
- b. American Standard Inc: www.americanstandard.com.
- c. Elkay Manufacturing Company: www.elkay.com.
- d. Just Manufacturing Inc.: www.justmfg.com.
- e. Kohler Company: www.kohlerco.com.

3. Carriers and Supports

- a. Jay R. Smith Manufacturing Company: www.jrsmith.com.
- b. Josam Company: www.josam.com.
- c. Wade: www.wadedrains.com.
- d. Watts Water Technologies Company: www.watts.com.
- e. Zurn Industries, Inc: www.zurn.com.

4. Drains and Traps

- a. BrassCraft Company.: www.brasscraft.com.
- b. Chicago Faucet Company: www.chicagofaucets.com.
- c. Keeney Manufacturing Company: www.keeneymfg.com.
- d. McGuire Manufacturing: www.mcguiremfg.com.
- e. Zurn Industries, Inc: www.zurn.com.

5. Stops and Supplies

- a. BrassCraft Company.: www.brasscraft.com.
- b. Chicago Faucet Company: www.chicagofaucets.com.
- c. McGuire Manufacturing: www.mcguiremfg.com.
- d. Zurn Industries, Inc: www.zurn.com.

6. Under Lav Protection

- a. McGuire Manufacturing: www.mcguiremfg.com.
- b. Plumberex Specialty Products, Inc: www.plumberex.com.
- c. Truebro IPS Corporation: www.truebro.com.
- d. Zurn Industries, Inc: www.zurn.com.

PART 2 PRODUCTS

2.01 SINKS

- A. S-1 Sink:
1. Fixture: ASME A112.19.3; Self rimming, double compartment 33" x 21" x 7-1/2" deep, 18 gauge type 304 satin finish stainless steel sink, sound dampening undercoat with 3½ inch drain openings, faucet holes to match selected faucet.
 - a. Elkay LR3321
 - b. Just DL-2133-A-GR
 2. Faucet: ASME A112.18.1; Lead free, polished chrome plated brass 8 inch deck faucet with 8 inch rigid/swing gooseneck spout and quarter turn ceramic disc cartridges. Vandal resistant 4 inch color coded metal wrist blade handles and 1.5 gpm vandal resistant aerator.
 - a. American Standard 6409.170
 - b. Elkay LK810GN08T4
 - c. Speakman SC-5724
 - d. T&S Brass B-1120-135X-WH4-CR w/B-0199-07-WS
 - e. Zurn Z871C4-XL
 3. Supplies: ½ inch compression lead free chrome plated cast brass angle stop with brass stem and wheel handle, chrome plated flexible copper tube riser and chrome escutcheon.
 - a. BrassCraft OCR-1912AX C
 - b. McGuire LF2165CC
 - c. Zurn Z8804-XL-LR-PC
 4. Drain: Heavy gauge stainless steel drain outlet with stainless basket strainer with attached neoprene stopper and 1½ inch chrome tailpiece.
 - a. Keeney 1432-SS
 - b. McGuire 151A
 - c. Zurn Z8741-SS
 5. Waste: double bowl, 1½ inch chrome plated 17 gauge end or center outlet with 1½ inch 17 gauge chrome tailpiece.
 - a. Keeney 1816ASN
 - b. McGuire 111C21G17
 - c. Zurn Z8754
 6. Trap: 1½" x 1½", 17 gauge, cast brass chrome plated, adjustable ground joint 'P' trap with cleanout plug and chrome plated escutcheon.
 - a. Keeney 5307XPC
 - b. McGuire 8912CBECO
 - c. Zurn Z8702-9B

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that walls and floor finishes are prepared and ready for installation of fixtures.
- B. Confirm that millwork is constructed with adequate provision for the installation of counter top lavatories and sinks.

3.02 PREPARATION

- A. Rough-in fixture piping connections in accordance with minimum sizes and locations indicated in fixture rough-in drawings.

3.03 INSTALLATION

- A. Install each fixture with trap, easily removable for servicing and cleaning.
- B. Provide chrome plated rigid where exposed or flexible supplies in cabinets to fixtures with loose key or wheel handle stops, reducers, and escutcheons.
- C. Install components level and plumb.
- D. Install and secure fixtures in place with wall supports and bolts.
- E. Equipment shall be suitably protected against damage before and after installation. Any damaged plumbing fixture or piece of equipment shall be replaced at the expense of the plumbing contractor. All fixtures to be acceptable for final inspection shall be free of chips, flaws, scratches, abrasions, discolorations or any defect, which, in the opinion of the Engineer would classify the fixture as unsuitable for use intended.
- F. All exposed trim including pipe nipples to plumbing fixtures shall be chromium plated and shall be completely free of tool marks, abrasions, or flattening of tubing, etc. All fixtures included in this specification and shown on the drawings shall be completed by the plumbing contractor together with all necessary hangers, bolts, anchors and brackets.
- G. All fixture heights, spacing apart and distances from walls shall be in accordance with Architectural details, floor plans and elevation. Deviation may necessitate alteration to comply with plans. Verify dimensions with General Contractor.
- H. Repair all leaks, dripping or running fixtures, faucets, etc. Regulate flow to water closets, showers, etc., for proper operation. Provide shutoffs at all individual fixtures.

3.04 INTERFACE WITH WORK OF OTHER SECTIONS

- A. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.

3.05 ADJUSTING

- A. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow. Repair any leaks, dripping or running fixtures.

3.06 CLEANING

- A. Clean plumbing fixtures and equipment at end of project.

END OF SECTION

**SECTION 23 05 00
COMMON WORK RESULTS FOR HVAC**

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Scope. This section includes information common to two or more technical specification sections or items that are of a general nature, not conveniently fitting into other technical sections. Included are the following topics:

- B. PART 1 - GENERAL
 - 1. Scope
 - 2. Related Work
 - 3. Reference
 - 4. Reference Standards
 - 5. Quality Assurance
 - 6. Continuity of Existing Services
 - 7. Protection of Finished Surfaces
 - 8. Sleeves and Openings
 - 9. Sealing and Firestopping
 - 10. Equipment Substitutions
 - 11. Submittals
 - 12. Off-site Storage
 - 13. Certificates and Inspections
 - 14. Operating and Maintenance Data
 - 15. Training of Owner Personnel
 - 16. Record Drawings

- C. PART 2 - Products
 - 1. Access Panels and Doors
 - 2. Identification
 - 3. Sealing and Firestopping

- D. PART 3 - EXECUTION
 - 1. Demolition
 - 2. Concrete Work
 - 3. Cutting and Patching
 - 4. Building Access
 - 5. Equipment Access
 - 6. Coordination
 - 7. Identification
 - 8. Lubrication
 - 9. Sleeves and Openings
 - 10. Sealing and Firestopping
 - 11. Smoke Detection System
 - 12. Cleaning Equipment, Ductwork, and Premises
 - 13. Guarantee
 - 14. Certification of Tests and Adjustments

1.02 RELATED WORK

- A. Section 23 05 13 - Common Motor Requirements for HVAC
- B. Section 23 33 00 - Air Duct Accessories

1.03 REFERENCE

- A. Applicable provisions of Division 1 govern work under this section.

1.04 REFERENCE STANDARDS

- A. Abbreviations of standards organizations referenced in other sections are as follows:

AABC	Associated Air Balance Council
ABMA	American Boiler Manufacturers Association
ADC	Air Diffusion Council
AGA	American Gas Association
AMCA	Air Movement and Control Association
ANSI	American National Standards Institute
ARI	Air Conditioning and Refrigeration Institute
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
AWS	American Welding Society
CGA	Compressed Gas Association
CTI	Cooling Tower Institute
EPA	Environmental Protection Agency
GAMA	Gas Appliance Manufacturers Association
IEEE	Institute of Electrical and Electronics Engineers
ISA	Instrument Society of America
MCA	Mechanical Contractors Association
MICA	Midwest Insulation Contractors Association
MSS	Manufacturer's Standardization Society of the Valve & Fitting Industry, Inc.
NBS	National Bureau of Standards
NEBB	National Environmental Balancing Bureau
NEC	National Electric Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association. Inc.
UL	Underwriters Laboratories Inc.
ASTM E814	Standard Test Method for Fire Tests of Through-Penetration Fire Stops
ASTM E84	Standard Test Method for Surface Burning Characteristics of Building Materials
UL1479	Fire Tests of Through-Penetration Firestops
UL723	Surface Burning Characteristics of Building Materials

1.05 QUALITY ASSURANCE

- A. Refer to Division 1, General Conditions, Equals and Substitutions.
- B. Where equipment or accessories are used which differ in arrangement, configuration, dimensions, ratings, or engineering parameters from those indicated on the contract documents, the contractor is responsible for all costs involved in integrating the equipment or accessories into the system and for obtaining the performance from the system into which these items are placed. This may include changes found necessary during the testing, adjusting, and balancing phase of the project.

1.06 CONTINUITY OF EXISTING SERVICES

- A. Do not interrupt or change existing services without prior written approval from the Owner. When interruption is required, coordinate the down time with the Owner to minimize disruption to their activities. Unless specifically stated, all work involved in interrupting or changing existing services is to be done during normal working hours.

1.07 PROTECTION OF FINISHED SURFACES

- A. Refer to Division 1, General Requirements, Protection of Finished Surfaces.
- B. Furnish one can of touch up paint for each different color factory finish which is to be the final finished surface of the product. Deliver touch up paint with other "loose and detachable parts" as covered in the General Requirements.

1.08 SLEEVES AND OPENINGS

- A. Refer to Division 1, General Requirements, Sleeves and Openings.

1.09 SEALING AND FIRESTOPPING

- A. Sealing and firestopping of sleeves/openings between ductwork, piping, etc. and the sleeve, structural or partition opening shall be the responsibility of the contractor whose work penetrates the opening. Provide all fire stopping of fire rated penetrations and sealing of smoke rated penetrations.

1.10 EQUIPMENT SUBSTITUTIONS

- A. Contractors and/or manufacturers may submit catalog data on material proposed for substitution to the engineer for evaluation up to 10 days prior to the date for opening bids. The engineer will render an opinion on whether or not the material can be bid as a substitute based on the information received. Final approval for the use of substitute equipment will not be given until complete shop drawings, samples or other information deemed necessary by the engineer has been submitted.

1.11 SUBMITTALS

- A. Refer to Division 1, General Conditions, Submittals.
- B. Submit for all equipment and systems as indicated in the respective specification sections, marking each submittal with that specification section number. Mark general catalog sheets and drawings to indicate specific items being submitted and proper identification of equipment by name and/or number, as indicated in the contract documents.

- C. Before submitting electrically powered equipment, verify that the electrical power and control requirements for the equipment are in agreement with the motor starter schedule on the electrical drawings. Starters and disconnects which are not explicitly defined as the responsibility of any contractor shall be provided by the Division 23 contractor. Include a statement on the shop drawing transmittal to the architect/engineer that the equipment submitted and the motor starter schedule are in agreement or indicate any discrepancies. See related comments in Section 23 05 13 in Part 1 under Electrical Coordination.
- D. Include wiring diagrams of electrically powered equipment.
- E. Submit sufficient quantities of shop drawings to allow the following distribution:
 - Operating and Maintenance Manuals 3 copies
 - Testing, Adjusting and Balancing Contractor 1 copy
 - A/E 1 copy
- F. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.12 OFF-SITE STORAGE

- A. Prior approval by General Contractor/Construction Manager and the A/E will be needed.
- B. Generally, ductwork, metal for making ductwork, duct lining, sleeves, pipe/pipe fittings and similar rough in material will not be accepted for off-site storage. For material that can be stored off site, no material will be accepted for off-site storage unless shop drawings for that material have been approved.

1.13 CERTIFICATES AND INSPECTIONS

- A. Refer also to Division 1, General Conditions, Permits, Regulations, Utilities and Taxes.
- B. Contractors installing heating, ventilating, and air conditioning systems or equipment in the State of Wisconsin must be licensed. The contractor must provide proof of current and valid license upon request and maintain license through project completion.
- C. Obtain and pay for all required State installation inspections except those provided by the Architect/Engineer in accordance with Wis Adm Code SPS 302. Deliver originals of these certificates to the A/E. Include copies of the certificates in the Operating and Maintenance Instructions.
- D. All utility connection fees shall be paid by the respective contractor.

1.14 OPERATING AND MAINTENANCE DATA

- A. All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.
- B. Assemble material in three ring or post binders, using an index at the front of each volume and tabs for each system or type of equipment. In addition to the data indicated in the General Requirements, include the following information:
 - Copies of all approved shop drawings
 - Manufacturer's wiring diagrams for electrically powered equipment
 - Records of tests performed to certify compliance with system requirements

- Certificates of inspection by regulatory agencies
- Temperature control record drawings and control sequences
- Parts lists for manufactured equipment
- Valve schedules
- Lubrication instructions, including list/frequency of lubrication done during construction
- Warranties
- Additional information as indicated in the technical specification sections
- A copy of signed Certification of Tests and Adjustments Form
- Final Testing, Adjusting, and Balance Report

1.15 TRAINING OF OWNER PERSONNEL

- A. Instruct Owner personnel in the proper operation and maintenance of systems and equipment provided as part of this project. Include not less than 2 hours of instruction, using the Operating and Maintenance manuals during this instruction. Demonstrate startup and shutdown procedures for all equipment. All training to be during normal working hours.

1.16 RECORD DRAWINGS

- A. Refer to Division 1, General Requirements, Record Drawings.
- B. In addition to the data indicated in the General Requirements, maintain temperature control record drawings on originals prepared by the installing contractor/subcontractor. Include copies of these record drawings with the Operating and Maintenance manuals.

PART 2 - PRODUCTS

2.01 ACCESS PANELS AND DOORS

- A. LAY IN CEILINGS: Removable lay in ceiling tiles in 2 X 2 foot or 2 X 4 foot configuration provided under Section 09500 are sufficient; no additional access provisions are required unless specifically indicated.

2.02 IDENTIFICATION

- A. STENCILS: Not less than 1 inch high letters/numbers for marking equipment.
- B. SNAP-ON PIPE MARKERS: Cylindrical self-coiling plastic sheet that snaps over piping insulation and is held tightly in place without the use of adhesive, tape or straps. Follow ANSI/ASME Pipe Marker Guidelines for proper identification including, but not limited to, letter heights, marker size, color, wording legend, flow direction arrows, and proper placement. W.H. Brady, Seton, Marking Services, or equal.
- C. ENGRAVED NAME PLATES: White letters on a black background, 1/16 inch thick plastic laminate, beveled edges, screw mounting, Setonply Style 2060 by Seton Name Plate Company or Emedolite- Style EIP by EMED Co., or equal by Marking Services, or W. H. Brady.
- D. VALVE TAGS: Round brass tags with 1/2 inch numbers, 1/4 inch system identification abbreviation, 1 1/4 inch minimum diameter, with brass jack chains or brass "S" hooks around the valve stem, available from EMED Co., Seton Name Plate Company, Marking Services, or W. H. Brady.

2.03 SEALING AND FIRESTOPPING

A. FIRE AND/OR SMOKE RATED PENETRATIONS:

1. Provide all fire stopping of fire rated penetrations and sealing of smoke rated penetrations in compliance with UL & ASTM.
2. Use a product that has a rating not less than the rating of the wall or floor being penetrated. Reference architectural drawings for identification of fire and/or smoke rated walls and floors.

B. NON-RATED PENETRATIONS:

1. Pipe Penetrations: At pipe penetrations of non-rated interior partitions, floors and exterior walls above grade, use urethane caulk in annular space between pipe insulation and sleeve. For non-rated drywall, plaster or wood partitions where sleeve is not required use urethane caulk in annular space between pipe insulation and wall material.
2. Duct Penetrations: Annular space between duct (with or without insulation) and the non-rated partition or floor opening shall not be larger than 2". Where existing openings have an annular space larger than 2", the space shall be patched to match existing construction to within 2" around the duct.
3. Where shown or specified, pack annular space with fiberglass batt insulation or mineral wool insulation. Provide 4" sheet metal escutcheon around duct on both sides of partition or floor to cover annular space.

PART 3 - EXECUTION

3.01 DEMOLITION

- A. Perform all demolition as indicated on the drawings to accomplish new work. Where demolition work is to be performed adjacent to existing work that remains in an occupied area, construct temporary dust partition to minimize the amount of contamination of the occupied space. Where pipe or duct is removed and not reconnected with new work, cap ends of existing services as if they were new work. Coordinate work with the Owner to minimize disruption to the existing building occupants.
- B. All pipe, wiring and associated conduit, insulation, ductwork, and similar items demolished, abandoned, or deactivated are to be removed from the site by the Contractor. All piping and ductwork specialties are to be removed from the site by the Contractor unless they are dismantled and removed or stored by the Owner. All designated equipment is to be turned over to the Owner for their use at a place and time so designated. Maintain the condition of material and/or equipment that is indicated to be reused equal to that existing before work began.
- C. Mechanical systems are shown on drawings that were coordinated with the existing conditions; however, variations may occur. Contractor shall verify dimensions, heights, door swings and any other information critical to the placement of devices with the drawings and existing conditions to assure proper installation. Field measurements shall take precedence over drawing dimensions and shall be verified. Plans shall not be scaled to locate equipment.

- D. It shall be the contractor's responsibility to visit the existing project site, become acquainted with all existing conditions, and ascertain the extent of work involved in installing equipment, ductwork, air distribution devices, piping, controls and all other appurtenances pertaining to the above. The contractor shall provide all labor, materials, etc., required for the complete, new installation required for the completion of the project. By the act of submitting a price; or in the case of time and material project, begin work, the contractor shall be deemed to have performed such an examination, to have accepted such conditions, and to have made allowances therefore preparing his price and resolving questions regarding work required.

3.02 CONCRETE WORK

- A. All cast in place concrete will be performed by the Division 3 Contractor unless otherwise noted. Provide all layout drawings, anchor bolts, metal shapes, and/or templates required to be cast into concrete or used to form concrete for support of mechanical equipment.

3.03 CUTTING AND PATCHING

- A. Refer to Division 1, General Requirements, Cutting and Patching.
- B. Skilled tradesmen shall be employed to do cutting and patching. Each Contractor shall be responsible for cutting and patching new openings for their use, in existing or previously constructed walls, ceilings, floors, roofs, etc., unless otherwise designated. Use core drills or saws to cut all openings. Air, jack or manual hammers shall not be used unless approved by the Architect/Engineer. Provide personnel protection under coring operations in occupied areas. Submit methods of supporting and sealing floor sleeves for approval. Holes cut in roof and exterior wall shall be weatherproofed immediately. Provide temporary dust barriers for cutting operations in occupied spaces. Where openings require lintels, they shall be provided by the trade requiring the opening unless specifically indicated on the drawings as being provided in another trade. Each contractor shall be responsible for sealing finished openings, for their use, water and air tight, unless otherwise designated.

3.04 BUILDING ACCESS

- A. Arrange for the necessary openings in the building to allow for admittance of all apparatus. When the building access was not previously arranged and must be provided by this contractor, restore any opening to its original condition after the apparatus has been brought into the building.

3.05 EQUIPMENT ACCESS

- A. Install all piping, conduit, ductwork, and accessories to permit access to equipment for maintenance and service. Coordinate the exact location of wall and ceiling access panels and doors with the General Contractor, making sure that access is available for all equipment and specialties. Access doors in general construction are to be furnished by the Mechanical Contractor and installed by the General Contractor.
- B. For equipment that is accessed above acoustical lay in ceilings or access doors, label the ceiling tile grid at the ceiling tile that is to be removed for access to the equipment or the access door. The label shall be pre-printed using clear polyester tape with black bold 28 size font for ceilings under 12 feet. For ceilings over 12 feet high, use bold 40 size font. For accessible ceilings, use an arrow to point at ceiling tile to be removed for access. Label shall match equipment tag designation used on mechanical plans.

- C. Ductwork, equipment, and piping below 7'-6" above finished floor shall have a resilient material (foam rubber, etc.) attached to all potentially dangerous edges.
- D. A guard is required on roof mounted equipment, including exhaust fans, located within 10' of roof edge and containing an open side that is greater than 30" above the floor, roof, or grade below. Guard must be at least 30" beyond side of unit.

3.06 COORDINATION

- A. Mechanical systems are shown on drawings that were coordinated with the architectural drawings; however, variations may occur. Contractor shall verify all information critical to the placement of devices with the architectural drawings to assure proper installation. Field measurements shall take precedence over drawing dimensions and shall be verified. Plans shall not be scaled to locate equipment. It shall be the contractor's responsibility to become acquainted with all conditions, and ascertain the extent of work involved in installing equipment, ductwork, air distribution devices, piping, controls and all other appurtenances pertaining to the above. The contractor shall provide all labor, materials, etc., required for the complete, new installation required for the completion of the project. By the act of submitting a price; or in the case of time and material project, begin work, the contractor shall be deemed to have performed such an examination, to have accepted such conditions, and to have made allowances therefore preparing his price and resolving questions regarding work required.
- B. Plans of piping and ductwork shown on scale drawings are diagrammatic only. They are intended to indicate size and/or capacity where stipulated, approximate location and/or direction and approximate general arrangement of one phase of work to another, but not the exact detail or arrangement of construction. Plans are based on equipment scheduled. Contractor shall be responsible for changes resulting from equipment other than scheduled.
- C. Verify that all devices are compatible for the surfaces on which they will be used. This includes, but is not limited to, diffusers, register, grilles, and recessed or semi recessed heating and/or cooling terminal units installed in/on architectural surfaces.
- D. Coordinate all work with other contractors prior to installation. Any installed work that is not coordinated and that interferes with other contractor's work shall be removed or relocated at the installing contractor's expense.
- E. Cooperate with the test and balance agency in ensuring Section 23 05 93 specification compliance. Verify system completion to the test and balance agency (flushing, pressure testing, chemical treatment, filling of liquid systems, proper pressurization and air venting of hydronic systems, clean filters, clean strainers, duct and pipe systems cleaned, controls adjusted and calibrated, controls cycled through their sequences, etc.), ready for testing, adjusting and balancing work. Install dampers, shutoff and balancing valves, flow measuring devices, gauges, temperature controls, etc., required for functional and balanced systems. Demonstrate the starting, interlocking and control features of each system so the test and balance agency can perform its work.

3.07 IDENTIFICATION

- A. Identify equipment in mechanical equipment rooms by stenciling equipment number and service with one coat of black enamel against a light background or white enamel against a dark background. Use a primer where necessary for proper paint adhesion. Do not label equipment such as cabinet heaters and ceiling fans in occupied spaces.
- B. Where stenciling is not appropriate for equipment identification, engraved name plates may be used.
- C. Identify piping not less than once every 30 feet, not less than once in each room, adjacent to valves and flanges, adjacent to directional changes, adjacent to each access door or panel, and on both side of the partition where piping passes through walls, floors or roofs. Place flow directional arrows at each pipe identification location. Provide Snap-On pipe markers as specified in Part 2 – Products.
- D. Identify valves with brass tags bearing a system identification and a valve sequence number. Valve tags are not required at a terminal device unless the valves are greater than ten feet from the device or located in another room not visible from the terminal unit. Provide a typewritten valve schedule indicating the valve number and the equipment or areas supplied by each valve; locate schedules in each mechanical room and in each Operating and Maintenance manual. Schedules in mechanical rooms to be framed under clear plastic.
- E. All valves, coils, controls, and other equipment requiring service located above ceilings, shall have the ceiling tile directly below identified with a colored tack inserted into the tile.
- F. Use engraved name plates to identify control equipment.
- G. Label fire, smoke and combination fire smoke dampers on the exterior surface of ductwork directly adjacent to access doors using a minimum of 0.5 inch height lettering reading, "SMOKE DAMPER" or "FIRE DAMPER". Smoke and combination fire smoke dampers shall also include a second line listing the individual damper tag. The tags must be coordinated with the mechanical schedules. Utilize stencils or manufactured labels. All other forms of identification are unacceptable. All labels shall be clearly visible from the ceiling access point. **

3.08 LUBRICATION

- A. Lubricate all bearings with lubricant as recommended by the manufacturer before the equipment is operated for any reason. Once the equipment has been run, maintain lubrication in accordance with the manufacturer's instructions until the work is accepted by Owner. Maintain a log of all lubricants used and frequency of lubrication; include this information in the Operating and Maintenance Manuals at the completion of the project.

3.09 SLEEVES AND OPENINGS

- A. DUCT SLEEVES:
 - 1. Duct sleeves are not required in non-rated partitions or floors.
 - 2. Provide sleeve required for fire dampers in fire-rated partitions and floors. Reference fire damper details on drawings.

3.10 SEALING AND FIRESTOPPING

A. FIRE AND/OR SMOKE RATED PENETRATIONS:

1. Provide all fire stopping of fire rated penetrations and sealing of smoke rated penetrations in compliance with UL & ASTM.

B. NON-RATED PARTITIONS:

1. At all interior walls and exterior walls, pipe penetrations are required to be sealed. Apply sealant to both sides of the penetration in such a manner that the annular space between the pipe sleeve or cored opening and the pipe or insulation is completely blocked.
2. Duct penetrations through non-rated partitions shall require sheet metal escutcheons with fiberglass or mineral wool insulation fill for spaces that include laboratories, clean rooms, animal rooms, kitchens, cart wash rooms, classrooms, janitor closets, toilet rooms, mechanical rooms, conference rooms, private consultation rooms, where ducts are exposed and where noted on drawings elsewhere.

C. PENETRATIONS SUBJECT TO WATER INTRUSION:

1. For penetrations (both rated and non-rated) in floors subject to water intrusion or in rooms housing electrical equipment (but not within walls) provide one of the following:
 - Duct penetrations. Provide 2" x 2" x 1/8" galvanized steel angles fastened to floor surrounding the penetration or group of penetrations to prevent water from getting to penetration. Provide urethane caulk between angles and floor and fasten angles to floor minimum 8" on center. Seal corners water tight with urethane caulk.
2. Floors subject to water intrusion or rooms housing electrical equipment include the following locations:
 - Restrooms
 - Mechanical/Plumbing Equipment Rooms
 - Electrical Equipment Rooms

3.11 SMOKE DETECTION SYSTEM

- A. Required in return air systems with more than 2000 cfm design capacity. Must be connected to fire alarm system if a system exists. Upon activation, smoke detectors shall shut down the air distribution system. If part of a smoke control system, the system shall switch to smoke control mode. Locate detectors upstream of any filters, exhaust air connections, outdoor air connections, or decontamination equipment.

3.12 CLEANING EQUIPMENT, DUCTWORK AND PREMISES

- A. Thoroughly clean all parts of the piping, valves, ductwork, grilles and equipment. Exposed parts which are to be painted shall be thoroughly cleaned of cement, plaster and other materials and all oil and grease spots shall be removed. Such surfaces shall be carefully wiped and all cracks and corners scraped out. Exposed metal work shall be carefully brushed down with steel brushes to remove rust and other spots and left smooth and clean.
- B. Clean filters shall be installed in all equipment specified with filters.
- C. Remove all construction debris, excess materials and equipment.

3.13 GUARANTEE

- A. All materials and workmanship shall be guaranteed for a period of one year after substantial completion. Where extended warranties are required, they shall be provided by the manufacturer or contractor as specified, in the equipment specification.

3.14 CERTIFICATION OF TESTS AND ADJUSTMENTS

A. Contractor _____

B. Division of Work _____

C. Project Name _____

D. Project Number _____

E. The Contractor named above certifies that the tests and adjustments indicated below have been completed in accordance with the specifications on the date indicated. Start-up of all HVAC equipment installed in this project is the responsibility of this Contractor unless otherwise indicated.

F. Tests:	Date
1. Heating Piping	_____
2. Cooling Piping	_____
3. Start-up of Air Systems	_____
4. Air Handling Unit Start-up	_____
5. Glycol Systems	
a. % of glycol in solution	_____
b. Freeze point of solution	_____

G. Contact _____

H. Signed By _____

I. Date _____

END OF SECTION

**SECTION 23 05 13
COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT**

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Scope. This section includes requirements for single and three phase motors that are used with equipment specified in other sections. Included are the following topics:
- B. PART 1 - GENERAL
 - 1. Scope
 - 2. Related Work
 - 3. Reference
 - 4. Reference Standards
 - 5. Quality Assurance
 - 6. Submittals
 - 7. Operation and Maintenance Data
 - 8. Electrical Coordination
 - 9. Product Criteria
- C. PART 2 - Products
 - 1. Three Phase, Single Speed Motors
 - 2. Single Phase, Single Speed Motors
- D. PART 3 - EXECUTION
 - 1. Installation

1.02 RELATED WORK

- A. Section 23 05 14 - Variable Frequency Drives
- B. Section 23 09 14 - Pneumatic and Electric Instrumentation and Control Devices for HVAC
- C. Division 26 - Electrical

1.03 REFERENCE

- A. Applicable provisions of Division 1 govern work under this section.

1.04 REFERENCE STANDARDS

- A. ANSI/IEEE 112 Test Procedure for Polyphase Induction Motors and Generators
- B. ANSI/NEMA MG-1 Motors and Generators
- C. ANSI/NFPA 70 National Electrical Code

1.05 QUALITY ASSURANCE

- A. Refer to Division 1, General Conditions, Equals and Substitutions.

1.06 SUBMITTALS

- A. Refer to Division 1, General Conditions, Submittals.
- B. Include with the equipment which the motor drives the following motor information: motor manufacturer, horsepower, voltage, phase, hertz, rpm, full load efficiency. Include project wiring diagrams prepared by the contractor specifically for this work.

1.07 OPERATION AND MAINTENANCE DATA

- A. All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.
- B. In addition to the general content specified under GENERAL REQUIREMENTS supply the following additional documentation:
 - 1. Lubrication instructions, including list/frequency of lubrication.
 - 2. Table noting full load power factor, service factor, NEMA design designation, insulation class and frame type for each motor provided.

1.08 ELECTRICAL COORDINATION

- A. All starters, overload relay heater coils, disconnect switches and fuses, relays, wire, conduit, pushbuttons, pilot lights, and other devices required for the control of motors or electrical equipment are furnished and installed by the Electrical Contractor, except as specifically noted elsewhere in this division of specifications.
- B. Electrical drawings and/or specifications show number and horsepower rating of all motors furnished by this Contractor, together with their actuating devices if these devices are furnished by the Electrical Contractor. Should any discrepancy in size, horsepower rating, electrical characteristics or means of control be found for any motor or other electrical equipment after contracts are awarded, Contractor is to immediately notify the architect/engineer of such discrepancy. Costs involved in any changes required due to equipment substitutions initiated by this contractor will be the responsibility of this contractor. See related comments in Section 23 05 00 - Common Work Results for HVAC, under Shop Drawings.
- C. Electrical Contractor will provide all power wiring and control wiring, except temperature control wiring.
- D. Furnish project specific wiring diagrams to Electrical Contractor for all equipment and devices furnished by this Contractor and indicated to be wired by the Electrical Contractor.

1.09 PRODUCT CRITERIA

- A. Motors to conform to all applicable requirements of NEMA, IEEE, ANSI, and NEC standards and shall be listed by U.L. for the service specified.
- B. Select motors for conditions in which they will be required to perform; i.e., general purpose, splashproof, explosion proof, standard duty, high torque or any other special type as required by the equipment or motor manufacturer's recommendations.
- C. Furnish motors for starting in accordance with utility requirements and compatible with starters as specified.

PART 2 - PRODUCTS

2.01 THREE PHASE, SINGLE SPEED MOTORS

- A. Use NEMA rated, three phase, 60 hertz motors for all motors 3/4 HP and larger unless specifically indicated.
- B. Use NEMA general purpose, continuous duty, Design B, normal starting torque, T-frame or U-frame motors with Class B or better insulation unless the manufacturer of the equipment on which the motor is being used has different requirements. Use open drip-proof motors unless totally enclosed fan-cooled, totally enclosed non-ventilated, explosion-proof, or encapsulated motors are specified in the equipment sections.
- C. Use grease lubricated anti-friction ball bearings with housings equipped with plugged/capped provision for relubrication, rated for minimum AFBMA 9, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at the end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
- D. All open drip-proof motors to have a 1.15 service factor. Other motor types may have minimum 1.0 service factors.
- E. All motors 1 HP and larger, except specially wound motors and inline pump motors 56 frame and smaller, to be high efficiency design with full load efficiencies which meet or exceed the values listed below when tested in accordance with NEMA MG 1.

FULL LOAD NOMINAL MOTOR EFFICIENCY BY MOTOR SIZE AND SPEED			
<i>Open Drip Proof Motors</i>			
Nominal Motor Speed			
MOTOR HP	1200 RPM	1800 RPM	3600 RPM
1	82.5	85.5	77.0
1½	86.5	86.5	84.0
2	87.5	86.5	85.5
3	88.5	89.5	85.5
5	89.5	89.5	86.5

FULL LOAD NOMINAL MOTOR EFFICIENCY BY MOTOR SIZE AND SPEED			
<i>Totally Enclosed Fan-Cooled Motors</i>			
Nominal Motor Speed			
MOTOR HP	1200 RPM	1800 RPM	3600 RPM
1	82.5	85.5	77.0
1½	87.5	86.5	84.0
2	88.5	86.5	85.5
3	89.5	89.5	86.5
5	89.5	89.5	88.5

2.02 SINGLE PHASE, SINGLE SPEED MOTORS

- A. Use NEMA rated 115 volt, single phase, 60 hertz motors for all motors 3/4 HP and smaller.
- B. Use electronically commutated motor, permanent split capacitor or capacitor start, induction run motors, as indicated, equipped with permanently lubricated and sealed ball or sleeve bearings and Class A insulation. Service factor to be not less than 1.35.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Mount motors on a rigid base designed to accept a motor, using shims if required under each mounting foot to get a secure installation.
- B. When motor will be flexible coupled to the driven device, mount coupling to the shafts in accordance with the coupling manufacturer's recommendations. Using a dial indicator, check angular misalignment of the two shafts; adjust motor position as necessary so that the angular misalignment of the shafts does not exceed 0.002 inches per inch diameter of the coupling hub. Again, using the dial indicator, check the shaft for run-out to assure concentricity of the shafts; adjust as necessary so that run-out does not exceed 0.002 inch.
- C. When motor will be connected to the driven device by means of a belt drive, mount sheaves on the appropriate shafts in accordance with the manufacturer's instructions. Use a straight edge to check alignment of the sheaves; reposition sheaves as necessary so that the straight edge contacts each sheave faces squarely. After sheaves are aligned, loosen the adjustable motor base so that the belt(s) can be added and tighten the base so that the belt tension is in accordance with the drive manufacturer's recommendations. Frequently recheck belt tension and adjust if necessary during the first day of operation and again after 80 hours of operation.
- D. Verify the proper rotation of each three-phase motor as it is being wired or before the motor is energized for any reason.
- E. Lubricate all motors requiring lubrication. Record lubrication material used and the frequency of use. Include this information in the maintenance manuals.

END OF SECTION

SECTION 23 05 14
VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Scope. This section includes variable frequency drives, bypass starters, and line reactors. Included are the following topics:
- B. PART 1 - GENERAL
 - 1. Scope
 - 2. Related Work
 - 3. Reference
 - 4. Reference Standards
 - 5. Submittals
 - 6. Operating and Maintenance Data
 - 7. Equipment Startup
 - 8. Warranty
- C. PART 2 - Products
 - 1. Manufacturers
 - 2. Design and Construction
 - 3. Performance Requirements
 - 4. Electrical Noise Criteria
 - 5. Control Features
 - 6. Protection Features
 - 7. Diagnostics
 - 8. Quality Assurance Tests
 - 9. Bypass Equipment
 - 10. AC Input Line Reactors
 - 11. Output Line Filters
- D. PART 3 - EXECUTION
 - 1. Variable Frequency Drives (VFD)
 - 2. Owner Training

1.02 RELATED WORK

- A. Section 23 05 13 - Common Motor Requirements for HVAC
- B. Section 23 12 13 - Facility Fuel-Oil Pumps
- C. Section 23 21 23 - Hydronic Pumps
- D. Section 23 34 00 - HVAC Fans
- E. Section 23 64 15 - Water Cooled Chillers
- F. Section 23 65 00 - Cooling Towers
- G. Section 23 73 13 - Modular Indoor Central-Station Air-Handling Units
- H. Section 26 05 26 - Grounding and Bonding for Electrical Systems
- I. Section 26 05 29 - Hangers and Supports for Electrical Systems
- J. Section 26 05 53 - Identification for Electrical Systems
- K. Section 26 27 02 - Equipment Wiring Systems

1.03 REFERENCE

- A. Applicable provisions of Division 1 govern work under this section.

1.04 REFERENCE STANDARDS

- A. ANSI/IEEE 519 Guide for Harmonic Control and Reactive Compensation of Static Power Converters

1.05 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Division 1, General Conditions of the Contract, and Division 26.
- B. Include physical, electrical, and performance characteristics of each variable frequency drive and associated components, including dimensions; weight; input and output performance; voltage, phase, current and overcurrent characteristics; installation instructions; protective features; wiring and block diagrams indicating specified options; electrical noise attenuation equipment where required to meet the criteria specified; line side voltage notch wave form and line side current harmonics; certified efficiency versus load and speed curves; and required operating environment.

1.06 OPERATION AND MAINTENANCE DATA

- A. All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

1.07 EQUIPMENT STARTUP

- A. Provide the services of a factory trained and certified technician to approve the installation; start-up, test, and adjust for proper operation of the unit(s). Upon completion of the equipment startup, submit a complete manufacturer's field report, including startup and test log, signed by the factory trained technician. Coordinate with the Temperature Control Contractor and the Balancing Contractor. The startup shall be coordinated with Division 26, Electrical and shall be completed within ten (10) working days from the startup date.

1.08 WARRANTY

- A. The warranty shall be for a period of twenty-four (24) months from the date of project Substantial Completion. Further, the warranty shall include all parts, labor, travel time, administrative costs, overhead, travel expenses, technical support and any and all other costs to provide the warranty service.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. ABB, Siemens, Toshiba, Danfoss, Trane/Danfoss, Yaskawa, Eaton/Cutler Hammer, Mitsubishi, Allen Bradley, Square D.

2.02 DESIGN AND CONSTRUCTION

- A. The unit shall be variable torque, modular design for control of the motors as specified in Division 23 and rated at the motor full load nameplate amps.
- B. The unit, including bypass starter (if provided), shall be U.L. or ETL listed, solid state, microprocessor-based with a pulse width modulated (PWM) output wave form (none others are acceptable).
- C. The VFD shall employ a full wave bridge rectifier and capacitors to minimize the ripple of the rectified voltage to maintain near constant DC voltage. Insulated gate bipolar transistors (IGBT's) shall be employed as the output switching device.
- D. EMI/RFI filters to meet EMC Immunity IEC 61800 – 3 first and second environment.
- E. The VFD package shall contain the equivalent of 5% impedance to reduce harmonic distortion. The 5% equivalent impedance shall be provided in the form of a DC bus choke, an input AC line reactor in each phase, or a combination of the two methods.
- F. Control circuitry shall be plug-in, plug-out modular basis with a corrosion resistant coating on printed circuit boards.
- G. Units to be suitable for an operating environment from 0°C to 40°C temperature and humidity up to 90% non-condensing.
- H. Electrically and physically isolate control circuitry and conductors from power circuitry and power conductors. Control conductors and power conductors shall not be run in the same pathway.
- I. The unit enclosure shall be NEMA Type 1, 3R, or 12 as required for the application minimum and all components shall be fully factory assembled and tested prior to leaving the manufacturing facility.
- J. Include the following operating and monitoring devices mounted on the front cover:
 - A disconnect switch or circuit breaker to de-energize both the drive and bypass circuit with door interlocked handle and lock-open padlocking provisions.
 - Operating mode selector switch marked "hand-off-auto".
 - Manual speed adjustment via keypad, mounted on the door.
 - Manual bypass selector switch to select power through drive or bypass (if a bypass is provided).
- K. Provide a manual bypass circuit and bypass starter to transfer from variable frequency drive operation to bypass operation (if a bypass is provided).
- L. Drives shall have SCCR (short circuit current rating) of 65 amps.

2.03 PERFORMANCE REQUIREMENTS

- A. Units shall be suitable for input power of electrical system as scheduled on the drawings $\pm 10\%$, 3 phase, 60 Hertz nominal.
- B. Use a current limiting control device to limit output current to 110% continuous for one minute; also refer to Protection Features in this section. Full load output current available from drive shall not be less than motor nameplate amperage. The full load amp rating of the VFD shall not be less than the values indicated in the NEC Table 430-150.
- C. Output power shall be suitable for driving standard NEMA B design, three phase alternating current induction motors at full rated speed with capability of 6:1 turndown.
- D. Additional performance capabilities to include the following:
 - Ride through a momentary power outage of 15 cycles.
 - Start into a rotating load without damage to drive components or motor.
 - Capable of automatic restart into a rotating load after a preset, adjustable time delay following a power outage.
 - Input displacement power factor: Min 0.95 throughout the speed range.
 - Minimum efficiency: 95% at 100% speed, 85% at 50% speed

2.04 ELECTRICAL NOISE CRITERIA

- A. Voltage and current distortion generated by VFD and attenuation devices measured at input of VFD assembly and as installed in place, shall not exceed the following criteria as referenced by IEEE Standard 519.
 - 1. Total harmonic distortion (THD) shall not exceed 5% RMS of fundamental input voltage at full load with maximum RMS value on any signal harmonic based on IEEE-519-1992 Table 10.3.
 - 2. Area of commutation notch (A_n) shall not exceed 16,400 volt-microseconds measured at point of coupling to distribution system. Point of common coupling shall be primary side of upstream utility transformer for current and secondary side of upstream utility transformer for voltage.
- B. VFD manufacturer shall perform harmonic analysis at input of distribution transformer to define compliance to IEEE-519-1992, General Category, is attained. Analysis shall include electrical one-line drawing defining resistance and impedance of each wire run and transformer leading to each VFD.
- C. Contractor shall be responsible for gathering VFD information from other specification sections and providing it to VFD manufacturer performing analysis. Analysis shall be computer generated and perform Fourier analysis of system. Results shall list current and voltage amplitudes of all harmonics up to 50th level at input of distribution transformer. A summary shall detail percent total harmonic distortion for voltage and total demand distortion for current. Analysis shall assume maximum transformer loading of 75% of nameplate value.
- D. Electrical one-line diagrams shown on Electrical Drawings include transformer kVA and impedance, and typical configuration of electrical system. Use this information for evaluation of harmonics for bidding purposes.

- E. Successful Contractor must provide required data for VFD manufacturer to complete harmonic analysis. Information shall include utility short circuit amperes capability; distribution transformer kVA and impedance; length, size and number of wires per phase to motor control center feeding VFD's; wire data to VFD's from motor control center; wire data to motor from VFD; and motor nameplate data.
- F. VFD manufacturer is responsible for cost of all equipment required to meet IEEE-519. Equipment, which can be provide, includes input line reactors, DC bus reactors and harmonic filters.

2.05 CONTROL FEATURES

- A. Use control circuits compatible with input signal from temperature control system in the automatic mode and from manual speed control in the manual mode. Vary motor speed in response to the input control signal. Include components necessary to accept the signal from the temperature control system in the form that it is sent.
- B. Include the following additional control features:
 - Hand-Off-Automatic (HOA) selector to select local or remote start/stop and speed control.
 - Analog input, selectable 0-10v or 4-20 mA, for automatic control from the temperature control system.
 - Local speed control at the VFD.
 - Adjustable acceleration and deceleration rate so that the time period from start to full speed and from full speed to stop can be field adjusted
 - Adjustable minimum and maximum speed settings for both automatic and manual modes of operation.
 - Manual transfer bypass circuit (if bypass option is provided).
 - Field adjustment of minimum and maximum output frequency.
 - Two (2) sets of programmable form "A" contacts for remote indication of variable frequency drive condition. Note: default programming to be set for "Drive Run & Fault".
 - When specified in the 23 09 93 sequence of operations, provide a VFD input and output for shutoff damper control that shall operate as follows: When the fan is remotely or locally commanded to start, VFD contact shall energize the shutoff damper to open the damper. The damper position end switch shall be wired to a run permissive input on the VFD and enable the VFD to start when the damper end switch provides the damper is open. This feature shall be provided for both inverter and bypass operation (if bypass option is provided).
 - Illuminated display keypad.
 - External Fault indicator.
 - One (1) input for a N.O. dry contact type input for a 2-wire remote start/stop.
 - One (1) input for a N.C. dry contact type input for external faults: (freezestats, fire alarm, smokes, etc). This input shall be factory wired to prevent both the VFD and bypass starter operation when external fault is present.
 - PID control loop capable of VFD control from an external device connected to a VFD analog input.

- C. The VFD controller shall convert VFD information into the BACnet MSTP protocol that will be compatible with the building direct digital energy management system (EMS) supplied on the project. This output shall be through a serial interface port capable of two-way communication with the building EMS provided on this project. Final connection shall not require any additional intermediate gateway devices to provide throughput of data. The following data shall be provided at a minimum:
- Fault condition
 - Speed
 - Amperage
 - Frequency
 - Voltage
 - Bypass status (if supplied)

2.06 PROTECTION FEATURES

- A. Use electronic protection circuitry in the power circuits to provide an orderly shutdown of the drive without blowing fuses or tripping circuit breakers and prevent component loss under the following abnormal conditions:
- Activation of any safety device
 - Instantaneous overcurrent and/or over voltage of output
 - Power line overvoltage and undervoltage protection
 - Phase loss
 - Single and three phase short circuiting
 - Ground faults
 - Control circuit malfunction
 - Overtemperature
 - Output current over limit
- B. Provide the following additional protective features:
- Input transient overvoltage protection up to 3000 volts per ANSI 37.90A
 - Input transient overvoltage protection up to 3000 volts per ANSI 37.90A;
 - DC bus fusing or other electronic controls which limit the rate of rise of the DC bus current and de-energizes the drive at a predetermined current level
 - Fusing for the control circuit transformer
 - Grounded control chassis
 - Devices and/or control circuitry to ensure that the variable frequency drive and bypass starter are not both energized and driving motor simultaneously

2.07 DIAGNOSTICS

- A. Provide an English character display (no error codes) with indicators for the following:
- Phase loss
 - Ground fault
 - Overcurrent
 - Overvoltage
 - Undervoltage
 - Over temperature
 - Overload
 - DC bus status

2.08 QUALITY ASSURANCE TESTS

- A. Use a factory heat stress test to verify proper operation of all functions and components under full load.
- B. Field performance test of variable frequency drives to determine compliance with this specification will be performed at the Owner's discretion and may include any specified feature, including operation of protective devices through a simulated fault. Contractor will pay for initial testing. Should drive be found deficient by this testing, drive manufacturer will be required to make any and all changes necessary to bring unit(s) into compliance with the specified performance and demonstrate this performance by retesting. Cost of changes and retest will be by this contractor.
- C. Variable frequency drive manufacturer or designated representative to perform a field test of each drive, in the presence of the Owner's representative, for the following items:
 - Provide general inspection to verify proper installation
 - Demonstrate adequate protection during switching from variable frequency drive operation to bypass starter operation and back again

2.09 BYPASS EQUIPMENT

- A. Bypass Starters:
 - 1. The bypass starters shall be across-the-line magnetic starter type, unless otherwise noted.
- B. Bypass Configuration:
 - 1. Provide one main disconnect switch or circuit breaker to de-energize both the drive and bypass circuit. Provide a drive input disconnect switch or fuse block to allow the drive to be isolated while the bypass circuit is energized. Provide one output drive contactor and one output bypass contactor. The two output contactors shall be electrically interlocked to allow only one contactor to be closed at any one time.
- C. Provide motor overload protection in the bypass circuit.
- D. Provide bypass equipment in a common enclosure with the VFD or, if not available, in a separate enclosure.

2.10 AC INPUT LINE REACTORS

- A. When needed to comply with the requirement for 5% equivalent impedance, furnish and factory install AC input line reactors.
- B. Line reactors shall be installed in each phase of the AC input side of the VFD and mounted within a common enclosure with the VFD
- C. Line reactor shall be a three-phase inductor, iron core, 600V, Class H insulation, 115 degree C rise, copper windings with screw type terminal blocks.

2.11 OUTPUT LINE FILTER

- A. Provide a three phase dV/dT output filter for any 460VAC drive with output line length of over 120 feet or as specified. Not required where motor complies with NEMA MG1 Part 31.
- B. The Vlk dampened low pass filter, (hereafter also known as "dV/dTGuard" or "PWM Output Filter"), minimizes motor failures due to IGBT-based drives that are connected by long leads. Motors controlled by variable frequency drives that are installed some distance away often fail as a result of high voltage- induced insulation breakdown. The extremely fast switching time of the IGBT drive is reflected by the steep edges (dV/dTs) of the PWM voltage waveform. When uncontrolled, these high dV/dT's result in voltage wave reflections which can become additive at the pulse level yielding a voltage overshoots or spikes. These voltage overshoots damage the motor and cable insulation and lead to motor failure as the length of the motor cables increase. The combined inductance, capacitance and resistance of the PWM Output Filter shall be specifically designed to reduce voltage waveform dV/dT. In so doing, the dV/dTGuard shall also minimize parasitic resonance interaction between the inductive and the capacitive elements within the long leads. Left unguarded, this conductor resonance phenomenon would likewise contribute to the formation of motor-damaging voltage spikes.
- C. The Vlk dampened, low pass filter consists of a gapped, three phase, iron core inductor; AC-rated, polypropylene capacitors; and wire-wound resistors. The filter shall be rated for application at a maximum fundamental system frequency of 60Hz at nominal system voltages up to 600V. The filter shall operate at a maximum carrier frequency of 5kHz at 40% of fundamental voltage. The ambient temperature of operation shall be 40°C. The maximum distance from the drive to the input terminals of the Vlk filter shall be 20 ft. Vlk filter application shall be effective for lead distances between the drive and the motor that range from 50 ft. to 3,000 ft., depending on the application details (consult factory). Leads should not be electrically oversized more than four cable sizes or the mechanical limitations of the cable connectors.
- D. Inductors:
 - 1. The three phase inductors shall be designed for harmonic filtering service and for slowing the rate of rapid current changes. The inductors shall be UL component-recognized and shall be built to comply with UL 508A standard. Construction shall be of copper wire wound on magnetic grade steel. Inductors shall be sized appropriately for the total connected load. The design maximum temperature rise for reactors shall be 115°C or 155°C depending on frame size at rated current.
 - 2. The core shall be made of laminated, electrical steel (grade M50 or better).
 - 3. Brackets shall be ASTM structural steel or structural aluminum. Coils shall be wedged in place and the core shall be locked in place using vertical ties or rods.
 - 4. Windings shall consist of copper wire or of copper foil. Terminations shall be copper alloy ring lugs, UL-recognized terminal blocks, or solid copper bus. Sheet insulation shall be Tufquin or Cequin IF or Dupont Nomex 410 of the thickness as required for UL insulation systems.
 - 5. Inductors shall be air-gapped to control saturation. Inductance shall be measured under full load and shall be within ±10% of design value.

6. Completed inductors shall be impregnated with 100% solid epoxy resin. All insulation varnish systems shall be rated class R (20°C) or H (180°C), 600V.
 7. Inductance shall remain above 50% of nominal for any overload up to 200% of rated current. Inductors shall not sustain any thermal damage for levels up to 150% of rated current for a minimum period of five minutes. Inductors shall be Hi-Pot tested (2,640V, 60 Hz, 1 second) line-to-line and line-to-ground.
- E. Capacitors:
1. Capacitors shall be constructed of metallized polypropylene film material.
 2. Capacitors shall be Y(Wye)-connected and ungrounded neutral. Each capacitor element shall be rated at minimum of 700V AC.
- F. Resistors:
1. Resistors shall consist of wire-wound cement construction and incorporate thermal insulating terminations.
 2. Resistors shall be derated to operate at twice the calculated worst case requirements for watts loss.
- G. Enclosure (optional) shall be designed to conform to NEMA 1 standards. Enclosure shall be constructed from steel with enamel finish. Enclosure openings shall be provided to allow for air flow convection cooling. Provisions shall be made to allow for permanent conduit entry sites. Enclosure shall have a removable cover that shall not at any time disrupt the conduit connections.
- H. The dV/dTGuard Vlk output filter shall be warranted free from defects in both materials and in workmanship for a period of one year from the date of installation or for a maximum of two years from the date of purchase, whichever comes first.

PART 3 - EXECUTION

3.01 VARIABLE FREQUENCY DRIVES

- A. Install where indicated on drawings and in accordance with approved submittals and manufacturer's published recommendations. Installation to be by the Division 26 00 00 - Electrical contractor.
- B. Input power wiring shall be installed in a separate conduit, output power wiring shall be installed in a separate conduit and control wiring shall be installed in a separate conduit. Do not mix input power, output power, or control wiring in a common conduit. Separate conduits for input and output power wiring shall be provided for each motor. Input and output power wiring for more than one motor shall not share a common conduit. Power wiring shall be furnished and installed by the Div. 26 contractor. If provided, do not mount output line filter below the drive.
- C. Control signal for drive will be provided under Division 23.
- D. Temperature Control Contractor will furnish and install the required temperature control wiring in metal conduit and in accordance with Division 26 00 00 - Electrical of this specification.

3.02 OWNER TRAINING

- A. Contractor to provide factory authorized representative and/or field personnel knowledgeable with the operations, maintenance and troubleshooting of the system and/or components defined within this section for a minimum period of two hours.

END OF SECTION

**SECTION 23 05 15
PIPING SPECIALTIES**

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Scope. This section contains specifications for HVAC piping specialties for all piping systems. Included are the following topics:
- B. PART 1 - GENERAL
 - 1. Scope
 - 2. Related Work
 - 3. Reference
 - 4. Quality Assurance
 - 5. Submittals
 - 6. Operation and Maintenance Data
 - 7. Design Criteria
- C. PART 2 - Products
 - 1. Thermometers
 - 2. Thermometer Sockets
 - 3. Test Wells
 - 4. P/T (Pressure/Temperature) Test Plugs
 - 5. Hose Connection Caps
 - 6. Pressure Gauges
 - 7. Strainers
 - 8. Air Vents
 - 9. Flow Sensing Devices
- D. PART 3 - EXECUTION
 - 1. Thermometers
 - 2. Thermometer Sockets
 - 3. Test Wells
 - 4. P/T (Pressure/Temperature) Test Plugs
 - 5. Hose Connection Caps
 - 6. Pressure Gauges
 - 7. Strainers
 - 8. Air Vents
 - 9. Flow Sensing Devices

1.02 RELATED WORK

- A. Section 23 11 00 - Facility Fuel Piping
- B. Section 23 21 13 - Hydronic Piping
- C. Section 23 22 13 - Steam and Condensate Heating Piping
- D. Section 23 24 00 - Internal-Combustion Engine Piping
- E. Section 23 83 16 - Radiant-Heating Hydronic Piping
- F. Section 23 05 23 - General-Duty Valves for HVAC Piping
- G. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment
- H. Section 23 07 00 - HVAC Insulation

1.03 REFERENCE

A. Applicable provisions of Division 1 govern work under this section.

1.04 QUALITY ASSURANCE

A. Refer to Division 1, General Conditions, Equals and Substitutions.

1.05 SUBMITTALS

A. Refer to Division 1, General Conditions, Submittals.

B. Required for all items in this section. Include materials of construction, dimensional data, ratings/capacities/ranges, pressure drop data where appropriate, and identification as referenced in this section and/or on the drawings.

1.06 OPERATION AND MAINTENANCE DATA

A. All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

1.07 DESIGN CRITERIA

A. All piping specialties are to be rated for the highest pressures and temperatures in the respective system in accordance with ANSI B31, but not less than 125 psig unless specifically indicated otherwise.

PART 2 - PRODUCTS

2.01 THERMOMETERS

A. Manufacturers: Ashcroft, Marsh, Taylor, H. O. Trerice, U. S. Gauge, Weiss, Weksler, Winters.

B. Stem Type, cast aluminum case, nine inch scale, clear acrylic window. adjustable angle brass stem with stem of sufficient length so the end of the stem is near the middle of a pipe without reducing the thickness of any insulation, red indicating fluid, black lettering against a white background, with scale ranges as follows:

<u>Service</u>	<u>Scale Range, °F</u>	<u>Min. Increment, °F</u>
Hot Water	30 - 240	2
Chilled Water	0 - 100	1

2.02 THERMOMETER SOCKETS

A. Brass with threaded connections suitable for thermometer stems and temperature control sensing elements in pipeline. Furnish with extension necks for insulated piping systems.

2.03 TEST WELLS

A. Similar to thermometer sockets except with a brass cap that thread into the inside of the test well to prevent dirt from accumulating. Secure cap to body with a short chain. Furnish with extension necks, where appropriate, to accommodate the pipeline insulation.

2.04 P/T (PRESSURE/TEMPERATURE) TEST PLUGS

- A. Brass plug with 1/4" NPT threads, EPDM or neoprene valve core, knurled cap with cap strap. Use extended length plugs to clear insulated piping. Adaptors shall have 1/4" FPT connection for standard pressure gauges.

2.05 HOSE CONNECTION CAPS

- A. Hose connection caps shall be pressure rated for 150 psig at 180 deg F.

2.06 PRESSURE GAUGES

- A. Manufacturers: Ametek/U. S. Gauge Division, Ashcroft, Marsh, Taylor, H. O. Trerice, Weiss, Weksler, Winters.
- B. Cast aluminum case of not less than 4.5 inches in diameter, double strength glass window, black lettering on a white background, phosphor bronze bourdon tube with bronze bushings, recalibration from the front of the dial, 99% accuracy over the middle half of the scale, 98.5% accuracy over the remainder of the scale, with scale range as follows:

<u>Service</u>	<u>Scale Range, psig</u>	<u>Min. Increment, psig</u>
Hot Water	0-60	1
Chilled Water	0-60	1

- C. Pressure Snubbers: Bronze construction, suitable for system working pressure, 1/4" size.
- D. Coil Syphons: Bronze or steel construction, suitable for system working pressure, 1/4" size.
- E. Gauge Valves: Use valves as specified in Section 23 05 23 - General-Duty Valves for HVAC Piping. For water systems, use 1/4" ball valves. For steam systems, use 1/4" gate valves suitable for system working pressure.

2.07 STRAINERS

- A. Manufacturers: Armstrong, Mueller Steam, Sarco, or Victaulic Company.
- B. Water Systems:
 - 1. Y type; cast ductile iron body; stainless steel screens; bolted or threaded screen retainer tapped for a blowoff valve; threaded body in sizes through 2 inch and rated at not less than 175 psi WOG; grooved end or flanged body in sizes over 2 inch and rated at not less than 300 psi WOG at 230°F. Screen to be 20 mesh for line sizes 2 inch and less, 0.125 inch perforations for line sizes 2-1/2 inch through 4 inch, and 0.25 inch perforations for line sizes 5 inch and larger. Equal to Victaulic Style 732 / W732.
- C. Water Systems with Design Pressures Over 150 PSIG: Y type; cast iron or cast steel body; stainless steel screens; bolted or threaded screen retainer tapped for a blowoff valve; threaded or socket weld body in sizes through 2 inch and rated at not less than 300 psi WOG at 150°F; flanged or butt weld body in sizes over 2 inch and rated at not less than 300 psi WOG at 150°F. Screen perforations to be 0.057 inch for line sizes 2 inch and less, 0.125 inch for line sizes 2-1/2 inch through 4 inch, and 0.25 inch for line sizes 5 inch and larger.

2.08 AIR VENTS

A. Manual Key Type Vents:

1. Bell and Gossett Model 4V; Eaton/Dole Model 9, 9B, or 14A.
2. Bronze body with nonferrous internal parts, screwdriver operated, designed to relieve air from the system when vent is opened, rated at not less than 125 psig at 220°F.

2.09 FLOW SENSING DEVICES

A. For water flow sensing devices 2 inch and smaller, use balance valves as specified in Section 23 05 23 - General-Duty Valves for HVAC Piping:

1. Nexus Venturi NVF, Flo-Pac VF, Bell & Gossett VF or approved equal.
2. Venturi flow measurement section with flanged inlet and outlet end connections. Chart for conversion of differential pressure readings to flow rate to monitor flow with a minimum friction head loss.

PART 3 - EXECUTION

3.01 THERMOMETERS

- A. Stem Type: Install in piping systems as indicated on the drawings and/or details using a separable socket in each location.
- B. Dial Type for Air Temperature Measurement: Install in ductwork where detailed or specified. Support capillary inside duct so it measures a uniform sample of air. Mount readout so it is readily visible on a portion of ductwork that is not externally insulated or on a sheet metal angle support secured to a nearby structural element.

3.02 THERMOMETER SOCKETS

- A. Install at each point where a thermometer or temperature control sensing element is located in a pipeline.

3.03 TEST WELLS

- A. Install in piping systems as indicated on the drawings and/or details wherever provisions are needed for inserting a thermometer at a later date.

3.04 P/T (PRESSURE/TEMPERATURE) TEST PLUGS

- A. Install in piping systems as indicated on the drawings and/or details. Do not insulate over test plugs.

3.05 HOSE CONNECTION CAPS

- A. Install in locations where indicated on the drawings and details.

3.06 PRESSURE GAUGES

- A. Install in locations where indicated on the drawings and/or details, including any gauge piping, with scale range appropriate to the system operating pressures.
- B. Pressure Snubbers: Install in gauge piping for all gauges used on water services.
- C. Coil Syphons: Install in gauge piping for all gauges used on steam services.
- D. Gauge Valves: Install at each gauge location as close to the main as possible and at each location where a gauge tapping is indicated.

3.07 STRAINERS

- A. Install all strainers where indicated on the project details, allowing sufficient space for the screens to be removed. Rotate screen retainer where required by the installation so blowdown can remove accumulated dirt from the strainer body.
- B. Water Systems: Install a ball valve for blowdown in the tapped screen retainer; valve to be the same size as the tapping.

3.08 AIR VENTS

- A. Manual Key Type Vents: Install at all high points where air may collect and not be carried by the system fluid. Use a soft Type L copper "pigtail" so the vent can be positioned for venting and collecting any water that might escape.

3.09 FLOW SENSING DEVICES

- A. Install where indicated on the drawings and details for flow sensing in hydronic piping systems. Butterfly valves installed at the location of a flow sensing device are to have a memory stop.

END OF SECTION

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**SECTION 23 05 23
GENERAL-DUTY VALVES FOR HVAC PIPING**

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Scope. This section includes valve specifications for all HVAC systems except where indicated under Related Work. Included are the following topics:
- B. PART 1 - GENERAL
 - 1. Scope
 - 2. Related Work
 - 3. Reference
 - 4. Quality Assurance
 - 5. Submittals
 - 6. Operation and Maintenance Data
 - 7. Design Criteria
- C. PART 2 - Products
 - 1. Manufacturers
 - 2. Water System Valves
 - a. Ball Valves
 - b. Butterfly Valves (System – Not Chilled Water Building Entrance)
 - c. Balance Valves
 - d. Drain Valves
- D. PART 3 - EXECUTION
 - 1. General
 - 2. Shut-off Valves
 - 3. Balancing Valves
 - 4. Drain Valves

1.02 RELATED WORK

- A. Section 23 05 15 - Piping Specialties
- B. Section 23 09 14 - Pneumatic and Electric Instrumentation and Control Devices for HVAC

1.03 REFERENCE

- A. Applicable provisions of Division 1 govern work under this section.

1.04 QUALITY ASSURANCE

- A. Refer to Division 1, General Conditions, Equals and Substitutions.

1.05 SUBMITTALS

- A. Refer to Division 1, General Conditions, Submittals.
- B. Contractors shall submit a schedule of all valves indicating type of service, dimensions, materials of construction, and pressure/temperature ratings for all valves to be used on the project. Temperature ratings specified are for continuous operation.

1.06 OPERATION AND MAINTENANCE DATA

- A. All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

1.07 DESIGN CRITERIA

- A. Where valves are specified for individual mechanical services (i.e. hot water heating, chilled water, steam, etc.) all valves shall be of the same manufacturer.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Anvil, Apollo, Armstrong, Bell & Gossett, Crane, Danfoss-Flomatic, DeZurik, Durco, Fisher, Grinnell, Griswold, Hoffman, Kitz, Kunkle, Leslie, Lunkenheimer/Cincinnati, Metraflex, Milwaukee, Mueller, Newco, Nexus, Nibco, Red-White Valve Corp, Sarco, Stockham, Taco, Thrush-Amtrol, Victaulic, Watts, or approved equal.

2.02 WATER SYSTEM VALVES

A. Ball Valves:

1. 2" and smaller: Two piece bronze or forged brass body; Vic-Press, threaded or soldered ends, as appropriate to the pipe material; stainless steel or chrome plated brass/bronze ball; conventional port; glass filled teflon seat; threaded packing gland follower; blowout-proof stem; 300 psig WOG.
2. Valve stems shall allow operators to clear insulation without interference. Provide stem extensions when valve operators interfere with pipe insulation.
3. Victaulic Series P589, Apollo 70-100/200 series, Hammond 8301/8311, Milwaukee BA100/150, Nibco T/S 585-70, Stockham S206/216.
4. 2-1/2" and over: Ball valves will not be accepted in sizes over 2 inch.

B. Butterfly Valves (System – Not Chilled Water Building Entrance Valves):

1. 2" and smaller: Use ball valves; butterfly valves will not be accepted in sizes 2 inch and smaller.
2. 2-1/2" and larger: Cast ductile iron body; stainless steel shaft; Teflon, nylatron, or acetal bearings; EPDM resilient seat (pressure responsive in sizes through 12"). Shaft shall be offset from the disc centerline to allow complete 360 degree circumferential seating. Disk to be bronze, aluminum-bronze, stainless steel, electroless-nickel plated or polyphenylene-sulfide coated ductile iron, cast iron with welded nickel edge, or stainless steel. Pressure rated to 300 psig. Valve assembly to be bi-directionally bubble tight to 300 psig with no downstream flange/pipe attached. Polymid or polyamide coated valves are not acceptable.
3. Valve stems shall allow operators to clear insulation without interference. Provide stem extensions when valve operators interfere with pipe insulation.

4. Use threaded lug type valves for installation with class 125/150 flanges.
 5. Centerline Series 200, DeZurik BOS-CL, Keystone Fig. 222, Nibco LD2000 (2-1/2"-12")/LD1000 (14" and above), Victaulic MasterSeal 300 series (2-1/2"-12") / AGS-Vic300 series (14"-24").
 6. Provide ten-position lever actuators for valves 6" and smaller. Provide worm gear operators for valves 8" and larger.
 7. Where butterfly valves are indicated or specified to be installed at the location of a flow sensing device, provide the butterfly valves with a memory stop.
- C. Balance Valves:
1. 2" and smaller: Multi-turn handwheel style balance valve, DZR brass (Ametal®), bronze or copper alloy body with calibrated ball, globe or venturi/valve arrangement, integral pointer and calibrated scale to register degree of valve opening, memory stop, drain tapping, threaded or soldered ends, with or without integral unions, P/T or Shraeder pressure taps with integral check valves and seals, adjustable memory stop, suitable for 250 psig water working pressure at 230°F.
 2. Armstrong CBV, Griswold SpeedSet, Nexus Ultra MB, Tour & Anderson STAS/STAD, Victaulic series 786/787, Oventrop VTR.
 3. Victaulic Koil-Kits Series 799, 79V, 79A, and 79B may be used at coil connections. The kit shall include a Series 786/787/78K circuit balancing valve, Series 78Y Strainer-Ball or Series 78T Union-Ball valve combination, Series 78U Union-Port fitting, and required coil hoses. A Style 793 and/or 794 differential pressure controller shall be provided as required. A meter shall be provided by the valve manufacturer that shall remain with the building owner after balancing/commissioning.
 4. Include one bellows type differential pressure meter kit that includes a six inch diameter gauge with 270° arc readout and having an accuracy of ±1% of full scale or better and suitable for the differential pressures of the valves supplied for this project, over-range protection, color coded hoses not less than ten feet in length with brass connectors suitable for connection to the low and high pressure connections on the balance valves, instrument valving so meter can be vented and drained, pressure and temperature rating at least equal to that of the valves. Provide meter and all accessories in a durable case with carrying handle.
 5. Barton 247A, Midwest 809.
 6. 2-1/2" and larger: Use butterfly valves as specified in this section along with a flow sensing device as specified in Section 23 05 15.
- D. Drain Valves: Use 3/4 inch ball valve with threaded hose adapter except strainer blowdown valves to be the same size as the blowdown connection.

PART 3 - EXECUTION

3.01 GENERAL

- A. Properly align piping before installation of valves in an upright position; operators installed below the valves will not be accepted.
- B. Install valves in strict accordance with valve manufacturer's installation recommendations. Do not support weight of piping system on valve ends.
- C. Install all temperature control valves.
- D. Install all valves with the stem in the upright position. Valves may be installed with the stem in the horizontal position only where space limitations do not allow installation in an upright position or where large valves are provided with chain wheel operators. Where valves 2-1/2" and larger are located more than 12'-0" above mechanical room floors, install valve with stem in the horizontal position and provide a chain wheel operator. Valves installed with the stems down, will not be accepted.
- E. Install stem extensions when shipped loose from valve.
- F. Prior to flushing of piping systems, place all valves in the full-open position.

3.02 SHUT-OFF VALVES

- A. Install shut-off valves at all equipment, at each branch take-off from mains, and at each automatic valve for isolation or repair.
- B. Water System: Butterfly valves installed at the location of a flow sensing device are to have a memory stop.

3.03 BALANCING VALVES

- A. Provide balancing valves for all major equipment and at each major branch takeoff and at the discharge of each pump as indicated on drawings and details.

3.04 DRAIN VALVES

- A. Provide drain valves for complete drainage of all systems. Locations of drain valves include low points of piping systems, equipment locations specified or detailed including reheat coils, other locations required for drainage of systems.

END OF SECTION

SECTION 23 05 29
HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Scope. This section includes specifications for supports of all HVAC equipment and materials as well as piping system anchors. Included are the following topics:
- B. PART 1 - GENERAL
 - 1. Scope
 - 2. Related Work
 - 3. Reference
 - 4. Reference Standards
 - 5. Quality Assurance
 - 6. Description
 - 7. Submittals
 - 8. Design Criteria
- C. PART 2 - Products
 - 1. Pipe Hanger and Support Manufacturers
 - 2. Structural Supports
 - 3. Pipe Hangers and Supports
 - 4. Concrete Inserts
 - 5. Anchors
 - 6. Equipment Curbs
- D. PART 3 - EXECUTION
 - 1. Installation
 - 2. Hanger and Support Spacing
 - 3. Anchors
 - 4. Equipment Curbs

1.02 RELATED WORK

- A. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment
- B. Section 23 07 00 - HVAC Insulation

1.03 REFERENCE

- A. Applicable provisions of Division 1 govern work under this section.

1.04 REFERENCE STANDARDS

- A. MSS SP-58 Pipe Hangers and Supports - Materials, Design and Manufacture.
- B. MSS SP-59 Pipe Hangers and Supports - Selection and Application.

1.05 QUALITY ASSURANCE

- A. Refer to Division 1, General Conditions, Equals and Substitutions.

1.06 DESCRIPTION

- A. Provide all supporting devices as required for the installation of mechanical equipment and materials. All supports and installation procedures are to conform to the latest requirements of the ANSI Code for pressure piping.
- B. Do not hang any mechanical item directly from a metal deck or run piping so it rests on the bottom chord of any truss or joist.
- C. Support apparatus and material under all conditions of operation, variations in installed and operating weight of equipment and piping, to prevent excess stress, and allow for proper expansion and contraction.
- D. Protect insulation at all hanger points; see Related Work above.

1.07 SUBMITTALS

- A. Refer to Division 1, General Conditions, Submittals.
- B. Schedule of all hanger and support devices indicating shields, attachment methods, and type of device for each pipe size and type of service. Reference section 23 05 00.

1.08 DESIGN CRITERIA

- A. Materials and application of pipe hangers and supports shall be in accordance with MSS Standard Practice SP-58 and SP-69 unless noted otherwise.
- B. Piping connected to base mounted pumps, compressors, or other rotating or reciprocating equipment is to have vibration isolation supports for a distance of one hundred pipe diameters or three supports away from the equipment, whichever is greater. Standard pipe hangers/supports as specified in this section are required beyond the 100 pipe diameter/3 support distance.
- C. Piping flexible connections and vibration isolation supports are required for piping connected to coils that are in a fan assembly where the entire assembly is mounted on vibration supports; the vibration isolation supports are required for a distance of one hundred pipe diameters or three supports away from the equipment, whichever is greater. Piping flexible connection and vibration isolation supports are not required when the fan section is separately and independently isolated by means of vibration supports and duct flexible connections. Standard pipe hangers/supports as specified in this section are required when there are no vibration isolation devices in the piping and beyond the 100 pipe diameter/3 support distance.
- D. Piping supported by lying on the bottom chord of joists or trusses will not be accepted.
- E. Fasteners depending on soft lead for holding power or requiring powder actuation will not be accepted.
- F. Allow sufficient space between adjacent pipes and ducts for insulation, valve operation, routine maintenance, etc.

PART 2 - PRODUCTS

2.01 PIPE HANGER AND SUPPORT MANUFACTURERS

- A. Anvil, B-Line, Fee and Mason, Kindorf, Michigan Hanger, Unistrut, or approved equal. Anvil figure numbers are listed below; equivalent material by other manufacturers is acceptable.

2.02 STRUCTURAL SUPPORTS

- A. Provide all supporting steel required for the installation of mechanical equipment and materials, whether or not it is specifically indicated or sized, including angles, channels, beams, etc. to suspend or floor support tanks and equipment.

2.03 PIPE HANGERS AND SUPPORTS

- A. Hangers for Steel Pipe Sizes 1/2" through 2": Carbon steel, adjustable, clevis, black finish. Anvil figure 65 or 260.
- B. Steel Hanger Rods:
 - 1. Threaded both ends, threaded one end, or continuous threaded, black finish.
 - 2. Size rods for individual hangers and trapeze support as indicated in the following schedule.
 - 3. Total weight of equipment, including valves, fittings, pipe, pipe content, and insulation, are not to exceed the limits indicated.

Maximum Load (Lbs.) (650°F Maximum Temp.)	Rod Diameter (inches)
610	3/8
1130	1/2

- 4. Provide rods complete with adjusting and lock nuts.

2.04 CONCRETE INSERTS

- A. Carbon steel expansion anchors, vibration resistant, with ASTM B633 zinc plating. Use drill bit of same manufacturer as anchor. Hilti, Rawl, Redhead.

2.05 ANCHORS

- A. Use welding steel shapes, plates, and bars to secure piping to the structure.

2.06 EQUIPMENT CURBS

- A. Prefabricated Metal Curb: Constructed of not less than 18 gauge galvanized steel reinforced so it is structurally capable of supporting the intended load with no penetrations through the curb flashing, inside and outside corner sections that are mitered and continuously welded, filled with 3 pound density rigid fiberglass insulation, integral deck mounting flange, nominal two inch wood nailer, galvanized steel counter flashing. Do not use built-in metal base flashings or cants. Use 18" high equipment curbs where the curb completely surrounds the perimeter of the equipment and there is no roof exposed to the weather.
- B. Wood Build Sleeper Curb: Constructed of wood blocking and anchored to the deck. The curb must be structurally capable of supporting the intended load with no penetrations through the curb flashing. Galvanized steel counter flashing. Do not use built-in metal base flashings or cants. Use 18" high equipment curbs where the curb completely surrounds the perimeter of the equipment and there is no roof exposed to the weather.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install supports to provide for free expansion of the piping and duct system. Support all piping from the structure using concrete inserts, beam clamps, ceiling plates, wall brackets, or floor stands. Fasten ceiling plates and wall brackets securely to the structure and test to demonstrate the adequacy of the fastening.
- B. Piping shall be supported independently from ductwork and all other trades.
- C. Where piping can be conveniently grouped to allow the use of trapeze type supports, use standard structural shapes for the supporting steel.
- D. Perform all welding in accordance with standards of the American Welding Society. Clean surfaces of loose scale, rust, paint or other foreign matter and properly align before welding. Use wire brush on welds after welding. Welds shall show uniform section, smoothness of weld metal and freedom from porosity and clinkers. Where necessary to achieve smooth connections, joints shall be dressed smooth.

3.02 HANGER AND SUPPORT SPACING

- A. Place a hanger within 12" of each horizontal elbow, valve, strainer, or similar piping specialty item.
- B. Where several pipes can be installed in parallel and at the same elevation, provide multiple or trapeze hangers.
- C. Support riser piping independently of connected horizontal piping.
- D. Adjust hangers to obtain the slope specified in the piping section of this specification.
- E. Space hangers for pipe as follows:

<u>Pipe Material</u>	<u>Pipe Size</u>	<u>Horizontal Max. Spacing</u>	<u>Vertical Max Spacing</u>
Steel	1/2" through 1-1/4"	6'-6"	15'-0"
Steel	1-1/2" through 6"	10'-0"	15'-0"

3.03 ANCHORS

- A. Install where indicated on the drawings and details. Where not specifically indicated, install anchors at ends of principal pipe runs and at intermediate points in pipe runs between expansion loops. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

3.04 EQUIPMENT CURBS

- A. Secure bottom of support flat on roof deck. Secure equipment to curb in accordance with equipment manufacturer's instructions. Flashing and counterflashing by the General Contractor.
- B. Fill the entire void space with compressible fiberglass insulation.

END OF SECTION

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**SECTION 23 05 93
TESTING, ADJUSTING, AND BALANCING FOR HVAC**

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Scope. This section includes air and water testing, adjusting and balancing for the entire project. Included are the following topics:
- B. PART 1 - GENERAL
 - 1. Scope
 - 2. Related Work
 - 3. Reference
 - 4. Reference Standards
 - 5. Description
 - 6. Quality Assurance (Qualifications)
 - 7. Pre-Installation Meeting and Scheduling
 - 8. Pre-Balance Conference
 - 9. Submittals
- C. PART 2 - Products
 - 1. Instrumentation
- D. PART 3 - EXECUTION
 - 1. Daily Reports
 - 2. Preliminary Procedures
 - 3. Existing Equipment
 - 4. Performing Testing, Adjusting, and Balancing
 - 5. Deficiencies

1.02 RELATED WORK

- A. Section 23 05 00 Common Work Results for HVAC
- B. Section 23 07 00 HVAC Insulation
- C. Section 23 09 14 Pneumatic and Electric Instrumentation and Control Devices for HVAC
- D. Section 23 09 23 Direct Digital Control System for HVAC
- E. Section 23 09 24 Direct Digital Control System for HVAC (Informational Purposes Only)
- F. Section 23 09 25 Direct Digital Control System for HVAC Integrated Terminal Units

1.03 REFERENCE

- A. Applicable provisions of the General Conditions, Supplementary General Conditions and General Requirements in Division 1 govern work under this section.

1.04 REFERENCE STANDARDS

- A. AABC National Standards for Total System Balance, Sixth Edition, 2002.
- B. ASHRAE ASHRAE Handbook, 2007 HVAC Applications, Chapter 37, Testing Adjusting and Balancing.

- C. NEBB Procedural Standards for Testing Adjusting Balancing of Environmental Systems, Seventh Edition, 2005.
- D. TABB Tab Procedural Guide, First Edition, 2003.

1.05 DESCRIPTION

- A. The Contractor will separately contract with an independent test and balance agency to perform all testing, adjusting, and balancing of air and hydronic systems required for this project. Work related to the testing, adjusting, and balancing that must be performed by the installing mechanical contractor is specified in other section of these specifications.
- B. Provide total mechanical systems testing, adjusting and balancing. Requirements include the balance of air and water distribution, adjustment of new and existing systems and equipment to provide design requirements indicated on the drawings, electrical measurement and verification of performance of all mechanical equipment, all in accordance with standards published by AABC, NEBB, or TABB.
- C. Test, adjust and balance all air and hydronic systems so that each room, piece of equipment or terminal device meets the design requirements indicated on the drawings and in the specifications.
- D. Accomplish testing, adjusting and balancing work in a timely manner that allows partial occupancy of major buildings, occupancy of one building when the project involves many buildings, and completion of the entire project in the time stated in the Instruction to Bidders and in accordance with the completion schedule established for this project.
- E. Verify that provisions are being made to accomplish the specified testing, adjusting and balancing work. If problems are found, handle as specified in Part 3 under Deficiencies.

1.06 QUALITY ASSURANCE (QUALIFICATIONS)

- A. An independent Firm specializing in the Testing and Balancing of HVAC systems for a minimum of 5 years. A Firm not engaged in the commerce of furnishing or providing equipment or material generally related to HVAC work other than that specifically related to installing Testing and Balancing components necessary for work in this section such as, but not limited to sheaves, pulleys, and balancing dampers.
- B. A certified member of AABC or certified by NEBB or TABB in the specific area of work performed. Maintain certification for the entire duration of the project.
- C. Technicians on this project must have satisfactorily completed work on a minimum of (5) five projects of at least 50% in size, and of similar complexity. Size is defined as the quantity of each specific individual item requiring testing and balancing such as, but not limited to, equipment, devices, terminal devices, and grilles/diffusers.
- D. Submit Qualifications of firm and project staff to A/E upon request.

1.07 PRE-INSTALLATION MEETING AND SCHEDULING

- A. The test and balance agency is required to attend a pre-installation meeting with all other project contractors before the construction process is started. The test and balance agency shall give the Lead Contractor a detailed schedule of testing and balancing tasks for incorporation into the project schedule.

1.08 PRE-BALANCE CONFERENCE

- A. 90 days prior to beginning testing, adjusting and balancing, schedule and conduct a conference with the Architect/Engineer, Owner's Project Representative and the mechanical system and temperature control system installing Contractors. Provide A/E with a complete copy of the TAB plan for the project. The objective is final coordination and verification of system operation and readiness for testing, adjusting and balancing procedures and scheduling procedures with the above-mentioned parties. Indicate work required to be completed prior to testing, adjusting, and balancing and identify the party responsible for completion of that work.

1.09 SUBMITTALS

- A. See also Related Work in this section.
- B. Submit testing, adjusting and balancing reports bearing the seal and signature of the NEBB, AABC, or TABB Certified Test and Balance Supervisor. The reports certify that the systems have been tested, adjusted and balanced in accordance with the referenced standards; are an accurate representation of how the systems have been installed and are operating; and are an accurate record of all final quantities measured to establish normal operating values of the systems.
 1. Submission:
 - a. Distribute electronic copies of the Report to the Mechanical Contractor and the Prime A/E.
 - b. Provide three (3) hard copies of Final Report to be included in O&M Manuals.
 2. Format: Cover page identifying project name, project number and descriptive title of contents. Divide the contents of the report into the below listed divisions:
 - General Information
 - Summary
 - Air Systems
 - Hydronic Systems
 3. Contents: Provide the following minimum information, forms and data:
 - a. General Information: Inside cover sheet identifying Test and Balance Agency, Contractor, Architect, Engineer, Project Name and Project Number. Include addresses, contact names and telephone numbers. Also include a certification sheet containing the seal and signature of the Test and Balance Supervisor.
 - b. Summary: Provide summary sheet describing mechanical system deficiencies. Describe objectionable noise or drafts found during testing, adjusting and balancing. Provide recommendations for correcting unsatisfactory performances and indicate whether modifications required are within the scope of the contract, are design related or installation related. List instrumentation used during testing, adjusting and balancing procedures.
 - c. The remainder of the report to contain the appropriate standard NEBB, AABC, or TABB forms for each respective item and system. Fill out forms completely. Where information cannot be obtained or is not applicable indicate same.

Clark County Courthouse, Branch 1 & 2 Courtroom Remodel
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PART 2 - PRODUCTS

2.01 INSTRUMENTTION

- A. Provide all required instrumentation to obtain proper measurements. Application of instruments and accuracy of instruments and measurements to be in accordance with the requirements of NEBB, AABC, or TABB Standards and instrument manufacturer's specifications.
- B. All instruments used for measurements shall be accurate, and calibration histories for each instrument to be available for examination by A/E upon request. Calibration and maintenance of all instruments to be in accordance with the requirements of NEBB, AABC, or TABB Standards.

PART 3 - EXECUTION

3.01 DAILY REPORTS

- A. Submit to Owner's Project Representative daily work activity reports for each day on which testing and balancing work is performed. Reports shall include description of day's activities and description of any system deficiencies.

3.02 PRELIMINARY PROCEDURES

- A. Review preconstruction meeting report, applicable construction bulletins, applicable change orders and approved shop drawings of equipment, outlets/inlets and temperature controls.
- B. Check filters for cleanliness, dampers and valves for correct positioning, equipment for proper rotation and belt tension, temperature controls for completion of installation and hydronic systems for proper charge and purging of air.
- C. Notify Owner's Project Representative on a daily basis during balancing. Identify deficiencies preventing completion of testing, adjusting and balancing procedures. Do not proceed until systems are fully operational with all components necessary for complete testing, adjusting and balancing. Installing Contractors are required to provide personnel to check and verify system completion, readiness for balancing and assist Balancing Agency in providing specified system performance.

3.03 EXISTING EQUIPMENT

- A. Circulating pump package called out for new system flow values under phase 1 and phase 2 work.

3.04 PERFORMING TESTING, ADJUSTING, AND BALANCING

- A. Perform testing, adjusting and balancing procedures on each system identified, in accordance with the detailed procedures outlined in the referenced standards except as may be modified below.
- B. Unless specifically instructed in writing, all work in this specification section is to be performed during the normal workday.

- C. In areas containing ceilings, remove ceiling tile to accomplish balancing work; replace tile when work is complete and provide new tile for any tile that are damaged by this procedure. If the ceiling construction is such that access panels are required for the work of this section and the panels have not been provided, inform the owner's project representative.
- D. Cut insulation, ductwork and piping for installation of test probes to the minimum extent necessary for adequate performance of procedures. Patch using materials identical to those removed, maintaining vapor barrier integrity and pressure rating of systems.
- E. In air systems employing filters, blank off sufficient filter area to simulate a pressure drop that is midway between that of a clean filter and that of a dirty filter.
- F. Measure and record system measurements at the fan and/or pump to determine total flow. Adjust equipment as required to yield specified total flow at terminals. Proceed taking measurements in mains and branches as required for final terminal balancing. Perform terminal balancing to specified flows balancing branch dampers, deflectors, extractors and valves prior to adjustment of terminals.
- G. Measure and record static air pressure conditions across fans, coils and filters. Indicate in report if cooling coil measurements were made on a wet or dry coil and if filter measurements were made on a clean or dirty filter. Spot check static air pressure conditions directly ahead of terminal units.
- H. Adjust outside air, return air and relief air dampers for design conditions at both the minimum and maximum settings and record both sets of data. Balance modulating dampers at extreme conditions and record both sets of data. Balance variable air volume systems at maximum air flow rate, full cooling, and minimum flow rate, full heating; record all data.
- I. Adjust register, grille and diffuser vanes and accessories to achieve proper air distribution patterns and uniform space temperatures free from objectionable noise and drafts within the capabilities of the installed system.
- J. Provide fan and motor drive sheave adjustments necessary to obtain design performance. Provide drive changes specifically noted on drawings, if any. If work of this section indicates that any drive or motor is inadequate for the application, advise the owner's project representative by giving the representative properly sized motor/drive information (in accordance with manufacturers original service factor and installed motor horsepower requirements); Confirm any change will keep the duct/piping system within its design limitations with respect to speed of the device and pressure classification of the distribution system. Required motor/drive changes not specifically noted on drawings or in specifications will be considered an extra cost and will require an itemized cost breakdown submitted to owner's project representative. Prior authorization is needed before this work is started.
- K. Areas or rooms designed to maintain positive, negative or balanced air pressures with respect to adjacent spaces, as indicated by the design air quantities, require special attention. Adjust fan drives, distribution dampers, terminals and controls to maintain indicated pressure relationship.
- L. Final air system measurements to be within the following range of specified cfm:

Fans	0% to +10%
Supply grilles, registers, diffusers	0% to +10%
Return/exhaust grilles, registers	0% to -10%
Room pressurization air	-5% to +5%

- M. Final water system measurements must be within the following range of specified gpm:
- | | |
|--------------------|------------|
| Heating flow rates | 0% to +10% |
| Cooling flow rates | -5% to +5% |
- N. Contact the Temperature Control Contractor for assistance in operation and adjustment of controls during testing, adjusting and balancing procedures. Cycle controls and verify proper operation and setpoints. Include in report description of temperature control operation and any deficiencies found.
- O. Permanently mark equipment settings, including damper and valve positions, control settings, and similar devices allowing settings to be restored. Set and lock memory stops.
- P. Leave systems in proper working order, replacing belt guards, closing access doors and electrical boxes, and restoring temperature controls to normal operating settings.
- Q. Verify and record, in the T&B Report, "K" factors for all VAV air terminal devices and air flow stations.
- R. Verify and record, in the T&B Report, values of damper positions and fan speeds for all characterization curves required in the 23 09 93 control sequences.
- S. Coordinate air handling unit minimum outside air set points with the Temperature Control Contractor.
- T. Hydronic Systems
1. For HVAC pumps 10 horsepower or less, valve throttling alone may be used for hydronic system balancing.

3.05 DEFICIENCIES

- A. Division 23 00 00 contractor to correct any installation deficiencies found by the test and balance agency that were specified and/or shown on the Contract Documents to be performed as part of that division of work. Test and balance agency will notify the Owner's Project Representative of these items and instructions will be issued to the Division 23 00 00 contractor for correction of the deficient work. All corrective work to be done at no cost to the Owner. Retest mechanical systems, equipment, and devices once corrective work is complete as specified.

END OF SECTION

**SECTION 23 07 00
HVAC INSULATION**

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Scope. This section includes insulation specifications for heating, ventilating and air conditioning piping, ductwork and equipment. Included are the following topics:
- B. PART 1 - GENERAL
 - 1. Scope
 - 2. Related Work
 - 3. Reference
 - 4. Reference Standards
 - 5. Quality Assurance
 - 6. Description
 - 7. Definitions
 - 8. Submittals
 - 9. Operation and Maintenance Data
 - 10. Environmental Requirements
- C. PART 2 - Products
 - 1. Materials
 - 2. Insulation Types
 - 3. Adhesives, Mastics, Sealants, and Reinforcing Materials
 - 4. Jackets
 - 5. Insulation Inserts and Pipe Shields
 - 6. Accessories
- D. PART 3 - EXECUTION
 - 1. Examination
 - 2. Installation
 - 3. Protective Jacket Installation
 - 4. Piping, Valve and Fitting Insulation
 - 5. Piping Protective Jackets
 - 6. Pipe Insulation Schedule
 - 7. Duct Insulation
 - 8. Ductwork Protective Coverings
 - 9. Duct Insulation Schedule

1.02 RELATED WORK

- A. Section 23 05 00 - Common Work Results for HVAC
- B. Section 23 11 00 - Facility Fuel Piping
- C. Section 23 21 13 - Hydronic Piping
- D. Section 23 22 13 - Steam and Condensate Heating Piping
- E. Section 23 24 00 - Internal-Combustion Engine Piping
- F. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment
- G. Section 23 31 00 - HVAC Ducts and Casings

1.03 REFERENCE

- A. Applicable provisions of Division 1 govern work under this section.

1.04 REFERENCE STANDARDS

ASTM B209	Aluminum and Aluminum Alloy Sheet and Plate
ASTM C165	Test Method for Compressive Properties of Thermal Insulations
ASTM C177	Heat Flux and Thermal Transmission Properties
ASTM C195	Mineral Fiber Thermal Insulation Cement
ASTM C240	Cellular Glass Insulation Block
ASTM C302	Density of Preformed Pipe Insulation
ASTM C303	Density of Preformed Block Insulation
ASTM C355	Test Methods for Test for Water Vapor Transmission of Thick Materials
ASTM C449	Mineral Fiber Hydraulic Setting Thermal Insulation Cement
ASTM C518	Heat Flux and Thermal Transmission Properties
ASTM C533	Calcium Silicate Block and Pipe Thermal Insulation
ASTM C534	Preformed Flexible Elastomeric Thermal Insulation
ASTM C547	Mineral Fiber Preformed Pipe Insulation
ASTM C552	Cellular Glass Block and Pipe Thermal Insulation
ASTM C553	Mineral Fiber Blanket and Felt Insulation
ASTM C578	Preformed, Block Type Cellular Polystyrene Thermal Insulation
ASTM C591	Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
ASTM C610	Expanded Perlite Block and Thermal Pipe Insulation
ASTM C612	Mineral Fiber Block and Board Thermal Insulation
ASTM C921	Properties of Jacketing Materials for Thermal Insulation
ASTM C1136	Flexible Low Permeance Vapor Retarders for Thermal Insulation
ASTM D412	Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension
ASTM D1000	Methods for Pressure-Sensitive Adhesive-Coated Tapes Used for Electrical and Electronic Applications
ASTM D1621	Standard Test Method for Compressive Properties Of Rigid Cellular Plastics
ASTM D1622	Standard Test Method for Apparent Density of Rigid Cellular Plastics
ASTM D1940	Method of Test for Porosity of Rigid Cellular Plastics
ASTM D2126	Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging
ASTM D2240	Standard Test Method for Rubber Property—Durometer Hardness
ASTM E84	Surface Burning Characteristics of Building Materials
ASTM E814	Standard Test Method for Fire Tests of Penetration Firestop Systems
ASTM E2336	Standard Test Methods for Fire Resistive Grease Duct Enclosure Systems
MICA	National Commercial & Industrial Insulation Standards
NFPA 225	Surface Burning Characteristics of Building Materials
UL 723	Surface Burning Characteristics of Building Materials

1.05 QUALITY ASSURANCE

- A. Refer to Division 1, General Conditions, Equals and Substitutions.
- B. Label all insulating products delivered to the construction site with the manufacturer's name and description of materials.
- C. Insulation systems shall be applied by experienced contractors. Within the past five (5) years, the contractor shall be able to document the successful completion of a minimum of five (5) projects of at least 50% of the size and similar scope of the work specified in this section.

1.06 DESCRIPTION

- A. Furnish and install all insulating materials and accessories as specified or as required for a complete installation. The following types of insulation are specified in this section:
 - Pipe Insulation
 - Duct Insulation
- B. Install all insulation in accordance with the latest edition of MICA (Midwest Insulation Contractors Association) Standard and manufacturer's installation instructions. Exceptions to these standards will only be accepted where specifically modified in these specifications.

1.07 DEFINITIONS

- A. Concealed: shafts, furred spaces, space above finished ceilings, utility tunnels and crawl spaces. All other areas, including walk-through tunnels, shall be considered as exposed.

1.08 SUBMITTALS

- A. Refer to Division 1, General Conditions, Submittals.
- B. Submit a schedule of all insulating materials to be used on the project, including adhesives, fastening methods, fitting materials along with material safety data sheets and intended use of each material. Include manufacturer's technical data sheets indicating density, thermal characteristics, jacket type, and manufacturer's installation instructions.

1.09 OPERATION AND MAINTENANCE DATA

- A. All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

1.10 ENVIRONMENTAL REQUIREMENTS

- A. Do not store insulation materials on grade or where they are at risk of becoming wet. Do not install insulation products that have been exposed to water.
- B. Protect installed insulation work with plastic sheeting to prevent water damage.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Manufacturers: Armacell, CertainTeed, Manson, Childers, Dow, Extol, Fibrex, Halstead, Foster, Imcoa, ITW, Johns Manville, Knauf Insulation, Owens-Corning, Pittsburgh Corning, VentureTape or approved equal.
- B. Materials or accessories containing asbestos will not be accepted.

- C. Use composite insulation systems (insulation, jackets, sealants, mastics, and adhesives) that have a flame spread rating of 25 or less and smoke developed rating of 50 or less, with the following exception:
 - 1. Pipe insulation which is not located in an air plenum may have a flame spread rating not over 25 and a smoke developed rating no higher than 450 when tested in accordance with UL 723 and ASTM E84.

2.02 INSULATION TYPES

- A. Insulating materials shall be fire retardant, moisture and mildew resistant, and vermin proof. Insulation shall be suitable to receive jackets, adhesives and coatings as indicated.
- B. Flexible Fiberglass Insulation: Minimum nominal density of 0.75 lbs. per cu. ft., and thermal conductivity of not more than 0.3 at 75 degrees F, rated for service to 250 degrees F.
- C. Rigid Fiberglass Insulation: Minimum nominal density of 3 lbs. per cu. ft., and thermal conductivity of not more than 0.23 at 75°F mean temperature, 0.25 at 125°F, 0.27 at 150°F, 0.29 at 200°F, 0.32 at 250°F, minimum compressive strength of 25 PSF at 10% deformation, rated for maximum service temperature of 450°F.
- D. Elastomeric Insulation: Flexible closed cell, minimum nominal density of 5.5 lbs. per cu. ft., thermal conductivity of not more than 0.27 at 75°F, minimum compressive strength of 4.5 psi at 25% deformation, maximum water vapor permeability of 0.17 perm inch, maximum water absorption of 6% by weight, rated for service range of -20°F to 220°F on piping and 180°F where adhered to equipment.

2.03 ADHESIVES, MASTICS, SEALANTS, AND REINFORCING MATERIALS

- A. Products shall be compatible with surfaces and materials on which they are applied and shall be suitable for use at operating temperatures of systems to which they are applied.
- B. Fiberglass Insulation Adhesive: Must comply with ASTM C916, Type II: Foster 85-60, Childers CP-127, Duro Dyne SSG.
- C. Vapor Retarding Mastic: For below ambient equipment/piping use a water-based mastic with a water vapor permeance of less than 0.04 perms at 40 mils dry film thickness per ASTM E 96: Childers CP-34, Foster 30-65 Vapor-Fas, Knauf Insulation, KI-900 or KI-905, Vimasco 749.
- D. For below ambient equipment/piping use water-based, anti-fungal mastic that meets ASTM D 5590 with a 0 growth rating (AF) and a water vapor permeance that is less than 0.013 perms at 43 mils dry film thickness per ASTM E 96 Procedure B: Foster 30-80AF Vapor Safe Mastic or equal.
- E. Lagging Adhesive/Coatings: For all indoors applications used in conjunction with canvas/glass cloth: Foster 30-36, Childers CP-50A MV1, Vimasco 713.
- F. Reinforcing Mesh: Use Foster 42-24 Mast A Fab, Childers Chil Glas #10 or Pittsburgh Corning PC 79.

G. Insulation Joint Sealant: Joint sealants to be non-shrinking and permanently flexible.

- Used on all below ambient piping to prevent moisture ingress.
- For Cellular Glass, Polyisocyanurate, Phenolic use Foster 95-44 Elastolar, Childers CP-76 Chil-Byl, Pittsburgh Corning CW Sealant.
- For Polystyrene use Foster 30-45N, Childers CP-70. For Elastomeric use Armaflex 520 or equal.

2.04 JACKETS

A. PVC Fitting Covers and Jackets (PFJ): White PVC film, gloss finish one side, semi-gloss other side, FS LP-535D, Composition A, Type II, Grade GU. Ultraviolet inhibited indoor/outdoor grade to be used where exposed to high humidity, ultraviolet radiation, in kitchens or food processing areas or installed outdoors. Jacket thickness to be minimum 30 mil unless otherwise noted.

B. All Service Jackets (ASJ Max): Heavy duty, poly-encapsulated, fire retardant material with white kraft reinforced foil vapor barrier, factory applied to insulation with a self-sealing pressure sensitive adhesive lap, maximum permeance of .02 perms and minimum beach puncture resistance of 50 units.

C. Foil Scrim All Service Jackets (FSJ): Glass fiber reinforced foil kraft laminate, factory applied to insulation. Maximum permeance of .02 perms and minimum beach puncture resistance of 25 units.

D. Vapor Retarding Jackets (VRJ).

1. Polyvinylidene chloride (PVDC) vapor retarding jacket material with minimum 6 mils material thickness and maximum permeance of 0.01 perms. Material shall not support the growth of mold or mildew. Dow Saran or equivalent.
2. Vapor retarding tape shall be specifically designed and manufactured for use with the vapor retarding jacket specified above. Tape shall be provided by the same manufacturer that provides jacketing. Vapor retarding tapes used with vapor retarding jackets shall have a maximum permeance of 0.01 perms.

2.05 INSULATION INSERTS AND PIPE SHIELDS

A. Manufacturers: B-Line, Pipe Shields, Value Engineered Products.

B. Construct inserts with calcium silicate or polyisocyanurate (service temperatures below 300°F only), minimum 140 psi compressive strength. Piping 12" and larger, supplement with high density 600 psi structural calcium silicate insert. Provide galvanized steel shield. Insert and shield to be minimum 180 degree coverage on bottom supported piping and full 360 degree coverage on clamped piping. On roller mounted piping and piping designed to slide on support, provide additional load distribution steel plate.

C. Where contractor proposes shop/site fabricated inserts and shields, submit schedule of materials, thicknesses, gauges and lengths for each pipe size to demonstrate equivalency to preengineered/premanufactured product described above. On low temperature systems, high density rigid polyisocyanurate may be substituted for calcium silicate provided insert and shield length and shield gauge are increased to compensate for lower insulation compressive strength.

- D. Precompressed 20# density molded fiberglass blocks, Hamfab or equal, of the same thickness as adjacent insulation may be substituted for calcium silicate inserts with one 1"x6" block for piping through 2-1/2" and three 1"x6" blocks for piping through 4". Submit shield schedule to demonstrate equivalency to preengineered/premanufactured product described above.
- E. Wood blocks will not be accepted.

2.06 ACCESSORIES

- A. All products shall be compatible with surfaces and materials on which they are applied, and be suitable for use at operating temperatures of the systems to which they are applied.
- B. Adhesives, sealants, and protective finishes shall be as recommended by insulation manufacturer for applications specified.
- C. Insulation bands to be 3/4" wide, constructed of aluminum or stainless steel. Minimum thickness to be .015" for aluminum and .010" for stainless steel.
- D. Tack fasteners to be stainless steel ring grooved shank tacks.
- E. Staples to be clinch style.
- F. Insulating cement to be ANSI/ASTM C195, hydraulic setting mineral wool.
- G. Finishing cement to be ASTM C449.
- H. Fibrous glass or canvas fabric reinforcing shall have a minimum untreated weight of 6 oz./sq. yd.
- I. Fungicidal water base duct liner coating (Foster 40-20 or equal) to be compatible with vapor retarding coating. This product must be EPA registered to be used inside HVAC ducts. Coating must comply with ASTM D 5590 with 0 growth rating.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that all piping, equipment, and ductwork are tested and approved prior to installing insulation. Do not insulate systems until testing and inspection procedures are completed.
- B. Verify that all surfaces are clean, dry and without foreign material before applying insulation materials.

3.02 INSTALLATION

- A. All materials shall be installed by skilled labor regularly engaged in this type of work. All materials shall be installed in strict accordance with manufacturer's recommendations, building codes, and industry standards. Do not install products when the ambient temperature or conditions are not consistent with the manufacturer's recommendations. Surfaces to be insulated must be clean and dry.
- B. Locate insulation and cover seams in the least visible location. All surface finishes shall be extended in such a manner as to protect all raw edges, ends and surfaces of insulation.

- C. Install insulation with smooth and even surfaces. Poorly fitted joints or use of filler in voids will not be accepted. Provide neatly beveled and coated terminations at all nameplates, uninsulated fittings, or at other locations where insulation terminates.
- D. Install fabric reinforcing without wrinkles. Overlap seams a minimum of 2".
- E. Use full length material (as delivered from manufacturer) wherever possible. Scrap piecing of insulation or pieces cut undersize and stretched to fit will not be accepted.
- F. All pipe and duct insulation shall be continuous through walls, ceiling or floor openings and through sleeves except where firestop or firesafing materials are required. Vapor barriers shall be maintained continuous through all penetrations.
- G. Provide a continuous unbroken moisture vapor barrier on insulation applied to systems noted below. Attachments to cold surfaces shall be insulated and vapor sealed to prevent condensation.
- H. Provide a complete vapor barrier for insulation on the following systems:
 - Chilled Water
 - Insulated Duct

3.03 PROTECTIVE JACKET INSTALLATION

- A. All Service Jackets (ASJ) and Foil Scrim Kraft Jackets (FSK): Install according to manufacturer's recommendations using factory supplied lap seals and butt strip seals. In addition to factory adhesive, secure lap seals and tape with clinch type staples
- B. Fabric Reinforced Mastic Jackets (FMJ): Glass fiber fabric shall be fitted without wrinkles. Glass fiber fabric shall be sized immediately upon application with lagging adhesive and shall be capable of drying within 6 hrs. Apply adhesive and coating in accordance with manufacturer's recommendations. All seams shall overlap not less than 2".
- C. Vapor Retarding Jackets (VRJ): Piping with vapor retarding jackets (VRJ) shall have elbows, fittings, valves and butt joints wrapped with 2 layers of vapor retarding tape. For piping without a (PFJ) jacket, wrap jacket with 1" wide vapor retarding tape at 12" centers with a 25% overlap. Piping with a PVC jacket (PFJ) installed over the vapor retarding jackets (VRJ) may be provided with a single, lapped layer of vapor retarding tape for elbows, fittings and valves under the PVC jacket. Vapor retarding tape shall be compatible with the jacket material used.

3.04 PIPING, VALVE, AND FITTING INSULATION

- A. General:
 - 1. Install insulation with butt joints and longitudinal seams closed tightly. Provide minimum 2" lap on jacket seams and 3" tape on butt joints, firmly cemented with lap adhesive unless otherwise noted. Additionally, secure with clinch style staples along seams and butt joints.
 - 2. On systems requiring a vapor retarding jacket, seal off all raw ends of insulation and butt joints with vapor retarding mastic at intervals of not more than 20 feet on piping to create a vapor dam. Also provide a vapor dam on each side of valves, unions, and tees. Coat staples, longitudinal and transverse seams with vapor retarding mastic and on systems requiring vapor retarding jacket, coat insulated elbows, fittings, and valves with vapor retarding mastic.

3. Where insulated piping is installed on hangers and supports, the insulation shall be installed continuous through the hangers and supports. High density inserts shall be provided as required to prevent the weight of the piping from crushing the insulation. Pipe shields are required at all support locations. The insulation shall not be notched or cut to accommodate the supporting channels.
 4. On low temperature systems, use premanufactured insulated pipe riser clamps such as Pipe Shields E1000 and E 2000 series.
 5. Fully insulate all reheat coil piping, fittings and valves (except for unions) up to coil connection to prevent condensation when coil is inactive during cooling season. Provide a vapor proof seal between the pipe insulation and the insulated coil casing.
- B. Insulation Inserts and Pipe Shields:
1. Provide pipe shields at all hanger and support locations. Rigid insulation inserts shall be installed between the pipe and the insulation shields. Quantity and placement of inserts shall be according to the manufacturer's installation instructions, however the inserts shall be no less than 12" in length. Inserts shall be of equal thickness to the adjacent insulation and shall be vapor sealed as required for system.
 2. Provide insulation inserts and pipe shields at all hanger and support locations. Inserts may be omitted on 3/4" and smaller copper piping provided 12" long 22 gauge pipe shields are used.
- C. Fittings and Valves: Fittings, valves, unions, flanges, couplings and specialties may be insulated with factory molded or built up insulation of the same thickness as adjoining insulation. Where the ambient temperature exceeds 150°F, cover insulation with fabric reinforcing and mastic. Where the ambient temperatures do not exceed 150°, furnish and install PVC fitting covers.
- D. Elastomeric and Polyolefin: Where practical, slip insulation on piping during pipe installation when pipe ends are open. Miter cut fittings allowing sufficient length to prevent stretching. Completely seal seams and joints for vapor tight installation. For elastomeric insulation, apply full bed of adhesive to both surfaces. For polyolefin, seal factory preglued seams with roller and field seams and joints with full bed of hot melt polyolefin glue to both surfaces. Cover elastomeric insulation on systems operating below 40°F with vapor barrier mastic.
- E. Extruded Polystyrene and Polyisocyanurate: Fittings, valves, unions, flanges, couplings and specialties shall be insulated with factory molded insulation of the same thickness as adjoining insulation. Secure insulation sections with two wraps of nylon filament tape 9"-12" on center. On single insulation layer systems and on the outer layer of double insulation layer systems, apply a 1/16" thick bead of joint sealant rated for system operating temperatures to the outer edge of all longitudinal and butt insulation joints. For piping service below 20°F, use two layers of insulation with inner and outer butt and longitudinal joints staggered and offset 90 degrees. Where two layers of insulation are used, do not use sealant on the inner layer or adhere the inner layer to the outer layer. Apply vapor stop bead of joint sealant between pipe and insulation on both sides of valves, expansion/contraction joints, flanges, thermometers/gauges, attached vent and drain lines. Insulate attached non-circulated lines, control lines, vents, etc. for a minimum distance of 6" from pipe. Cover insulation with a protective jacket as specified below. Do not penetrate protective covering or insulation with mechanical fasteners.

3.05 PIPING PROTECTIVE JACKETS

- A. In addition to the jackets specified in the pipe insulation schedule below the following protective jackets are required:
- B. Provide a protective PVC jacket (PFJ) for the following insulated piping:
 - Chilled water piping and valves in walk-thru tunnels and valve pits.
- C. Provide a protective PVC (PFJ) or Fabric Reinforced Mastic (FMJ) jacket for the following insulated piping:
 - All piping within mechanical rooms

3.06 PIPE INSULATION SCHEDULE

- A. Provide insulation on new and existing remodeled piping as detailed, as noted on plans, and as indicated in the following schedule:

Service	Insulation	Jacket	Insulation Thickness by Pipe Size				
			< 1"	1" < 2"	2" - <4"	4" < 8"	8" >
Heating Hot Water	Rigid Fiberglass	ASJ	1.5"	1.5"	2"	2"	2"
<i>Note: On 1" or smaller hot water pipe runouts to terminal unit coils the insulation thickness may be reduced to ½" on both the supply and return pipes within 4ft of the coil but not on the distribution system side of the temperature control valve.</i>							
Chilled Water	Polyiso./Polysty.	VRJ or SAJ	1.5"	1.5"	1.5"	1.5"	1.5"
Cooling Coil Condensate Drain	Rigid Fiberglass	ASJ	0.5"	0.5"	1"	1"	1"

- B. Insulation on all steam distribution systems and high pressure steam pipe over 2" shall be installed in multiple layers not exceeding 3" in thickness.
- C. The following piping and fittings are not to be insulated:
 - Hot water piping inside radiation, convector, or cabinet heater enclosures
 - Piping unions for systems not requiring a vapor barrier
- D. For systems with fluid temperatures 65°F or less, furnish and install removable elastomeric insulation covers, plugs or caps for all mechanical equipment and devices that require access by balancing contractors or service and maintenance personnel. Examples include but are not limited to: flow sensing devices, circuit setters, manual ball valve air vents, drain valves, blowdown valves, pressure/temperature test plugs, grease fittings, pump bearing caps, equipment labels, etc. Covers shall be tight fitting to ensure a complete vapor barrier.

3.07 DUCT INSULATION

A. General:

1. Secure flexible blanket duct insulation on sides and bottom of ductwork over 24" wide with weld pins. Space fasteners 18" on center or less as required to prevent sagging. Compress insulation no more than 25%.
2. Secure rigid board insulation to ductwork with weld pins. Apply insulation with joints firmly butted as close as possible to the equipment surface. Pins shall be located a maximum of 3" from each edge and spaced no greater than 12" on center.
3. Install weld pins without damage to the interior galvanized surface of the duct. Clip pins back to washer and cover penetrations with tape of same material as jacket. Firmly butt seams and joints and cover with 4" tape of same material as jacket. Seal tape with plastic applicator and secure with staples. All joints, seams, edges and penetrations to be fully vapor sealed with vapor retarding mastic.
4. Stop and point insulation around access doors and damper operators to allow operation without disturbing insulation or jacket material.
5. External supply duct insulation is not required where ductwork contains continuous 1" acoustical liner, unless otherwise indicated. Provide 4" overlap of external insulation over ends of acoustically lined sections.
6. Where insulated ductwork is supported by trapeze hangers, the insulation shall be installed continuous through the hangers. Drop the supporting channels required to facilitate the installation of the insulation. Where rigid board or flexible insulation is specified, install high density inserts to prevent the weight of the ductwork from crushing the insulation.
7. Where insulated low temperature (below 45°F) ductwork is supported by steel metal straps or wire ropes that are secured directly to the duct, the straps or ropes shall be completely covered with insulation and sealed to provide a complete vapor barrier.
8. Where insulated duct risers are supported by steel channels secured directly to the duct, extend the insulation and vapor barrier jacketing to encapsulate the support channels.

3.08 DUCTWORK PROTECTIVE COVERINGS

- A. In addition to the jackets specified in the duct insulation schedule below the following protective coverings are required:
- B. Provide a protective covering of 2 coats of indoor/outdoor vapor retarding mastic with fibrous glass or canvas fabric covering (FMJ) or self-adhering jacket (SAJ) meeting 25/50 Flame Spread/Smoke Rating for the following ductwork:
 - Insulated ductwork located in mechanical rooms, mezzanines, catwalks, or as otherwise noted on plans.
 - Insulated ductwork located within 6' of floor.

3.09 DUCT INSULATION SCHEDULE

A. Provide duct insulation on new and existing remodeled ductwork as detailed, as noted and scheduled on plans, and as indicated in the following schedule:

Service	Insulation Type	Jacket	Insulation Thickness
Outside air ducts	Rigid Fiberglass	FSK	2"
Mixed air ducts	Rigid Fiberglass	FSK	2"
Exposed supply ducts*	Rigid Fiberglass	FSK	2"
Concealed supply ducts	Flexible Fiberglass	FSK	2" (R6 min. installed)
Exhaust and Relief ducts downstream of backdraft dampers	Rigid Fiberglass	FSK	2"

* Exposed supply branch ducts located in the space they are serving do not require insulation. Exposed supply main ducts running through spaces they serve shall be insulated as exposed supply ducts scheduled above.

** Outside air ductwork between the isolation damper and the outside air intake does not require insulation where it is located in an unheated attic.

END OF SECTION

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SECTION 23 09 14
PNEUMATIC AND ELECTRIC INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Scope. This section includes control system specifications for all HVAC work as well as related control for systems found in other specification sections. Included are the following topics:
- B. PART 1 - GENERAL
 - 1. Scope
 - 2. Point List
 - 3. Related Work
 - 4. Reference
 - 5. Quality Assurance
 - 6. Reference Standards
 - 7. System Description
 - 8. Submittals
 - 9. Demolition
 - 10. Design Criteria
 - 11. Operation and Maintenance Data
 - 12. Material Delivery and Storage
- C. PART 2 - Products
 - 1. Control Dampers
 - 2. Control Valves
 - 3. Control System Instrumentation
 - 4. Thermostat Guards
 - 5. Communicating Thermostats
 - 6. Temperature Control Panels
 - 7. Temperature Sensors
 - 8. Humidity Sensors
 - 9. Carbon Dioxide (CO₂) Sensor
 - 10. Power Supplies
- D. PART 3 - EXECUTION
 - 1. Installation
 - 2. Wire and Air Piping Conduit and Tubing Installation Schedule
 - 3. Control Dampers
 - 4. Control Valves
 - 5. Control System Instrumentation
 - 6. Room Thermostats and Temperature Sensors
 - 7. Temperature Control Panels
 - 8. Owner Training

1.02 POINT LIST (Section 23 09 15)

1.03 RELATED WORK

- A. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC - Coordination
- B. Section 23 09 15 - Direct Digital Control Input/Output Point Summary Tables
- C. Section 23 09 23 - Direct Digital Control System for HVAC
- D. Section 23 09 24 - Direct Digital Control System for HVAC (Informational purposes only)
- E. Section 23 09 25 - Direct Digital Control System for Integrated Terminal Units
- F. Section 23 09 93 - Sequence of Operation
- G. Section 23 33 00 - Ductwork Accessories - for control damper installation
- H. Division 23 - HVAC - Equipment provided to be controlled or monitored
- I. Division 26 - Electrical - Installation Requirements & Equipment provided to be controlled or monitored
- J. Division 28 - Electronic Safety and Security

1.04 REFERENCE

- A. Applicable provisions of Division 1 govern work under this section.

1.05 QUALITY ASSURANCE

- A. Refer to Specification Section 23 09 24.
- B. Installing contractor must be a manufacturer's branch office or an authorized representative of a Direct Digital Control (DDC) equipment manufacturer that provides engineering and commissioning of the DDC equipment. The installing contractor shall have successfully completed all necessary training required for engineering, installation, and commissioning of equipment and systems and that such authorization has been in effect for a period of not less than five years. DDC equipment may or may not be required to be installed by this contractor as part of the project, but the intent of this quality assurance specification is to ensure that the installing contractor has the capabilities to engineer, install, and commission the field devices supplied under this section for temperature control.

1.06 REFERENCE STANDARDS

- A. ANSI B16.22 Wrought Copper and Wrought Copper Alloy Solder Joint Pressure Fittings
- B. ANSI/ASTM B32 Specification for Solder Metal
- C. ASTM B75 Seamless Copper Tube
- D. ASTM D1693 Environmental Stress-Cracking of Ethylene Plastics
- E. ASTM D 635 Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position
- F. UL 94 Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
- G. AMCA 500-D Laboratory Method of Testing Dampers for Rating

1.07 SYSTEM DESCRIPTION

- A. System is to use direct digital control with electric actuation for air handling units; direct digital control with electric actuation for room temperature, room humidity, and terminal airflow control; and electric control for other terminal units.

1.08 SUBMITTALS

Include the following information:

- A. Manufacturer's data sheets indicating model number, pressure/temperature ratings, capacity, methods and materials of construction, installation instructions, and recommended maintenance. General catalog sheets showing a series of the same device is not acceptable unless the specific model is clearly marked.
- B. Schematic flow diagrams of systems showing fans, pumps, coils, dampers, valves, and other control devices. Label each device with setting or adjustable range of control. Indicate all wiring, clearly, differentiating between factory and field installed wiring. Wiring should be shown in schematics that detail contact states, relay references, etc. Diagrammatic representations of devices alone are not acceptable.
- C. Details of construction, layout, and location of each temperature control panel within the building, including instruments location in panel and labeling. Also include on drawings location of mechanical equipment controlled (room number), horsepower and flow of motorized equipment (when this data is available on plans), locations of all remote sensors and control devices (either by room number or column lines).
- D. Schedule of control dampers indicating size, leakage rating, arrangement, pressure drop at design airflow, and number and size of operators required.
- E. Schedule of control valves indicating system in which the device is to be used, rated capacity, flow coefficient, flow required by device served, actual pressure drop at design flow, size of operator required, close-off pressure, and locations where valves are to be installed.
- F. A complete description of each control sequence for equipment that is not controlled by direct digital controls. Direct digital controlled equipment control sequences will be provided by the DDC control contractor.
- G. Prior to request for final payment, submit record documents which accurately record actual location of control components including panels, thermostats, wiring, and sensors. Incorporate changes required during installation and start-up.

1.09 DEMOLITION

- A. Where existing control devices, piping, or wiring are discontinued from use, remove and turn over to owner. If owner does not want them remove from premises. Remove any previously abandoned control devices in a similar manner.

1.10 DESIGN CRITERIA

- A. Size all control apparatus to properly supply and/or operate and control the apparatus served.
- B. Provide control devices subject to corrosive environments with corrosion protection or construct them so they are suitable for use in such an environment.
- C. Provide devices exposed to outside ambient conditions with weather protection or construct them so they are suitable for outdoor installation.

- D. Use only UL labeled products that comply with NEMA Standards. Electrical components and installation to meet all requirements of the electrical sections (Division 26) of project specifications.

1.11 OPERATION AND MAINTENANCE DATA

- A. All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.
- B. In addition to the general content specified under GENERAL REQUIREMENTS supply the following additional documentation:
 - 1. Lubrication instructions, including list/frequency of lubrication.
 - 2. List indicating types and grades of oil and/or grease, packing materials, normal and abnormal tolerances for devices, and method of equipment adjustment.
 - 3. Table noting full load power factor, service factor, NEMA design designation, insulation class and frame type for each motor provided.
 - 4. A complete set of record control drawings.

1.12 MATERIAL DELIVERY AND STORAGE

- A. Provide factory shipping cartons for each piece of equipment and control device. This contractor is responsible for storage of equipment and materials inside and protected from the weather.

PART 2 - PRODUCTS

2.01 CONTROL DAMPERS

- A. Provide control dampers shown on the plans and as required to perform the specified functions. Dampers shall be rated for velocities that will be encountered at maximum system design and rated for pressure equal or greater than the ductwork pressure class as specified in Section 23 31 00 of the ductwork where the damper is installed.
- B. Use only factory fabricated dampers with mechanically captured replaceable resilient blade seals, stainless steel jamb seals and with entire assembly suitable for the maximum temperature and air velocities encountered in the system.
- C. All dampers in stainless steel, PCD coated steel, PVC, PTFE, or fiberglass ductwork shall be constructed of stainless steel.
- D. All dampers in aluminum ductwork shall be constructed of stainless steel or aluminum.
- E. Dampers in galvanized ductwork shall be constructed of galvanized steel and/or aluminum.

- F. All dampers, unless otherwise specified, to be rated at a minimum of 180° F working temperature. Leakage testing shall be certified to be based on latest edition of AMCA Standard 500-D and all dampers, unless otherwise specified, shall have leakage ratings as follows:

Damper Class	Differential Pressure	Leakage
Class IA	1" w.g.	≤3 CFM/ft ²
Class I	4" w.g.	≤8 CFM/ft ²
Class I	8" w.g.	≤11 CFM/ft ²
Class I	12" w.g.	≤14 CFM/ft ²

- G. Leakage rate dampers for differential pressures that they will encounter at maximum system design pressures.
- H. Steel framed dampers: Nailor models 2010 & 2020; Greenheck models VCD-33 & VCD-42; Johnson Controls model V-1330; Ruskin Models CD60 & CD40; other approved equal.
- I. Aluminum frame and blade dampers: Nailor models 2010EAF & 2020EAF; Greenheck model VCD-43; Ruskin model CD50; Arrow model AFD-20; other approved equal.
- J. Dampers used as shut-off dampers in open-ended ductwork, louvers without duct connections, in exhaust fan inlets with no outlet ductwork or where indicated shall be aluminum frame with insulated aluminum blades: Nailor models 2010IB & 2020IB; Greenheck model ICD-44; Ruskin model CDTI50; Arrow model AFDTI-25; other approved equal.
- K. Dampers used for directed mixing of airstreams, i.e. outside air and return air, to be parallel blade type and sized for an air velocity of 1800 to 2000 fpm with the damper blades shall be arranged so that the air streams are directed at one another to facilitate mixing. Dampers used for throttling or modulating applications other than air stream mixing to be opposed blade type. Two position dampers may be parallel or opposed blade type.
- L. Maximum damper width is 48 inches; where required width exceeds 48 inches, use multiple damper sections. Inside frame free area shall be a minimum of 90% of total inside duct area.
- M. Multiple width damper sections shall utilize jack shaft linkages unless noted below. Sections over 144 inches wide shall be actuated from two locations on the jack shaft. Double width damper sections for two-position operation may be actuated without jack shafts if each damper section is actuated separately. Dampers that have multiple width and multiple vertical sections shall have a jackshaft for each vertically stacked set of dampers and be provided with crossover linkages between jack shafts to transfer uneven loading.
- N. Jack shafts shall be extended outside of the ductwork for external actuator mounting. Provide bearings on the point of exit for support of damper shafts to prevent wear on the shaft and the ductwork. If locating actuators out of the air stream is impossible, obtain mounting location approval from the designer unless the contract documents indicate in air stream mounting is acceptable. In no cases shall damper actuators for fume exhaust systems be located in the air stream or require entering the air stream to service an actuator.
- O. Provide weatherproof NEMA 4 enclosures (Belimo N4 option or equal, Belimo ZS-100 or ZS-150 are not acceptable) that have removable covers that have clasps or machine screws (no sheet metal screws) and that do not require removing fasteners from the ductwork to prevent actuator failure or freeze-up when mounting in locations exposed to harsh environments or outdoor locations.

- P. Size operators for smooth and positive operation of devices served, and with sufficient torque capacity to provide tight shutoff against system temperatures and pressure encountered. For electric modulating actuation, use fully proportional actuators with zero and span adjustments. For two-position electric actuation use 24 VAC for DDC controlled actuators, 120 VAC actuators may be used for hardwire interlocking. See 23 09 15 for specific type of input signal required. Actuator stroke times shall match the requirements of the DDC controllers provided under 23 09 23 and/or the specific system requirements for proper operation. All electric actuators will be provided with overload protection to prevent motor from damage when stall condition is encountered. Equip operators with spring return for applications involving fire, freeze protection, moisture protection or specified normally open/closed operation. If spring return actuators are not available for applications because of torque requirements or other application requirements, stored energy fail safe may be used if approved by the A/E.
- Q. Where control sequences require damper position indication or interlock, provide damper end switches integral to the damper actuators with form "C" contacts. Damper end switches shall have adjustable positions that can be set for proving the damper open, closed, or both depending on the specified application. End switch contact ratings shall be suitable for application. Where multiple banks of dampers are provided and not physically interlocked, end switches shall be provided for each bank of dampers and wired together to prove all dampers are in the position to be indicated. End switches shall not contain mercury.
- R. All power required for electric actuation shall be provided by this contractor if it is not able to be directly provided from the DDC controller.
- S. Provide operators with linkages and brackets for mounting on device served.

2.02 CONTROL VALVES

- A. Provide all control valves as shown on the plans/details and as required to perform functions specified. Spring ranges must be selected to prevent overlap of operation and simultaneous heating and cooling.
- B. Size operators to allow smooth and positive operation of devices served and to provide sufficient torque capacity for tight shutoff against system temperatures and pressure encountered. For electric modulating actuation, use fully proportional actuators with 0-10VDC inputs and zero and span adjustments unless specified otherwise in the chart below. If TriState with feedback is specified, valve position shall be fed back to the controller and controller shall position valve based on this feedback. For two-position electric actuation use 24 VAC for DDC controlled actuators, 120 VAC actuators may be used for hardwire interlocking. Electric actuators, for applications other than terminal units, shall be provided with a manual override capability. All electric actuators shall be provided with a visible position indicator.
- C. All power required for electric actuation shall be provided by this contractor if it is not able to be directly provided from the DDC controller.
- D. Provide operators that are full proportioning or two-position, as required for specified sequence of operation. Provide spring-return for applications involving fire, freeze protection, moisture protection or specified normally open/closed operation. Valves shall move to their fail positions on loss of electrical power to the actuator.
- E. Provide end switches integral to the valve actuator to prove the valve open, closed, or both to meet the application where specified in the plans or specifications. End switch contact ratings shall be suitable for application.

- F. Two-position shut-off valves shall be sized for a maximum pressure drop of 2 PSI at design flow and shall be a minimum of line size.
- G. Provide operators with linkages and brackets for mounting on device served.
- H. All valves unless specifically noted on the plans or indicated below shall be ball style valves.

VALVE SERVING	TYPE Globe Butterfly (BF) Ball Press. Independ. Ball (PI Ball)	Signal 0-10 VDC TriState (24VAC) 2-Position Elect.	Spring Return Required Yes/No	Fail Position Open (thru coil) Closed (bypass coil) Last Position
AHU Hot Water Coil	Ball	0-10 VDC	Yes	Open
AHU Cooling Coil	Ball	0-10 VDC	Yes	Closed

See plan details, notes, and schedules for where 2-way and 3-way valves should be used.

I. Water Systems:

1. Use equal percentage valves for two-way control valves; size for a pressure drop not less than 4 psi or more than 6 psi. Where valve sizes are less than line size, Corrected Cv should be used to correct for piping reducers/increasers. Modulating valve size should never be less than half of line size. Consult with A/E for acceptable pressure drop if available valve selections do not fall within the desired pressure range. Note: For low flows, the required minimum Cv size will result in lower pressure drop than 4 psi.
2. Globe valves 2" and smaller: Cast bronze or forged brass body, brass plug and brass or stainless steel seat, stainless steel stem, screwed ends, suitable for use on water systems at 150 psig and 240° F. Seat leakage with actuator supplied will meet ANSI class IV leakage (0.01%). For globe valves that are specified to fail in place, valves shall be open when the stem is up. Only the following globe valve body styles will be acceptable for terminal unit control: Siemens Powermite 599 VF Series (599 VE Series Zone Valves are not acceptable), Invensys VB7200 Series, Johnson Controls VG7000 Series, Belimo G200 and G300 Series, and Honeywell V5011/V5013 Series. Minimum size for globe valves shall be 0.7 Cv.
3. Globe valves 2 1/2" and larger: Iron body, brass plug and seat, stainless steel stem, spring loaded Teflon, or EPDM packing, flanged ends, suitable for use on water systems at 150 psig and 240°F.
4. Butterfly valves: Iron body, stainless steel shaft, bronze bearings, and resilient seat. Disc to be aluminum-bronze, nickel-plated ductile iron, cast iron with welded nickel edge, or stainless steel. Valve assembly to be bubble tight, suitable for use on water systems at 150 psig and 240°F. When butterfly valves are used in modulating applications, entering and leaving pipe sizes and required transition distances shall be detailed on the control valve submittals. The control contractor shall be responsible for coordinating the proper pipe sizes and transitions with the mechanical contractor to provide the correct Cv at 70° open position.

5. Characterized Ball Valves 2" and smaller: The following manufacturers are acceptable: Honeywell, Belimo, Johnson Controls, KMC Controls, Yamatake, Bray, Siemens. Forged brass or bronze body, stainless steel shaft and ball, reinforced Teflon or PTFE ball seals, double O-ring stem seals, characterized disk, maximum of ANSI Class IV (0.01%) leakage, suitable for use on water systems at 150 psig and 212°F. Minimum size for ball valves shall be 0.4 Cv.
6. Characterized Ball Valves 2-1/2" and larger: Brass or cast iron body, stainless steel shaft and ball, reinforced PTFE Ball seats, EPDM double O-ring stem seals or reinforced PTFE stem packing, characterized disk, iron flanged ends, maximum of ANSI Class IV (0.01%) leakage, suitable for use on water systems at 218 psig and 280°F.

2.03 CONTROL SYSTEM INSTRUMENTATION

- A. Manufacturers: Averaging Type - Johnson Controls, or equal; Bulb Type - Johnson Controls, Ashcroft, Marshall, Weksler.
- B. DUCT THERMOMETERS: 3" or larger dial type with swivel mount. Maximum scale graduations of 2°F. Thermometers in ducts above 6 square feet to have averaging type, liquid or gas filled capillary sensing elements a minimum of 6 feet and supported across the width of the duct. Thermometer temperature range shall not be more than twice the expected temperature range at installed location.
- C. PIPE THERMOMETERS: 9" stem type with an adjustable swivel mount. Scale graduations of 2°F and mid-range accuracy of $\pm 1^\circ\text{F}$. Install thermometers in separable brass wells filled with conductive fluid. Thermometer temperature range shall not be more than twice the expected temperature range at installed location.
- D. REMOTE BULB THERMOMETERS: 3" or larger dial type with recalibration screw on face. Accuracy within 1% of scale range. Thermometers with sensing elements in air ducts with an area of above 6 square feet to have averaging liquid or gas filled capillary sensing elements. Provide separable wells for all pipeline applications. Thermometer temperature range shall not be more than twice the expected temperature range at installed location.

2.04 THERMOSTAT GUARDS

- A. Provide clear plastic locking covers keyed the same. For locations that are subject to physical abuse, provide metal guard, Johnson Controls GRD10A-601, Shaw Perkins Series 16 or equal.

2.05 COMMUNICATING THERMOSTATS

- A. GENERAL: The following thermostat(s) may be used only where specified to be allowed in the 23 09 93 specification sequence of operation for a given terminal unit type. Where not specified in the terminal unit sequence of operation and DDC control is required, an application specific controller shall be used.
- B. STAGED HEATING/COOLING THERMOSTAT: Viconics model VT8600, Johnson Controls model TEC3000, Alerton VLD-362, or approved equal. The radiation DDC thermostat shall have a backlit touchscreen display that will display room temperature and provide for adjustable setpoints. The thermostat shall have the capability to be programmed locally with the setpoint parameters adjustable from the building automation system. The heating and cooling setpoint adjustments shall have the ability to be limited through the building automation system. The unit shall directly control the heating and cooling staged outputs, and have two configurable binary inputs for functions such as remote night setback, service or filter alarms, motion detector and window status and have an analog input for monitoring discharge temperature. The unit shall be capable of modulated economizer damper control and shall have an auxiliary binary output that can be programmed for controlling a minimum outside air damper when indexed to occupied mode. The thermostat shall use BACnet MSTP communication protocol and be integrated into the building DDC system. See DDC Input/Output Summary and sequence of operation for connected points and programming requirements.

2.06 TEMPERATURE CONTROL PANELS

- A. Constructed of steel or extruded aluminum, with hinged door, keyed lock, and baked enamel finish. Install controls, relays, transducers, and automatic switches inside panels. Label devices with permanent printed labels and provide asbuilt wiring/piping diagram within enclosure. Provide raceways for wiring and poly within panel for neat appearance. Provide termination blocks for all wiring terminations. Label outside of panel with panel number corresponding to plan tags and asbuilt control drawings as well as building system(s) served.
- B. Control panels that have devices or terminations that are fed or switch 50V or higher shall enclose the devices, terminations, and wiring so that Personal Protective Equipment (PPE) is not required to service the under 50V devices and terminations within the control panel. As an alternative, a separate panel for only the 50V and higher devices may be provided and mounted adjacent to the under 50V control panel.
- C. For panels that have 120VAC power feeds provide a resettable circuit breaker. Provide label within the panel indicating circuit number of 120VAC serving panel.
- D. Provide a service shutdown toggle switch for each air handling unit system and associated exhaust fan systems (not general exhaust fans) and energy recovery systems located inside the temperature control panel that will initiate a logical shutdown of the air handling unit system as specified under Section 23 09 15. Label the switch "Service Shutdown" and so it is clear which position is shut down and which is auto.

2.07 TEMPERATURE SENSORS

- A. Thermistor temperature sensor manufacturers: PreCon, BAPI, and ACI.
- B. Use thermistor or RTD type temperature sensing elements constructed so accuracy and life expectancy is not affected by moisture, physical vibration, or other conditions that exist in each application.

- C. RTD's shall be of nickel or platinum construction and have a base resistance of 1000Ω at 70°F and 77°F respectively. 100Ω platinum RTD's are acceptable if used with temperature transmitters.
- D. The temperature sensing device used must be compatible with the DDC controllers used on the project.

RTD	
Accuracy (Room Sensor Only)	minimum \pm 1.0°F
Accuracy (Averaging)	minimum \pm 1.2°F
Accuracy (Other than Room Sensor or Averaging)	minimum \pm 0.65°F
Range	minimum -40 - 220°F

Thermistor	
Accuracy (All)	minimum \pm 0.36°F
Range	minimum -30 - 230°F
Heat Dissipation Constant	minimum 2.7 mW/°C

Temperature Transmitter	
Accuracy	minimum \pm 0.1°F or \pm 0.2% of span
Output	4-20 mA

- E. Provide limited range or extended range sensors if required to sense the range expected for a respective point. Use RTD type sensors for extended ranges beyond -30 to 230°F. If RTD's are incompatible with DDC controller direct temperature input use temperature transmitters in conjunction with RTD's.
- F. Use wire size appropriate to limit temperature offset due to wire resistance to 1.0°F. If offset is greater than 1.0°F due to wire resistance, use temperature transmitter. If feature is available in DDC controller, compensate for wire resistance in software input definition.

2.08 HUMIDITY SENSORS

- A. Use capacitive thin-film polymer sensor types with a range of 0-100% RH. Accuracy to be no less than \pm 2% in the range of 20% RH to 80% RH with a response time of 120 seconds or less. Provide covers for room humidity sensors as specified for temperature sensors.
- B. For outside air applications, use sensor designed for outside air use along with weather enclosure. Provide sensor equal to Vaisala Model HMD60UO w/ DTR503B enclosure and weather resistant mounting hardware.
- C. For space humidity sensors, provide a humidity sensor that has both humidity and temperature sensors and display. Space humidity sensor accuracy to be a minimum of 1.7 %RH accuracy from 0-90 %RH and 2.5 %RH accuracy from 90 – 100 %RH humidity at temperatures from 50 to 104 DegF, with NIST traceable calibration certificate. Temperature sensor accuracy to be a minimum of + or - 0.54 DegF at temperatures from 50 to 86 DegF, Vaisala model HMW92D or equal. Duct humidity sensor accuracy to be a minimum of 1.5 %RH accuracy from 0-90 %RH and 2.5 %RH accuracy from 90 – 100 %RH at temperatures from 50 to 104 DegF, with NIST traceable calibration certificate. Vaisala model HMD65 or equal.

- D. Outdoor air humidity and temperature monitoring. Provide an outdoor air humidity and temperature sensor with an integrated radiation shield. Humidity sensor accuracy to be a minimum of ± 2 %RH accuracy from 0-90 %RH and ± 3 %RH accuracy from 90 – 100 %RH at temperatures from 50 to 86 DegF. Temperature sensor accuracy ± 0.36 °F. Vaisala model HMS112 or approved equal.

2.09 CARBON DIOXIDE (CO₂) SENSOR

- A. Provide a Carbon Dioxide (CO₂) sensor that shall utilize non-dispersive infrared (NDIR) technology. The sensor shall have a linear analog output over a range of 0-2000 ppm and have built in display of CO₂ level. The sensor shall have an automatic calibration algorithm that will compensate for sensor drift over time due to sensor element degradation. Unit shall be provided with a 0-10VDC or 4-20mA analog output that is selectable and a field adjustable relay alarm output. Accuracy shall be better than $\pm 5\%$ of reading or ± 50 ppm whichever is higher. The sensor shall be user calibratable with a minimum calibration interval of five years.

2.10 POWER SUPPLIES

- A. Provide all required power supplies for transducers, sensors, transmitters, and relays. All low voltage transformers shall have a resettable secondary circuit breaker and be listed as class 2 power supplies. All transformer assemblies in enclosures shall have isolated high and low voltage compartments with separate removeable covers for connections.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install system with trained mechanics and electricians employed by the control equipment manufacturer or an authorized representative of the manufacturer. Where installing contractor is an authorized representative of the control manufacturer, such authorization shall have been in effect for a period of no less than three years.
- B. Install all control equipment, accessories, wiring, and piping in a neat and workmanlike manner. All control devices must be installed in accessible locations. This contractor shall verify that all control devices furnished under this Section are functional and operating the mechanical equipment as specified in Section 23 09 93.
- C. Label all control devices except for terminal unit devices with permanent printed labels that correspond to control drawings. Labeling for each device shall be unique within each mechanical system. Temperature control junction and pull boxes shall be identified utilizing spray painted green covers. Other electrical system identification shall follow the 26 05 53 specification. For control devices mounted above accessible ceilings, label the ceiling tile grid at the ceiling tile that is to be removed for access to the control device. The label shall be pre-printed using clear polyester tape with black bold 28 size font for ceilings under 12 feet. For ceilings over 12 feet high, use bold 40 size font. For accessible ceilings, use an arrow to point at ceiling tile to be removed for access.
- D. All control devices and electrical boxes mounted on insulated ductwork shall be mounted over the insulation. Provide mounting stand-offs where necessary for adequate support. Cutting and removal of insulation to mount devices directly on ductwork is not acceptable. This contractor shall coordinate with the insulation contractor to provide for continuous insulation of ductwork.

- E. Mounting of electrical or electronic devices shall be protected from weather if the building is not completely enclosed. This Contractor shall be solely responsible for replacing any equipment that is damaged by water that infiltrates the building if equipment is installed prior to the building being enclosed.
- F. Provide all electrical relays and wiring, line, and low voltage, for control systems, devices, and components. Install all high voltage and low voltage wiring (includes low voltage cable) in metal conduit, Electrical Non-metallic Tubing (ENT), or Electrical Metallic Tubing (EMT), as scheduled below and hereafter referred to generically as conduit except above accessible ceilings as noted below. See Wire and Air Piping Conduit Installation Schedule below for specific conduit or tubing to be used. All raceways, enclosures, fittings, and associated supports shall be provided and installed according to the requirements set forth in Division 26, NFPA 90 (NEC) and Chapter SPS 316 of the Wisconsin Administrative Code. All conduits shall be routed parallel and/or perpendicular to walls and adjacent piping. Raceways shall be located to maintain headroom and working clearance around equipment and devices that require inspection and service.
- G. In general, support all raceways from the building structure. No component of a raceway system shall be secured to corrugated metal roof deck. Do not impose on the installations of other trades. Securing conduit, rods, straps, hangers, etc. to suspended ceiling components, electrical raceways, plumbing piping, fire protection sprinkler piping, HVAC piping or ductwork, or their associated support systems, will not be accepted.
- H. Conduit shall be a minimum of 1/2" for low voltage control provided the pipe fill does not exceed 40%.
- I. Minimum low voltage wiring gauge to be 18 AWG for outputs and 20 AWG for inputs. All low voltage wiring to be stranded.
- J. Low voltage wiring can be run without conduit above accessible lay-in tile ceilings. All wiring in mechanical rooms, above inaccessible hard ceilings, exterior locations, and in any exposed areas, and in all other locations shall be installed in conduit. Wire for wall sensors shall be installed in conduit concealed in the wall. Wiring for radiation valves shall be installed in conduit concealed in the wall. For retrofit installations, all wiring for sensors and valves shall be installed in conduit concealed in new walls. Sensor wiring for existing walls shall be installed without conduit and concealed in the wall (fished) where possible. If running wire concealed in the existing wall is not possible, install in surface raceway as specified or if not specified, consult with the A/E for raceway type and color to be provided.
- K. Where wiring is installed free-air, installation shall consider the following:
- Wiring shall utilize the cable tray wherever possible.
 - Wiring shall run at right angles and be kept clear of other trades work.
 - Wiring shall be supported utilizing "J" or "Bridal-type" steel mounting rings anchored to ceiling concrete, piping supports, walls above ceiling or structural steel beams. Mounting rings shall be of open design (not a closed loop) to allow additional wire to be strung without being threaded through the ring. For mounting rings that do not completely surround the wire, attach the wire to the mounting ring with a strap.

- At HVAC terminal units only, where the wiring serves a specific device; e.g., controller, actuator, transmitter, etc. associated with the unit, the j-hooks or Bridal rings required to support the wiring, may be secured to the rods or straps that support the ductwork or piping that serves the unit. Wall penetrations shall be sleeved.
 - Supports shall be spaced at a maximum 4-foot interval unless limited by building construction. If wiring "sag" at mid-span exceeds 6-inches; another support shall be used.
 - Wall penetrations shall be sleeved, and fire stopped as specified.
 - Wiring shall not be supported from existing cabling, existing tubing, plumbing or steam piping, ductwork, any component of a suspended ceiling, or electrical or communications conduit.
- L. Control panels serving equipment fed by emergency power shall also be served by emergency power. This contractor shall be responsible for all 120VAC power, not provided in the Division 26 specifications, required for equipment provided under this section. Power shown for temperature control panels on plans may be utilized by the 23 09 contractor.
- M. Provide communication trunk wiring to integrated devices (i.e. VFD's, Flow Meters, Chillers, Lighting Panels, Electrical Meters, etc.) that are specified to be connected to the building automation system. Communication trunk wiring shall be as required by the equipment specified under the 23 09 24 or 23 09 23 Sections and shall be routed to the DDC panel designated for that equipment as shown on the plans or the closest DDC panel if not designated. If communication trunks required daisy chained style wiring, provide two communication cables to the DDC panel so that the communication trunk is not dead ended.
- N. Install all terminal unit DDC controls and associated sensors furnished under Section 23 09 14, 23 09 23 or 23 09 24 that are field mounted at the terminals units (not terminal unit controls that are mounted in centralized temperature control panels). For terminal units, i.e., fin tube radiation, convectors, cabinet unit heaters, fan coils, where the DDC controller is to be installed in the terminal unit enclosure, the DDC controller shall be installed in a location within the terminal unit enclosure designed to house controls. In no cases shall DDC controllers be installed in the convective or forced air flow stream of the terminal unit.
- O. Install communicating thermostats and associated sensors furnished under this Section. All communication wiring, power supplies and wiring, programming, and commissioning of communicating thermostats shall be provided under this Section.
- P. Above accessible lay-in tile ceilings where VAV box DDC controllers are designed to be directly mounted on air terminals, the DDC controller shall be installed without an enclosure. Above accessible lay-in tile ceilings where additional controllers are required, they shall not be mounted directly to the ductwork but be mounted on din rail or back panel in an accessible location as close as possible to the terminal unit(s) being controlled. In exposed ceilings or in mechanical rooms, an equipment enclosure that completely encloses the DDC controller and allows for conduit terminations shall be provided as described below.
- Q. In mechanical rooms or other locations where the VAV terminal is not above an accessible lay-in ceiling, the enclosure will be provided under Section 23 36 00. If other terminals are associated and controlled from the same VAV terminal DDC controller and additional controllers are required for control, the Section 23 09 23 or 23 09 24 contractor shall provide the enclosure for mounting under this Section.

- R. Any devices other than DDC controllers, i.e., relays, pressure switches or sensors, etc. associated with VAV terminal unit control shall be installed in an enclosure furnished under this Section.
- S. Where occupancy sensors are to be interlocked with terminal units that serve more than one room, all occupancy sensors for the rooms served shall be wired in parallel and wired to the terminal unit DDC controller.
- T. Provide all 24VAC power transformers and wiring for DDC terminal unit controls. Provide all communication wiring to the DDC supervisory controller for the terminal units provided under 23 09 23 or 23 09 24. Provide all power and communication wiring type and installation as required by the DDC controller manufacturer for the terminal units. Tag all terminal units with printed labels to match the terminal unit room schedules. Terminate wiring for all terminal unit controllers and perform end to end point checkout of all inputs and outputs to the terminal unit controllers. Verify the communication trunk and controller addressing.
- U. Start/stop and safety relays for motor loads shall be mounted remotely at the VFD or starter being controlled. Label these relays per above tagging requirements and locate in position on the VFD or starter where the label and power indication light for the relay is visible.
- V. Install "hand/off/auto" selector switches on systems where automatic interlock controls are specified and "hand/off/auto" selector switches are not supplied with the equipment controlled. Control panel power will not be required for "hand" switch to operate. When switch is in "hand" position, allow manual operation of the selected device without operating the interlocked motors but allowing all unit safety devices to stay in the circuit.
- W. Install all shutdown switches furnished under this Section where specified or shown on the plans. Boiler kill switches shall be wired to each boiler safety circuit and an auxiliary contact shall be wired to a DDC binary input. Emergency HVAC shutdown switches shall be wired to DDC binary inputs for shutdown of all HVAC equipment serving the building.
- X. For service shutdown switches provided in temperature control panels for service shutdown of HVAC systems, label the associated VFD's or motor starters that there is a service shutdown switch and the temperature control panel designation where the switch is located.
- Y. All wiring in control panels shall be terminated on a terminal strip. Wire nuts are not acceptable. A maximum of two wires shall be terminated under any one terminal.
- Z. Utilizing a control panel as a raceway for wiring to another control panel is prohibited.
- AA. All pneumatic tubing, cabling and electrical wiring terminated at controllers, devices and terminal strips are to be permanently tagged or labeled with permanent adhesive labels within one inch of terminal strip with a numbering system to correspond exactly with the "Record Drawings". Jumpers where both ends of the wire are visible and terminations are within 6" of each other do not need to be labeled. Spare wires are to be labeled as "Spare" with unique number designations.
- BB. After completion of installation, test and adjust control equipment. Submit data showing set points and final adjustments of controls.

3.02 WIRE AND AIR PIPING CONDUIT AND TUBING INSTALLATION SCHEDULE

- A. The following conduit schedule shall apply to both polyethylene tubing and wire in conduit where conduit is specified for air tubing or wiring. Conduit and tubing referenced below shall meet specifications in Section 26 05 33 and as defined below.
 - 1. Concealed Dry Interior Locations: Rigid steel conduit. Intermediate metal conduit. Electrical metallic tubing.
 - 2. Exposed Dry Interior Locations: Rigid steel conduit. Intermediate metal conduit. Electrical metallic tubing.
 - 3. Exposed Dry Interior Locations for Control Devices with Conduit Connections: EMT or Flexible Metal Conduit (FMC). Minimum length shall be one foot (300 mm); maximum length shall be three feet (900 mm). Minimum size FMC of 3/8".
 - 4. Exposed Dry Interior Locations for Control Devices without Conduit Connections: Where HVAC equipment control panels or devices do not provide for the direct connection of conduits, exposed wiring may be extended to complete the final connections in dry locations, providing it does not exceed 18 inches in length.

3.03 CONTROL DAMPERS

- A. All control dampers furnished by the control manufacturer are to be installed by the Mechanical Contractor under the coordinating control and supervision of the Control Contractor in locations shown on plans or where required to provide specified sequence of control.
- B. Damper end switches, where required, shall be integral to the actuator that is mounted to the damper drive shaft or auxiliary shaft attached to a damper drive blade. End switches shall be adjusted to prove the damper the position opposite the fail position of the damper actuator unless the control sequence requires a different position to be proven to accomplish the specified control sequence.
- C. Coordinate installation with the sheetmetal installer to obtain smooth duct transitions where damper size is different than duct size. Blank off plates will not be accepted.
- D. Each operator shall serve a maximum damper area of 36 square feet. Where larger dampers are used, provide multiple operators.

3.04 CONTROL VALVES

- A. All temperature control valves furnished by the control manufacturer are to be installed by the Mechanical Contractor under the coordinating control and supervision of the Control Contractor in locations shown on plans or where required to provide specified sequence of control.
- B. Steam valve actuators shall be mounted between 45 and 90 degrees from upright vertical to prevent over heating of the actuator unless this orientation is specifically prohibited by the manufacturer. All other valves shall be mounted in the upright vertical position. If upright vertical mounting is not possible due to lack of space, obtain approval from the mechanical engineer of record on the project for alternate mounting that meet the manufacturers recommended installation. Radiation control valves shall not be located in the convective air flow above the heating element.

3.05 CONTROL SYSTEM INSTRUMENTATION

- A. Install thermometers at each point of temperature transmission (sensors) and control, except reheat coils, unless the drawings indicate a thermometer is to be installed by the piping or sheetmetal installer. Install thermometers to permit easy reading from the floor or operating platform. Provide remote mounting or swiveled mounting as required for easy reading. Flush mounting where not easily read is not acceptable.

3.06 ROOM THERMOSTATS AND TEMPERATURE SENSORS

- A. Check and verify location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation. Locate room thermostats and sensors 48 inches above floor. Align with light switches and humidistats. For drywall installations, thermostat mounting shall use a back-box attached to a wall stud, drywall anchors are not acceptable.
- B. Any room thermostats or sensors mounted on an exterior wall shall be mounted on a thermally insulated sub-base. Subbase to provide a minimum of one-half inch of insulation.
- C. Where thermostats or sensors are mounted on exterior walls or in any location where air transfer will affect the measured temperature or humidity seal the conduit and any other opening that will affect the measurement.
- D. Provide guards on thermostats in entrance hallways, other public areas, in locations where thermostat is subject to physical damage and where indicated on plans.
- E. For reheat coil discharge temperature sensors, mount in the duct a minimum of three feet downstream of the reheat coil.

3.07 TEMPERATURE CONTROL PANELS

- A. Mount control panels adjacent to associated equipment on vibration-free walls or freestanding angle iron supports. All control panel openings shall be plugged. Conduits and other penetrations on the top of the cabinets shall be sealed on the exterior of the cabinet with silicone caulk to resist water penetration. One cabinet may accommodate more than one system in same equipment room. Provide permanent printed labeling for instruments and controls inside cabinet and engraved plastic nameplates on cabinet face.
- B. Provide as-built control drawings of all systems served by each local panel in a location adjacent to or inside of panel cover. Provide a protective cover or envelope for drawings.

3.08 OWNER TRAINING

- A. Contractor to provide factory authorized representative and/or field personnel knowledgeable with the operations, maintenance and troubleshooting of the system and/or components defined within this section for a minimum period of 2 hours.

END OF SECTION

SECTION 23 09 24
DIRECT DIGITAL CONTROL SYSTEM FOR HVAC
(INFORMATIONAL PURPOSES ONLY)

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Scope. The work associated with this section WILL NOT be bid as part of the Division 23 scope of work. Work in this section includes Direct Digital Control (DDC) panels, main communication trunk, software programming, and other equipment and accessories necessary to constitute a completely coordinated extension of the existing building Direct Digital Control (DDC) system. This system interfaced with pneumatic/electric controls (Section 23 09 14) utilizing Direct Digital Control signals to operate actuated control devices will meet, in every respect, all operational and quality standards specified herein, a fully coordinated modification and extension via DDC of the existing Central Building Automation System.

- B. PART 1 - GENERAL
 - 1. Scope
 - 2. Related Work
 - 3. Reference
 - 4. Reference Standards
 - 5. Additional Work
 - 6. Quality Assurance
 - 7. Submittals
 - 8. Operation and Maintenance Data
 - 9. Material Delivery and Storage

- C. PART 2 - Products
 - 1. General
 - 2. Local Control Panels
 - 3. Direct Digital Controls (DDC)
 - 4. Networking/Communications
 - 5. BACnet Requirements
 - 6. Supervisory Controllers
 - 7. System Software Features
 - 8. Programmable Controllers
 - 9. Application Specific Controllers - HVAC
 - 10. Operator Interface Requirements
 - 11. Web Based HTML Browser Interface

- D. PART 3 - EXECUTION
 - 1. General
 - 2. Installation
 - 3. Owner Training

1.02 RELATED WORK

- A. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC - Coordination
- B. Section 23 09 14 - Pneumatic and Electric Instrumentation and Control Devices for HVAC
- C. Section 23 09 15 - Direct Digital Control Input/Output Point Summary Tables
- D. Section 23 09 93 - Sequence of Operation for HVAC Controls
- E. Division 23 - HVAC - Equipment provided to be controlled or monitored

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1.03 REFERENCE

- A. Applicable provisions of Division 1 govern work under this section.

1.04 REFERENCE STANDARDS

- A. FCC Part 15, Subpart J, Class A - Digital Electronic Equipment to Radio Communication Interference.

1.05 ADDITIONAL WORK

- A. Section 23 09 14 work includes furnishing and installing all field devices, including electronic sensors for the DDC of this section, equipment, and all related field wiring, interlocking control wiring between equipment, pneumatic tubing, sensor mounting, etc., that is covered in that section.
- B. Motorized control dampers and actuators, thermowells (temperature sensing wells), automatic control valves and their actuators are also covered in Section 23 09 14.

1.06 QUALITY ASSURANCE

- A. MANUFACTURER: Siemens by Complete Control, Inc.
- B. INSTALLER: A firm specializing and experienced in DDC control system installation for no less than 5 years. All engineering and commissioning work shall be done by qualified employees of this manufacturer, or qualified employees of an Authorized Representative of that manufacturer that provides engineering and commissioning of the manufacturer's control equipment. Where installing contractor is an authorized representative of the control equipment manufacturer, submit written confirmation of such authorization. Indicate in letter of authorization that the installing contractor has successfully completed all necessary training required for the engineering, installation, and commissioning of equipment and systems to be provided for the project and that such authorization has been in effect for a period of not less than three years. The letter of authorization should also indicate that the installing contractor is authorized to install the manufacturer's DDC equipment at the project location at the time the project is bid. Installation of the equipment shall be done by qualified mechanics and/or electricians in the direct employ or be directly subcontracted and under the supervision of the manufacturer or Authorized Representative. The contractor providing and installing the equipment under this specification section shall be the same contractor providing and installing equipment under the 23 09 14 specification section.
- C. RESPONSE TIME: During warranty period, four (4) hours or less, 24-hours/day, 7 days/week.
- D. ELECTRICAL STANDARDS: Provide electrical products, which have been tested, listed and labeled by Underwriters' Laboratories (UL) and comply with NEMA standards.
- E. DDC Standards: DDC manufacturer shall provide written proof with shop drawings that the equipment being provided is in compliance with F.C.C. rules governing the control of interference caused by Digital Electronic Equipment to Radio Communications (Part 15, Subpart J, Class A).

1.07 SUBMITTALS

- A. Include the following information: Details of construction, layout, and location of each temperature control panel within the building, including instrument's location in panel and labelling. Indicate which piece of mechanical equipment is associated with each controller and what area within the building is being served by that equipment. For terminal unit control, provide a room schedule that would list mechanical equipment tag, room number of space served, address of DDC controller, and any other pertinent information required for service.
- B. **PRODUCT DATA:** Submit manufacturer's specifications for each control device furnished, including installation instructions and startup instructions. General catalog sheets showing a series of the same device is not acceptable unless the specific model is clearly marked. Annotated software program documentation shall be submitted for system sequences, along with descriptive narratives of the sequence of operation of the entire system involved. Submit wiring diagram for each electrical control device along with other details required to demonstrate that the system has been coordinated and will function as a system.
- C. **MAINTENANCE DATA:** Submit maintenance data and spare parts lists for each control device. Include this data in maintenance manual.
- D. **RECORD DRAWINGS:** Prior to request for final payment provide complete composite record drawings incorporating the DDC and Pneumatic/Electric fieldwork.

1.08 OPERATION AND MAINTENANCE DATA

- A. All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

1.09 MATERIAL DELIVERY AND STORAGE

- A. Provide factory shipping cartons for each piece of equipment and control device. This contractor is responsible for storage of equipment and materials inside and protected from the weather.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Provide DDC control products in sizes and of capacities as required, conforming to manufacturer's standard materials and components as published in their product information, designed and constructed as recommended by the manufacturer and as required for application indicated.
- B. System shall be capable of operating with 120 VAC power supply, fully protected with a shutdown-restart circuit, and associated hardware and software.
- C. All DDC controllers shall use screw terminals for termination of individual wires. Spade lugs are not acceptable.

2.02 LOCAL CONTROL PANELS

- A. Use control panels with suitable mounting brackets for each supply fan system. Locate panel adjacent to system served.
- B. Fabricate panels of 14 gauge furniture grade steel or 6063-T5 extruded aluminum alloy, totally enclosed on six sides, hinged door and keyed lock, with manufacturer's standard shop painted finish and color.
- C. Provide UL listed cabinets for use with line voltage devices.
- D. Control panels that have devices or terminations that are fed or switch 50V or higher shall enclose the devices, terminations, and wiring so that Personal Protective Equipment (PPE) is not required to service the under 50V devices and terminations within the control panel. As an alternative, a separate panel for only the 50V and higher devices may be provided and mounted adjacent to the under 50V control panel. For DDC controllers that are directly fed by 120VAC, provide an externally mounted 120VAC, 5A fast blow fuse to feed these controllers.
- E. Plastic control enclosures will be approved provided all conduits are bonded and grounded.
- F. Provide control panels for all DDC Controllers, ASC's and associated function modules. All controls to be in control panels provided under this Section except for the following:
 - 1. Terminal unit controllers mounted within the terminal unit equipment enclosure as specified under Section 23 09 14.
 - 2. Above accessible lay-in tile ceilings where VAV box controllers designed to be directly mounted on air terminals.
 - 3. Above accessible lay-in tile ceilings where additional controllers are required for air terminal unit control. Where additional controllers are required, they shall not be mounted directly to the ductwork but be mounted on din rail or back panel in an accessible location as close as possible to the terminal unit(s) being controlled.
 - 4. Any devices other than DDC controllers, i.e. relays, pressure switches, etc. shall be installed in an enclosure.
- G. All wiring for controllers shall be managed in a neat and workmanlike manner.
- H. Permanently label all controls; tag all control wiring and document both on control drawings.

2.03 DIRECT DIGITAL CONTROLS (DDC)

- A. System to be capable of integrating multiple building functions, including equipment supervision and control, alarm management, energy management, and trend data collection.
- B. DDC to consist of Supervisory Controllers, Programmable Controllers, stand-alone Application Specific Controllers (ASC's), and operator interface devices.
- C. The vendor of the system provided under this Section shall provide all software and communication interface hardware necessary to program and upload/download programmable and application specific controllers from a laptop computer and make additional copies and future software revisions available for sale directly to the Owner.

- D. The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, ASC's, and operator devices.
- E. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

2.04 NETWORKING/COMMUNICATIONS

- A. The design of the DDC shall be networked. The highest level networking shall use Ethernet and the sub-level networking shall use serial communications. Inherent in the system's design shall be the ability to expand or modify the highest network either via a local area network (LAN), wide area network (WAN), or a combination of the two schemes.
- B. The highest-level DDC communications network shall be capable of direct connection to and communication with a high-speed LAN or WAN utilizing an Ethernet connection. Communication protocol used shall be BACnet/IP.
- C. The supervisory controller shall directly oversee a local network such that communications may be executed directly to and between programmable controllers and ASC's. All operator devices, either network resident or connected via dial-up modems, shall have the ability to access all points and application reports on the network.
- D. Provide serial communication ports on all ASC's for operator's terminal communications with the DDC Controller.
- E. Access to system data shall not be restricted by the hardware configuration of the DDC system.
- F. Global data sharing or global point broadcasting shall allow point data to be shared between programmable controllers and ASC's when it would be impractical to locate multiple sensors.
- G. Network design shall include the following provisions:
 - Data transfer rates for alarm reporting and quick point status from multiple programmable controllers and ASC's. The minimum baud rate shall be 9600 baud.
 - Support of any combination of programmable controllers and ASC's. A minimum of 32 programmable controllers and ASC's shall be supported on a single local network. The buss shall be addressable for up to 32 ASC's.
 - Detection of single or multiple failures of ASC's or the network media.
 - Error detection, correction, and re-transmission to guarantee data integrity.
 - Use commonly available, multiple-sourced, networking components.
 - Use of an industry standard communication transport, such as, ARCNET, Ethernet, and IEEE RS-485 communications interface.

2.05 BACNET REQUIREMENTS

- A. BACnet of highest level network communications will utilize BACnet/IP over Ethernet and field level communications shall utilize BACnet MSTP. No other communication protocol is acceptable.
- B. All controllers shall provide a Protocol Implementation Conformance Statement (PICS) and BACnet Interoperability Building Blocks (BIBB"S) as required by the American National Standards Institute/American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ANSI/ASHRAE) Standard 135-2001, BACnet protocol.
- C. In general, all devices shall support the following:
 1. Segmentation Capability
 2. Segmentation requests supported
 3. Segmentation responses supported
 4. Standard Object Types Supported
 - Analog input
 - Analog output
 - Analog value
 - Binary input
 - Binary output
 - Binary value
 - Calendar
 - Device
 - Event enrolment
 - Group
 - Multistate input
 - Multistate output
 - Multistate value
 - Notification class
 - Schedule
 5. Character Sets supported
 - ANSI X3.4
 - ISO 10646 Universal Character Set-2
 6. All highest level networked supervisory devices shall support the following:
 - a. Data Link Layer Option
 - BACnet Internet Protocol (IP) (Annex J)
 - b. Networking Options
 7. BACnet/IP Broadcast Management Device (BBDM)
- D. BACnet object name and description shall match the existing naming conventions used by the Owner for their existing Building Automation System, where applicable. Coordinate with Owner control personnel to establish the naming conventions prior to programming of any controllers provided under this specification section. All controllers shall have object names, descriptions, and engineering units that are writable at the controller level and shall be programmed so that the object names, descriptions, and engineering units match the desired naming standards as specified above. Ensure that the BACnet object attributes for object name, object description, engineering units and other required attributes will be transferred through to the Supervisory Controller when the auto-discovery function is executed.

- E. Coordinate BACnet device instance numbering with the facility personnel for controllers provided under this Section that are being connected to an existing building automation system. This contractor shall be responsible for correcting any conflicts with existing devices that may occur or changing the device instance numbers to comply to follow the agency BACnet device instance numbering scheme.

2.06 SUPERVISORY CONTROLLERS

- A. Supervisory controllers shall be microprocessor-based, multi-tasking, multi-user and digital control processors.
- B. Supervisory controllers shall be BTL Listed and shall be provided with open connectivity to any manufacturers BACnet programmable or application specific direct digital controllers.
- C. The contractor shall provide all labor to build the supervisory controller database in conjunction with and under the supervision of the Owner's control personnel. Naming conventions, database structure, and global application strategies shall be reviewed and approved by the Owner's control personnel before implementation
- D. Each supervisory controller shall have sufficient memory to support its own operating system and databases including:
- Control processes
 - Energy management application
 - Alarm management
 - Trend data
 - Maintenance support applications
 - Operator I/O
 - Dial-up communications
 - Manual override monitoring
- E. The system shall be modular in nature, and shall permit easy expansion through the addition of field controllers, sensors, and actuators.
- F. Supervisory controllers shall provide at least two RS-232C or USB serial communication ports or Ethernet ports for simultaneous operation of multiple operator I/O devices, such as laptop computers, personal computers, and video display terminals.
- G. Supervisory controllers shall monitor the status of all overrides and include this information in the logs and summaries to inform the operator that automatic control has been inhibited.
- H. Each supervisory controller shall continuously perform self-diagnostics, communications diagnostics, and diagnostics of all subsidiary equipment. Supervisory controllers 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 supervisory controller.
- I. 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 to allow all signal wiring to be run in the same conduit as high voltage wiring acceptable by electrical code.

- J. In the event of the loss of normal power, there shall be an orderly shutdown of the supervisory controller to prevent the loss of data base or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data, and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours.
- K. Upon restoration of normal power, the supervisory controller shall automatically resume full operation without manual intervention.
- L. Should supervisory controller memory be lost for any reason, the supervisory controller shall have the capability of reloading its programming via high speed local area network from the control system archive workstation or server, the local RS-232C port, or telephone line dial-in.

2.07 SYSTEM SOFTWARE FEATURES

- A. All necessary software to form a complete operating system, as described in this specification, shall be provided as an integral part of the supervisory controller, and shall not be dependent upon higher level computer for execution
- B. Control software shall include a provision for limiting the number of times that each piece of equipment may be cycled within any one-hour period.
- C. 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.
- D. Supervisory controllers shall have the ability to perform any or all of the following energy management routines:
 - Time of day scheduling
 - Calendar based scheduling
 - Holiday scheduling
 - Optimal start
 - Optimal stop
 - Demand limiting
 - Load rolling
 - Heating/cooling interlock
- E. All programs to be executed automatically without the need for operator intervention, and be flexible enough to allow user customization. Programs shall be applied to building equipment described in Section 23 09 93 of this specification.
- F. Supervisory controllers shall be able to execute configured processes defined by the user to automatically perform calculations and control routines.
- G. It shall be possible to use any of the following in a configured process:
 - Any system-measured point data or status
 - Any calculated data
 - Any results from other processes
 - Boolean logic operators (and, or)

- H. Configured processes may be triggered based on any combination of the following:
- Time of day
 - Calendar date
 - Other processes
 - Events (e.g., point alarms)
- I. A single process shall be able to incorporate measured or calculated data from any and all other ASC's.
- J. A single process shall be able to issue commands to points in any and all other programmable controllers and ASC's on the local network.
- K. Alarm management shall be provided to monitor, buffer, and direct alarm reports to operator devices and memory files. Each supervisory controller shall perform distributed; independent alarm analysis and filtering to minimize network traffic and prevent alarms from being lost. At no time shall the ability of supervisory controllers to report alarms be affected by either operator activity at the local I/O device or communications with other ASC's on the network.
- L. All alarm or point change reports shall include the English language description of each point and the time and date of the occurrence.
- M. 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. Users shall have the ability to manually inhibit alarm reporting for each point.
- N. The user shall also be able to define conditions under which point changes need to be acknowledged by an operator and/or logged for analysis at a later date.
- O. Alarms reports and messages shall be directed to an operator device.
- P. In addition to the point's descriptor and the time and date, the user shall be able to print, display or store a 60-character alarm message to more fully describe the alarm condition or direct operator response.
- Q. Each supervisory controller shall be capable of storing a library of at least 100 messages. Each message may be assignable to any number of points in the panel.
- R. A data collection utility shall be provided to automatically sample, store, and display system data.
- S. Measured and calculated analog and binary data shall 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 to 24 hours, in one minute or one hour intervals, shall be provided. Each supervisory controller shall have a dedicated buffer for trend data and shall be capable of storing 16 trend logs. Each trend log shall have up to four points trended at 48 data samples each. Data shall be stored at the supervisory controller and up-loaded to the DDC system server when archiving is desired.
- T. Supervisory controllers shall automatically accumulate and store runtime hours for binary input and output points specified in Section 23 09 14 of this specification.

- U. Supervisory controllers shall automatically sample, calculate and store consumption totals on a daily, weekly, or monthly basis, user defined, for user-selected analog and binary pulse input type points.
- V. Totalization shall provide calculation and storage accumulations of up to 9,999,999 units (e.g., KWH, gallons KBTU, tons, etc.).
- W. The totalization routine shall have a sampling resolution of one minute.
- X. The user shall have the ability to define a warning limit. Unique, user specified messages shall be generated when the limit is reached.
- Y. The information available from pulse totalization shall include, but not be limited to, the following:
 - Peak demand, with date and time stamp
 - 24-hour demand log
 - Accumulated KWH for day
 - Sunday through Saturday KWH usage
 - Demand KW annual history for past 12 periods
 - KWH annual history for past periods
- Z. Supervisory controllers shall have the ability to count events, such as the number of times a pump or fan system is cycled on and off.
- AA. The event totalization feature shall be able to store the records associated with a minimum of 9,999,999 events before reset.

2.08 PROGRAMMABLE CONTROLLERS

- A. Programmable controllers shall be provided with a software program that shall allow the user to design flexible software algorithms for the control sequences as described in Sections 23 09 14 and 23 09 93 portions of this specification.
- B. Programmable controllers shall support all necessary point inputs and outputs to perform the specified control sequence in a totally stand-alone fashion.
- C. Each programmable controller shall perform its own limit and status monitoring and analysis to maximize network performance by reducing unnecessary communications.
- D. Each programmable controller shall support the use of a locally mounted status and adjust panel interface to allow for the local adjustment of all setpoints, temporary override of any input or output points and status of all points directly at the controller. The capabilities of the locally mounted status and adjust panel shall include, but not be limited to, the following information for the programmable controllers to which:
 - Display temperatures
 - Display status
 - Display setpoints
 - Display control parameters
 - Override binary output control
 - Override analog output control
 - Override analog setpoints
 - Modification of gain and offset constants

- E. All system set points, 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 programmable controller.
- F. Programmable controllers shall support, but not be limited to, the following configurations of systems to address current requirements as described in Sections 23 09 14 and 23 09 93 portions of this specification, and for future expansion of air handling units:
 - Mixed air handling units
 - Boiler or chiller plants with pump logic
 - Generic system interlocking through hardware

2.09 APPLICATION SPECIFIC CONTROLLERS - HVAC

- A. Each supervisory controller shall be able to extend its monitoring and control through the use of stand-alone application specific controllers (ASC's).
- B. Each ASC shall operate as a stand-alone 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 databases including:
 - Control Processes
 - Energy Management Applications
 - Operator I/O (Portable Service Terminal)
- D. The operator interface to any ASC point or program shall be through the supervisory controller connection to any ASC on the network.
- E. ASC's shall directly support the temporary use of a portable service terminal that can be connected to the ASC via zone temperature or directly at the controller. The capabilities of the portable service terminal shall include, but not be limited to, the following information for the:
 - Display temperatures
 - Display status
 - Display setpoints
 - Display control parameters
 - Override binary output control
 - Override analog output control
 - Override analog setpoints
 - Modification of gain and offset constants
- F. All system set points, 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 ASC.
- G. ASC's shall support, but not be limited to, the following configurations of systems to address current requirements as described in Sections 23 09 14 and 23 09 93 portions of this specification, and for future expansion of air handling units:
 - Variable Air Volume Terminals
 - Reheat Terminals

- H. All system setpoints, proportional bands, control algorithms, calibration constants, and any other programmable parameters shall be stored such that a power failure of any duration does not necessitate reprogramming the ASC.
- I. All application specific controllers shall be fully programmable. Question and answer or template programming are not acceptable unless this is used to generate the initial application program and the result is able to be freely modified without restriction. Control sequences for terminal unit control that utilize devices wired directly to the terminal unit application controller shall be programmed in the application specific controller and shall be stand-alone in function, i.e., occupancy sensing, temperature setpoint setback, etc. Supervisory controllers shall not be involved in the control sequence logic unless it involves sharing data between or from individual terminal unit controllers to be utilized in a global sequence, i.e., trim and respond strategies, terminal unit grouping, etc.

2.10 OPERATOR INTERFACE REQUIREMENTS

- A. **COMMAND ENTRY/MENU SELECTION PROCESS:** Operator interface software shall minimize operator training through the use of English language prompting and English language point identification.
- B. **TEXT-BASED DISPLAYS:** The operator interface shall provide consistent text-based displays of all system point and application data described in this specification. Point identification, engineering units, status indication, and application naming conventions shall be the same at all operator devices.
- C. **GRAPHIC-BASED DISPLAYS:** The operator interface shall provide graphic based displays of each system. The point data associated with each system shall dynamically update at a minimum of every 30 seconds. Graphic displays shall be linked to each other to provide a "drill down" capability from main graphic displays to more specific system-based displays. Provide a building level graphic display that links to system graphics. For systems that have ASC controlled terminal unit controls, provide a building floor plan with dynamic temperatures shown on the graphic that can be drilled into for more specific terminal information. Points provided in the graphic shall have the override and adjust capability specified under operator commands. The contractor providing the DDC system under this Section shall provide all graphic displays for the project. Submit all graphic displays to the Owner's control personnel for review and approval. Graphics shall be completed to provide enough time for approval and time for binding to be in place before control system commissioning is scheduled to occur.
- D. **PASSWORD PROTECTION:**
 - 1. Multiple-level password access protection shall be provided to allow the user/manager to limit control, display, and data base manipulation capabilities as he deems appropriate for each user, based upon an assigned password.
 - 2. Passwords shall be exactly the same for all operator devices.
 - 3. A minimum of three levels of access shall be supported:
 - Level 1: Data access and display
 - Level 2 = Level 1 + operator overrides and commands
 - Level 3 = Level 2 + database generation and modification
 - 4. A minimum of 4 passwords shall be supported at each supervisory controller.

5. Operators will be able to perform only those commands available for their respective passwords. Menu selections displayed at any operator device shall be limited to only those items defined for the access level of the password used to log-on.
 6. Provide user definable, automatic log-off timers of from 1 to 60 minutes to prevent operators from inadvertently leaving devices on-line.
- E. OPERATOR COMMANDS: The operator interface shall allow the operator to perform commands including, but not limited to, the following:
- Start-up or shutdown selected equipment
 - Adjust setpoints
 - Override analog and binary outputs
 - Add/modify/delete time programming
 - Enable/disable process execution
 - Lock/unlock alarm reporting for each point
 - Enable/disable totalization for each point
 - Enable/disable trending
 - Enter temporary override schedules
 - Define holiday schedules
 - Change time/date
 - Enter/modify analog alarm limits
 - Enable/disable analog alarm limits
 - Enable/disable demand limiting
 - Enable/disable duty cycle
- F. LOGS AND SUMMARIES:
1. Reports shall be generated manually, and directed to the displays. As a minimum, the system shall allow the user to easily obtain the following general listing of all points in the system that shall include, but not be limited to:
 - Points currently in alarm
 - Off-line points
 - Points currently in override status
 - Points in weekly schedules
 - Holiday programming
 2. 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 on the facility management system. Under no conditions shall the operator need to specify the address of hardware controller to obtain system information.

G. SYSTEM CONFIGURATION AND DEFINITION:

1. 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.
2. The system shall be provided complete with all equipment, software, and documentation necessary to allow an operator to independently perform the following functions:
 - Add/delete/modify application specific controllers
 - Add/delete/modify points of any type, and all associated point parameters, and tuning constants
 - Add/delete/modify alarm reporting definition for each point
 - Add/delete/modify energy management applications
 - Add/delete/modify time and calendar-based programming
 - Add/delete/modify totalization for every point
 - Add/delete/modify historical data trending for every point
 - Add/delete/modify configured control processes
 - Add/delete/modify dial-up telecommunication definition
 - Add/delete/modify all operator passwords
 - Add/delete/modify alarm messages

H. PROGRAMMING DESCRIPTION: Definition of operator device characteristics, ASC's, individual points, and shall be performed through fill-in-the-blank templates.

I. NETWORK-WIDE STRATEGY DEVELOPMENT: Inputs and outputs for any process shall not be restricted to a single ASC, but shall be able to include data from any and all other ASC's to allow the development of network-wide control strategies.

J. SYSTEM DEFINITION/CONTROL SEQUENCE DOCUMENTATION: All portions of system definition shall be self-documenting and be capable of providing hardcopy printouts of all configuration and application data.

K. DATA BASE SAVE/RESTORE/BACK-UP: Backup copies of all programmable controller, ASC and supervisory controller databases shall be stored in at least one personal computer or laptop. Users shall also have the ability to manually execute downloading of a programmable controller, ASC or supervisory controller database.

2.11 WEB BASED HTML BROWSER INTERFACE

- A. Provide a HTML based browser interface (Web Server) for accessing the DDC system. This shall include all hardware and software to provide an Ethernet twisted pair connection to the owners local or wide area network (LAN or WAN) that can be used to access the DDC system through a standard internet browser.
- B. All information shall be provided to the owner's IT staff to facilitate connection through the owner's LAN/WAN.
- C. At a minimum, this interface shall be capable of all functions described under the Operator Interface section, Password Protection, Operator Commands, and Logs and Summary subsections of this specification.

PART 3 - EXECUTION

3.01 GENERAL

- A. All electronic work required as an integral part of the central building automation system work is the responsibility of this section unless specifically indicated otherwise in this section, Section 23 09 14, or in Division 26.
- B. This contractor shall provide all labor, materials, engineering, software permits, tools, check-out and certificates required to install a complete DDC expansion to the existing central building automation system as herein specified. This system expansion shall be compatible with and interfaced to the existing computer driven automation center, and shall operate through all the existing I/O devices, central processing unit (CPU), and digital communication trunks. This connection to the digital communications trunk shall be true bi-directional analog and digital communications with the existing central building automation system.
- C. Any and all points added with this project shall be properly interfaced into the existing central building automation system format and grouped for display purposes into the system such that all points associated with a new or existing DDC system can appear together on the CRT display or printed log. Assignment of points to a group shall not be restricted by hardware configuration of the points of direct digital control. It shall be possible to assign a point to appear in more than one system. An English descriptor and an alpha/numeric identifier shall identify each system.
- D. This central building automation system expansion as herein specified shall be fully integrated and completely installed by this section. It shall include all required computer CPU software and hardware. Include the engineering, installation, supervision, calibration, software programming, and checkout necessary for a fully operational system.

3.02 INSTALLATION

- A. All work and materials are to conform in every detail to the rules and requirements of the National Electrical Code and present manufacturing standards. All wiring and cable installation shall conform to the wiring installation as specified in the installation section of Section 23 09 14. All material shall be UL approved.
- B. The addition of this specified system expansion shall in no way impair the future capabilities of any existing functions of the computer driven central building automation system. A system expansion with lesser capabilities will not be accepted. Further, this contractor will not put in jeopardy the normal, uninterruptable operation of the entire building automation system the time it is interfaced through the completion of this project.
- C. Install system and materials in accordance with manufacturer's instructions, rough-in drawings and details on drawings.
- D. Line voltage wiring to power the DDC Controllers, not provided by the Division 26 contractor, to be by this contractor.
- E. Control panels serving equipment fed by emergency power shall also be served by emergency power.
- F. Provide uninterruptable power supplies where necessary to provide proper startup of equipment or to accomplish power restart control sequences specified.

- G. Mount control panels adjacent to associated equipment on vibration-free walls or free-standing angle iron supports. One cabinet may accommodate more than one system in same equipment room. Provide engraved plastic nameplates for instruments and controls inside cabinet and on cabinet face.
- H. Provide as-built control drawings of all systems served by each local panel in a location adjacent to or inside of panel cover. Provide a protective cover or envelope for drawings.
- I. Where a new system is required to be extended to an existing Building Automation Network (BAN) (typically connected via the Owner Local Area Network (LAN) or Wide Area Network (WAN)), extension of the data-net between DDC Controllers and to the BAN to be by this contractor. All wiring and cable installation shall conform to the wiring installation as specified in the installation section of Section 23 09 14.
- J. Provide all necessary routers and or repeaters to accomplish connection to the BAN via the panel-mounted port provided.
- K. Provide two data jacks in control panels housing supervisory controllers and allocate 6"x6" for each data jack in the panel. The first jack will be used for connecting the supervisory controller to the BAN. The second jack will be used as a spare for connecting to the BAN by service personnel.
- L. All tubing, cable and individual wiring is to be permanently tagged, with numbers corresponding with "Record Drawings", spares are to be labelled as "Spare".
- M. Provide technician to work with air balancing contractor and/or provide balancing contractor with necessary hardware to over-ride DDC controllers for air balancing.
- N. Provide documentation to demonstrate that all points, input and output, have been checked out and verified operational, note any points not operating properly with notation of reason.

3.03 OWNER TRAINING

- A. All training provided for the Owner shall comply with the format, general content requirements and submission guidelines specified.
- B. Contractor to provide factory authorized representative and/or field personnel knowledgeable with the operations, maintenance and troubleshooting of the system and/or components defined within this section for a minimum period of 4 hours.
- C. Provide two follow-up visits for troubleshooting and instruction, one six months after substantial completion and the other at the end of the warranty period. Length of each visit to be not less than 2 hours or the time necessary to provide required information and complete troubleshooting and inspection activity for all controls installed under this section. Coordinate the visit with the Owner and provide an inspection report to the Owner of any deficiencies found.

END OF SECTION

SECTION 23 09 93
SEQUENCE OF OPERATION FOR HVAC CONTROLS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Scope. This section includes control sequences for HVAC equipment as well as equipment furnished by others that may need monitoring or control. Included are the following topics:
- B. PART 1 - GENERAL
 - 1. Scope
 - 2. Related Work
 - 3. Reference
 - 4. Description of Work
 - 5. Submittals
 - 6. Operation and Maintenance Data
 - 7. Design Criteria
- C. PART 2 - Products
 - 1. Not Applicable
- D. PART 3 - EXECUTION
 - 1. General Control
 - 2. Constant Volume Mixed Air Handling Unit Control (AHU-3 & 4)

1.02 RELATED WORK

- A. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC – Coordination
- B. Section 23 09 14 - Pneumatic and Electric Instrumentation and Control Devices for HVAC
- C. Section 23 09 23 - Direct Digital Control System for HVAC
- D. Division 23 - HVAC - Equipment provided to be controlled or monitored
- E. Division 26 - Electrical - Equipment provided to be controlled or monitored
- F. Division 28 - Electronic Safety and Security

1.03 REFERENCE

- A. Section 23 09 14 work includes furnishing and installing all field devices, including electronic sensors for the DDC of this section, equipment, and all related field wiring, interlocking control wiring between equipment, pneumatic tubing, sensor mounting, etc., that is covered in that section.
- B. Motorized control dampers and actuators, thermowells (temperature sensing wells), automatic control valves and their actuators are also covered in Section 23 09 14.

1.04 DESCRIPTION OF WORK

- A. Control sequences are hereby defined as the manner and method by which automatic controls function. Requirements for each type of operation are specified in this section.
- B. Operation equipment, devices and system components required for automatic control systems are specified in other Division 23 control sections of these specifications.
- C. All temperature, humidity, and pressure sensing, and all other control signal transportation for the control sequences shall be furnished as specified under Section 23 09 14.
- D. Sequences for equipment controlled by Direct Digital Controls (DDC) as specified are accomplished by hardware and software provided under Section 23 09 24. Sequences for equipment controlled by pneumatic or electric self-contained controls are accomplished by hardware provided under Section 23 09 14.

1.05 SUBMITTALS

- A. Refer to Division 1, General Conditions, Submittals, Section 23 05 00 and Sections 23 09 24, and 23 09 14 for descriptions of what should be included in the submittals.
- B. Shop drawings shall be provided by contractor(s) providing equipment under Sections 23 09 24 and 23 09 14. The contractor shall provide a complete narrative of the sequence of operations for equipment that is controlled through the DDC system or directly from the 23 09 14 equipment (without control logic through the DDC system). The narrative of the sequence of operation shall not be a verbatim copy of the sequences contained herein, but shall reflect the actual operation as applied by the contractor.

1.06 OPERATION AND MAINTENANCE DATA

- A. All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

1.07 DESIGN CRITERIA

- A. Reference Section 23 09 14.

PART 2 - PRODUCTS

2.01 NOT APPLICABLE

- A. Reference Sections 23 09 24 and 23 09 14 for product descriptions.

PART 3 - EXECUTION

3.01 GENERAL CONTROL

- A. **BACNET OBJECTS:** All hardwired points listed in 23 09 15 and any setpoints, timers, or other control elements that are specified to be adjustable (adj.) in the following control sequences shall be mapped as BACnet objects and be available on the user interface to be adjusted. Consult with the owner's HVAC and/or DDC personnel prior to programming to determine if there are any items that they do not want to have mapped as BACnet objects. This is especially important for DDC controlled items that are duplicative, i.e., air terminal units.
- B. **BACNET ADDRESSING:** BACnet instance IDs shall be coordinated with the owner's established BACnet instance ID addressing scheme. If there is not such a scheme in place, the contractor(s) providing BACnet DDC controllers shall work with the agency to establish such a scheme and document this in the asbuilt control drawings. BACnet/IP addressing shall be coordinated with the agency prior to installation. BACnet MSTP addressing shall be addressed to provide for consecutive addressing to provide for the best speed of response. Max Master address shall be set appropriately for speed of response.
- C. **USER INTERFACE/FEATURE SOFTWARE:** Consult with the owner's HVAC and/or DDC personnel prior to programming to determine BACnet object naming conventions, user views, graphic layout, security matrix, alarming, trending, and scheduling preferences desired by the agency. Failure to consult and come to agreement prior to programming shall require the DDC contractor to make changes in the above listed items as desired by the owner to the system at no cost. Section 23 09 15 feature software checkmarks are guides only and are not specific to what is required by the owner.
- D. **SETPOINTS:** All setpoints indicated in the control specification are to be adjustable. The setpoints shall be readily available to be modified in the mechanical system software system summary (either textual or graphic based) and under the same software level as hardware points. Some less used setpoints may be provided on a lower software level, if requested by the owner for clarity. The setpoints indicated herein are only specified as a calculated starting point (or initial system operation). It is expected that setpoint adjustments and control loop tuning shall be required to provide optimum system operation based on requirements of the building. The control contractor shall work with the balancing contractor and the owner to provide the final system setpoint adjustments and control loop tuning after the system is in operation and building is in use. Document all final setpoints on the as-built control drawings. Any questions regarding the intended operation of the HVAC equipment and control systems shall be referred to the HVAC design engineer through the appropriate construction communication process. The following setpoints should be used as initial setpoints unless otherwise specified in the individual control sequences:
- Occupied Space Terminal Unit Heating: 70°F
 - Occupied Space Terminal Unit Cooling: 74°F
 - Unoccupied Space Terminal Unit Heating: 64°F
 - Unoccupied Space Terminal Unit Cooling: 80°F
 - Entry Way Heating: 60° F
 - Mechanical or Unoccupied Space Ventilation: 80°F
 - Mechanical or Unoccupied Space Heating: 60°F

- E. ANTI-CYCLING: When HVAC equipment or a sequence is specified to be started and stopped by a temperature, humidity, pressure setpoint or any other controlled variable, there shall be an adjustable differential setpoint that shall be set to prevent short cycling of the systems and equipment due to minor changes in the controlled variable. Temperature differential setpoints shall be set at 2°F and non-temperature setpoints shall be set at 10% of the controlled range unless otherwise specified. Setpoints shall indicate at when the process should be turned on. Heating and cooling differentials shall be set for above setpoint and will be used to turn the process off. For example, an economizer sequence called to switch at 68°F, would turn on at 68°F and off at 70°F since it is a cooling function. A heating lockout setpoint of 50°F would turn on heating control at 50°F and off at 52°F. Non-temperature differentials shall be set above setpoint if the setpoint is indicating a minimum value or below setpoint if the setpoint is indicating a maximum value. Provide minimum runtime timers for loads that are cycled to prevent over-cycling. Timers shall be set as specified or as needed to prevent damage or excessive wear to the equipment. Unless otherwise specified in the individual control sequences, fans and pumps shall have a minimum runtime on timers of 15 minutes (adj.) and off timers of 5 minutes (adj.). Safeties shall override runtime timers.
- F. DEADBANDS: Provide deadbands for all DDC control loops to prevent constant hunting of output signals to controlled devices. Deadbands shall be set to provide adequate control around setpoint as follows unless otherwise specified in the individual control sequences:
- Temperature Control: $\pm 0.5^{\circ}\text{F}$
 - Humidity Control: $\pm 1\% \text{ RH}$
 - Airflow Control: $\pm 2\%$ of total flow
 - AHU Static Pressure Control: $\pm 0.01 \text{ in. w.c.}$
- G. ALARMS:
1. Provide all alarmed points with adjustable time delays to prevent nuisance tripping under normal operation and on equipment start-up. For all commanded outputs that have status feedback, provide an alarm that will indicate the commanded output is not in its commanded state. Provide alarms on all points as indicated on point charts. For existing building automations systems, add/delete what is called on the point charts for after consultation with owner to provide consistent alarming throughout the automation system.
 2. For devices that have form "C" contacts available for alarm monitoring, use closed contacts for the Normal condition and open contacts on Alarm condition. This shall provide a level of supervision by detecting a break in the wiring.
- H. EQUIPMENT START/STOP FAILURE STATES: All start/stop points for equipment shall utilize normally open contacts unless called out specifically in the individual control sequences.
- I. LEAD/LAG SEQUENCING: For sequences that call for lead/lag of equipment connected to building automation systems, the lead device shall be able to be chosen through a selectable day of the week and time of day through the building automation system. Coordinate with the owner for scheduling switchover and frequency. Unless otherwise directed, switchover shall occur at 10AM Tuesday and shall rotate the lead device on a weekly cycle rotating through all devices sequentially. For standalone lead/lag sequence controllers (non-DDC), the lead device shall be selected by a switch on the panel face.

- J. VARIABLE FREQUENCY DRIVE (VFD) MOTOR RUN STATUS: Use the VFD programmable relay dry contact output specified to be provided with the VFD under Section 23 05 14 to prove motor run status and detect belt loss or coupling break. If a bypass contactor is provided with the VFD, provide an adjustable current switch and wire it in parallel with the VFD output for proving motor status.
- K. VFD BYPASS & SAFETY INTERLOCKS: VFD's equipped with bypass starters shall be interlocked so that the start/stop and safety circuits that are called out for VFD operation shall be functional when the VFD is indexed to the bypass starter mode. Unless otherwise specified in the sequence below, the switch from inverter to bypass starter modes shall be through a manual switch provided on the VFD/bypass starter package.
- L. VFD MINIMUM SPEED & RAMP TIMERS: The VFD start-up technician shall work with the DDC Temperature Control Contractor determine the minimum speed required for the motor controlled by the VFD to provide cooling of the motor as installed to prevent heat related problems. This minimum speed shall be set in the VFD controller. The VFD start-up technician shall work with the DDC Temperature Control Contractor to set the acceleration and deceleration timers in the VFD controller at 30 seconds for motors less than 40 HP and 60 seconds for motors 40 HP and greater.
- M. CURRENT SWITCH SETUP: When current switches are used for proving fan or pump status, they shall be set up so that they will detect belt or coupling loss by the reduction in current draw on loss of coupled load. The current switch set up shall be redone by the 23 09 14 contractor after the balancer is complete.
- N. DAMPER INTERLOCKS FOR FANS WITH STARTERS: For fan systems with magnetic starters and shutoff dampers specified with end switches, the damper interlock shall be hardwired in such a way that the damper shall open if the fan starter hand / off / auto switch is in the hand or in the auto position and being called to start. After the damper end switch has proven the damper open, a hardwire interlock from the end switch to the starter holding coil for the fan shall cause the fan to start. For fan systems that are ducted in parallel, see specific sequence for fan system on interlock requirements.
- O. DAMPER INTERLOCKS FOR FANS WITH VFD'S: For fan systems with VFD's and shutoff dampers specified with end switches, hardwire interlock the shutoff damper with the fan VFD. When the fan is remotely or locally commanded to start, VFD contacts shall energize outside air damper actuator to open damper. The damper position end switch shall be wired to run permissive input on the VFD and enable the VFD to start when the damper position end switch provides the damper is open. This operation shall be provided for VFD and bypass operation if the VFD is provided with a bypass. The damper end switch shall also be monitored by the DDC system. For fan systems that are ducted in parallel, see specific sequence for fan system on additional interlock requirements.
- P. FAN INTERLOCKING: Provide interlocks between supply and return or exhaust fan systems as scheduled on the plans or called out in individual control sequences. If DDC controlled, interlocks shall be done through DDC start/stop points unless otherwise specified in individual control sequences. If not DDC controlled, interlocks shall be accomplished via hardwire interlocks between fan starters or VFD's.
- Q. THERMOSTATS AND SENSORS: All devices and equipment including terminal units, specified to be controlled in a control sequence by a thermostat or sensor, shall be provided with a thermostat or sensor, whether or not the device is indicated on the plans. Consult the HVAC design engineer for the thermostat or sensor location.

- R. ORIGINAL EQUIPMENT MANUFACTURER (OEM) CONTROLLER DDC INTEGRATION: Provide DDC programming to define all equipment integral input/output points, setpoints, data points, calculations, etc. that are available through the manufacturer's communication interface. Consult with the owner's DDC operations personnel to determine if some of the points should be omitted (for clarity or lack of value). The following equipment shall be integrated into the DDC system:
- Variable Frequency Drives
- S. WEEKLY SCHEDULING: Provide scheduling of DDC terminal units in groups based on occupancy. Work with the owner to determine how many groups are required and which zones should be included. Individual terminal units shall be able to receive temporary schedules that will override the group schedules. Temporary override buttons at the zone sensor (where specified on point charts) shall override the scheduling to occupied. When groups that consist of more than 20% of terminal units are indexed to occupied, the associated air handling unit shall start if not already running.
- T. DDC CONTROLLER COMMUNICATION BUS CONFIGURATION: The actively controlled primary mechanical equipment (AHU's, hot water, chilled water, boilers, etc.) DDC controllers shall be configured to be located on the same supervisory controller BACnet MSTP communication trunk unless the supervisory controller capacity prevents it. If this is the case, the primary mechanical equipment DDC controllers shall be separated onto supervisory controllers in such a way that the systems that need to share information for operation and interlocking shall reside on the same supervisory controllers. When AHU systems have associated exhaust fan systems that are interlocked and designed to operate together as a combined air system within a building, these must be on the same BACnet MSTP trunk. Peer-to-peer communication shall be used for interlocks and data sharing between the AHU and exhaust fans systems, when possible, to limit air system disruptions in the event of a supervisory controller failure. Other critical building systems that require communication between DDC controllers to operate shall be on the same BACnet MSTP communication trunk. Terminal unit controllers shall be located on a separate BACnet MSTP trunks if necessary to allow for primary equipment to reside on the same BACnet MSTP trunk. If the DDC controllers used for control of primary mechanical equipment and interlocks or point information is required for proper operation as described above do not use BACnet MSTP communication but use Ethernet communication, the DDC controllers shall be connected to the same Ethernet switch. If the controllers cannot be connected to the same switch, hardwired points between controllers shall be used to share information.
- U. CONTROLLED VARIABLE REQUIREMENTS: All controlled variables, i.e., static pressure, differential pressure, temperature, humidity, etc., shall be wired directly to the DDC controller in which the software PID loop or other similar software loop resides unless the control sequence specifically allows the controlled variable to be routed over the network. Where a controlled variable is used for reset of a PID loop, the controlled variable shall be allowed to be shared over the network unless specified to be directly wired to the DDC controller.

V. CALCULATED DATA POINTS

1. Provide calculated data points for actual dirty pressure drop for all variable volume air handling units with supply flow measurement based on the following equation:
 - Actual Dirty Filter $\Delta P = (\text{Meas. Supply CFM}/\text{Design CFM})^2 \times \text{Design Dirty Filter } \Delta P$
2. Provide a calculated data point for outside airflow for all fans that have return and outside air mixing dampers and the points required to allow for the following equation:
 - Outside Airflow = Supply CFM x (MAT-RAT)/(OAT-RAT)
3. Where Supply CFM is measured either on variable volume fans or as balanced on constant volume units, MAT is Mixed Air Temperature, RAT is Return Air Temperature, and OAT is Outside Air Temperature. This point is designed as a check for outside air flow stations accuracy and outside air ventilation minimum damper positions. It should be noted that the accuracy of the calculated outside airflow will diminish as outside air temperature approaches return air temperature. It should be used as a check only when the RAT and OAT are greater than 20°F and the accuracy of the RAT and OAT temperature sensors are assured.

3.02 CONSTANT VOLUME MIXED AIR HANDLING UNIT CONTROL (AHU-3 & 4)

A. GENERAL:

1. The air handling unit is constant air volume, indoor air unit.
2. The air handling unit is controlled by direct digital controller (DDC).
3. The air handling unit is equipped with the following:
 - Supply fan with VFD.
 - Supply fan with starter.
 - Duct mounted CO2 sensor furnished by TCC. (Refer to specification 23 09 14)
 - Outside air damper furnished by TCC. (Refer to specification 23 09 14)
 - Return air damper furnished by TCC. (Refer to specification 23 09 14)
 - Remote exhaust (relief) fan.
 - Relief air damper furnished by TCC. (Refer to specification 23 09 14)
 - Chilled water coil for cooling.
 - Hot water coil for heating.
 - 30% filter bank.
 - Actuators furnished by TCC. (Refer to specification 23 09 14)

B. FAN CONTROL:

1. Start/Stop: The DDC system shall start and stop the supply fan via their respective VFD. Provide scheduling of the AHU if desired by the owner. On any fan failure, controlled elements within the AHUs shall be controlled as described under Shutdown Control. When failed fan status proves on, fan system shall automatically restart per sequences below. On a failure of the supply fan, an alarm shall be sent through the DDC system.

C. CURRENT STATUS SWITCH:

1. Provide as described under GENERAL, VFD Motor Run Status, in this Section for both the supply and return fans.

D. VENTILATION AIR CONTROL:

1. Minimum Outside Ventilation Air Flow Control: When the economizer sequence is not enabled, the outside air damper shall be positioned at its minimum position to maintain the scheduled outside air flow ventilation rate. When the economizer sequence is enabled, the outside air damper shall be limited from closing below the minimum outside air ventilation position. The control contractor shall work with the balancing contractor to calibrate the outside air damper minimum position to establish the minimum scheduled ventilation airflow.
2. Carbon Dioxide Reset of Outside Ventilation Air Flow:
 - a) Install a carbon dioxide sensor in the return ductwork upstream of the air handling unit and an outside air reference carbon dioxide sensor. The outside air damper shall have a minimum and maximum position that shall correspond to the required minimum and maximum ventilation air flow rates. The control contractor shall work with the balancing contractor to calibrate the outside air damper positions to establish the following airflow:
 - Minimum - 250 CFM
 - Maximum - 565 CFM
 - b) The minimum outside airflow rates shall be reset between minimum and maximum ventilation airflow rates to maintain a suitable carbon dioxide level using a proportional reset. This reset shall be set so the minimum ventilation is reset from 100 ppm (adj.) above the measured ambient CO₂ level to maximum ventilation at the steady state CO₂ setpoint for the activity level of the space of [insert setpoint] ppm. An alarm shall be sent to the operator interface if the space carbon dioxide level exceeds the steady state CO₂ setpoint by 300 ppm.

E. FILTERS:

1. Install a differential static pressure sensor across each filter bank. Ensure that the static probes do not impede filter removal.
2. For pre-filter bank, provide an alarm to the operator interface when the differential static pressure exceeds 1.0" w.g. (adj.).
3. For final filter bank, provide an alarm to the operator interface when the differential static pressure exceeds 1.0" w.g. (adj.).

F. DISCHARGE AIR TEMPERATURE CONTROL:

1. Install a temperature sensor in the supply duct downstream of the supply fan, and all coils.
2. Discharge Air Temperature Setpoint Reset from Zone Temperature (Heating and Cooling Unit): Reset the discharge air temperature setpoint based on the zone temperature between 55°F (adj.) and 80°F (adj.) to maintain a zone heating and economizer setpoint of 70°F (adj.). Mechanical cooling shall maintain a zone mechanical cooling setpoint of 74°F (adj.). Mechanical cooling shall be locked out below the mechanical cooling setpoint unless dehumidification control is required.

3. The heating coil, mixed air dampers, and the cooling coil shall be controlled in sequence to maintain the discharge air setpoint temperature. At no time shall the heating coil be operating when the mixed air dampers are economizing, or the chilled water valve is open. Whenever the discharge air temperature is above the setpoint, the following shall occur in sequence: The heating coil control shall modulate closed as sequenced below. When heating is completely off and the economizer sequence is enabled, the outside air damper, return air damper, and relief damper shall be modulated together in sequence to maintain discharge air temperature setpoint. When the outside air damper is completely open, or the economizer sequence is not enabled, the chilled water valve shall modulate open to maintain the zone mechanical cooling temperature setpoint as described above. The cooling control shall be limited to the low discharge temperature reset setpoint. When the discharge air setpoint is below setpoint the reverse shall occur. Cooling coil control shall be locked out below 50°F (adj.) outside air temperature

G. HOT WATER HEATING COIL CONTROL:

1. Modulate the heating coil control valve as sequenced under discharge air control.

H. COLD WEATHER STARTUP:

1. On AHU start up when the outside air temperature is below 20°F (adj.), add 25°F (adj.) to the discharge temperature setpoint and ramp the discharge temperature setpoint down by 5°F (adj.) every two minutes (adj.). When the ramped down discharge temperature setpoint is within ramp down increment, release setpoint back to the normal discharge temperature setpoint. This sequence should be initiated after the heating optimal start routine below has terminated and the AHU is indexed to the occupied mode.
2. For units with reclaim coils upstream of the preheat coil, open the reclaim coil valve to provide full flow through the coil allowing time for the valve to provide full flow through the reclaim coil before starting the AHU. Release reclaim coil to control when supply fan status is proven.

I. ECONOMIZER CONTROL:

1. When the economizer sequence is enabled by the switchover sequence below, the outside air economizer damper and return damper shall modulate to provide outside air to be used for free cooling as described in the Discharge Air Control sequence.
2. Fixed Enthalpy Economizer Switchover: The economizer sequence shall be enabled whenever the outside air enthalpy is less than 28 Btu/lb. of dry air. The enthalpy differential setpoint shall be 1 Btu/lb. (adj.) of dry air.
3. If a globally shared data point is used for economizer switchover, provide a dry bulb economizer backup control sequence that shall enable the economizer whenever the building outside air temperature sensor is sensing below 68°F (adj.) outside air temperature and communication is lost to the globally shared data point.

J. RELIEF AIR CONTROL:

1. Exhaust Fan with VFD Relief Control Using Characterized Damper Position: Open the relief (exhaust) air damper whenever the exhaust fan is on. The exhaust fan shall start at minimum speed whenever the outside air damper is open further than 10% (adjustable) above minimum position. The exhaust fan speed shall be varied based on a five-segment curve to maintain a slight negative space pressure as follows (the values shown for the fan speed are arbitrary and will vary depending on fan selection and system design):

OA DAMPER POSITION	EXHAUST FAN SPEED
10%-20%	15%-30%
20%-40%	30%-50%
40%-60%	50%-75%
60%-80%	75%-90%
80%-100%	90%-100%

2. The balancer shall work with the controls contractor to determine the fan speeds for each segment of the damper position curve to maintain a slight negative pressure in the space relative to the adjacent indoor space as shown on the plans.

K. SAFETIES:

1. General: All safeties shall be hard wired to the supply and return fan starters or VFD safety circuits. Starters shall not function in the "Hand" or "Auto" and VFD's shall be disabled if they are indexed to the "Auto" or "Hand" position in either the VFD or bypass modes.
2. Freezestat: Install an electric freezestat (refer to specification Section 23 09 14 for location) to shut down the unit (see Unit Shutdown for additional information) if the temperature downstream of the heating coil drops below 35°F (adj.). The electric freezestat shall act independently of the DDC system via hardwire interlock and shall override the DDC system control signal to open the heating coil control valve(s). A freezestat trip shall notify the DDC system that shall send an alarm to the operator interface.

L. FIRE ALARM SHUTDOWN:

1. Upon a Fire Alarm System alarm, the fire alarm control module provided by the electrical contractor at the temperature control panel shall change state of its contacts. This shall cause the unit to be shut down (see Unit Shutdown for additional information) An auxiliary contact shall be provided to notify the DDC system of a fire alarm shutdown. Upon reset of the fire alarm system, the unit shall restart automatically without user intervention subject to any restart delays. See Section 28 31 00 for fire alarm system programming requirements for AHUs.

M. UNIT SHUTDOWN:

1. Whenever the air handling unit is indexed off, the supply and return fans shall stop. Whenever both supply and return fans are off for any reason or the air handling unit is in fan failure mode as described under the Fan Control sequence the following shall occur:
2. The outside air damper and relief air damper shall close, and the return damper shall open.

3. The chilled water control valve(s) shall close.
4. The heating coil control valve(s) shall remain under control from the mixed air sensor to maintain 55 °F (adj.). Freezestat shall override heating control valve(s) open.

N. UNOCCUPIED CONTROL:

1. General: Occupied/unoccupied schedule shall be set at the DDC operator interface. When indexed to unoccupied the unit shall shutdown. Where provided, index DDC controlled heating and cooling terminal units associated with this air handling unit to maintain setback and setup temperature setpoints unless overridden by occupancy sensor or manual pushbutton.
2. Unit Cycling to Maintain Setback/Setup Temperatures: Cycle the air handling unit on to maintain the setback and setup temperature zone setpoints to maintain 64°F and 80°F respectively. Reset supply return fan volume offset for return air fan control to zero. Supply fan shall be limited to the maximum return fan airflow. In the heating mode, the outside air and relief air dampers shall close, and the return air damper shall open, and heating discharge temperature control shall function as specified. In the cooling mode, the economizer and chilled water discharge temperature control shall be allowed to function as specified. Minimum on runtime timer shall be set for 15 minutes (adj.) and the off timer for 30 minutes (adj.).

O. HEATING OPTIMUM STARTUP:

1. This cycle shall override the unoccupied cycle. If the system was operating as a result of the unoccupied cycle, the system shall continue to operate. The DDC system shall measure the zone air temperature designated on the plans and the outside air dry bulb temperature to determine the minimum run time to warm the zone(s) to its setpoint. When the computed start time is reached, the DDC system shall start the air handling system and operate with the outside air and relief air dampers closed and the return air damper open. The air handling unit discharge air temperature shall be controlled as specified under Discharge Air Control. When the occupied time is reached, the unit shall be switched to occupied control and ventilation air shall be provided.

P. COOLING OPTIMUM STARTUP:

1. This cycle shall override the unoccupied cycle. If the system was operating as a result of the unoccupied cycle, the system shall continue to operate. The DDC system shall measure the zone air temperature designated on the plans and the outside air dry bulb temperature to determine the minimum run time to cool the zone(s) to its setpoint. When the computed start time is reached, the DDC system shall start the air handling system. The air handling unit discharge air temperature shall be controlled as specified under Discharge Air Control with the economizer and chilled water control active. When the occupied time is reached, the unit shall be switched to occupied control and ventilation air shall be provided.

END OF SECTION

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**SECTION 23 21 13
HYDRONIC PIPING**

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Scope. This section contains specifications for all HVAC hydronic pipe and pipe fittings for this project. Included are the following topics:
- B. PART 1 - GENERAL
 - 1. Scope
 - 2. Related Work
 - 3. Reference
 - 4. Reference Standards
 - 5. Quality Assurance
 - 6. Submittals
 - 7. Delivery, Storage, and Handling
 - 8. Design Criteria
 - 9. Welder Qualifications
- C. PART 2 - Products
 - 1. Heating Hot Water
 - 2. Chilled Water
 - 3. Cooling Coil Condensate
 - 4. Unions and Flanges
 - 5. Gaskets
 - 6. Mechanical Grooved Pipe Connections
- D. PART 3 - EXECUTION
 - 1. Erection
 - 2. Welded Pipe Joints
 - 3. Threaded Pipe Joints
 - 4. Mechanical Grooved Pipe Connections
 - 5. Copper Pipe Joints
 - 6. Cooling Coil Condensate
 - 7. Unions and Flanges
 - 8. Gaskets
 - 9. Piping System Leak Tests
 - 10. Hydronic Piping System Flushing
 - 11. Initial Fill and Vent
 - 12. Piping System Test Report
 - 13. Piping System Flush Report

1.02 RELATED WORK

- A. Section 23 05 23 - General-Duty Valves for HVAC Piping
- B. Section 23 05 15 - Piping Specialties
- C. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment
- D. Section 23 07 00 - HVAC Insulation
- E. Section 23 25 00 - HVAC Water Treatment

1.03 REFERENCE

- A. Applicable provisions of Division 1 govern work under this section.

1.04 REFERENCE STANDARDS

- A. ANSI B16.3 Malleable Iron Threaded Fittings
- B. ANSI B16.4 Cast Iron Threaded Fittings
- C. ANSI B16.5 Pipe Flanges and Flanged Fittings
- D. ANSI B16.22 Wrought Copper and Wrought Copper Alloy Solder Joint Pressure Fittings
- E. ASME B16.51 Copper and Copper Alloy Press-Connect Pressure Fittings
- F. ASTM A53 Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless
- G. ASTM A74 Cast Iron Soil Pipe and Fittings
- H. ASTM A105 Forgings, Carbon Steel, for Piping Components
- I. ASTM A126 Gray Cast Iron Castings for Valves, Flanges, and Pipe Fittings
- J. ASTM A181 Forgings, Carbon Steel for General Purpose Piping
- K. ASTM A197 Cupola Malleable Iron
- L. ASTM A234 Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
- M. ASTM A380 Practice for Cleaning and Descaling Stainless Steel Parts, Equipment, and Systems
- N. ASTM B75 Seamless Copper Tube
- O. ASTM B88 Seamless Copper Water Tube
- P. ASTM F1476 Performance of Gasketed Mechanical Couplings for Use in Piping Applications

1.05 QUALITY ASSURANCE

- A. Order all Type E and Type S steel pipe with heat numbers rolled, stamped, or stenciled to each length or each bundle, depending on the size of the pipe, and in accordance with the appropriate ASTM specification.
- B. Any installed material not meeting the specification requirements must be replaced with material that meets these specifications without additional cost to the Owner.
- C. All grooved joint couplings, fittings, valves, and specialties shall be of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
- D. All castings used for fittings, couplings, valve bodies, etc., shall include a cast date stamp for quality assurance and traceability.
- E. Installers of Press-Connect Joints: Installers shall be certified by press-connect joint manufacturer as having been trained and qualified to join piping with press-connect pipe couplings and fittings.
- F. Installer shall be a qualified installer, licensed within the jurisdiction, and familiar with the installation of press joint systems.
- G. Press fittings shall be installed using proper tool, actuator, jaws, and rings as instructed by the press fitting manufacturer.

1.06 SUBMITTALS

- A. Refer to Division 1, General Conditions, Submittals.
- B. Contractor shall submit schedule indicating the ASTM specification number of the pipe being proposed along with its type and grade and sufficient information to indicate the type and rating of fittings for each service.
- C. TYPE F STEEL PIPE: Statement from manufacturer on his letterhead that the pipe furnished meets the ASTM specification contained in this section.
- D. TYPE E OR S STEEL PIPE: Mill certification papers, also known as material test reports, for the pipe furnished for this project, in English. Heat numbers on these papers to match the heat numbers stenciled on the pipe. Chemical analysis indicated on the mill certification papers to meet or exceed the requirements of the referenced ASTM specification.
- E. COPPER TUBE: Statement from manufacturer on his letterhead that the pipe furnished meets the ASTM specification contained in this section.
- F. Grooved joint couplings and fittings shall be referred to on drawings and product submittals and shall be identified by the manufacturer's style or series designation. Trade names and abbreviations are not acceptable.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Promptly inspect shipments to ensure that the material is undamaged and complies with specifications.
- B. Cover pipe to eliminate rust and corrosion while allowing sufficient ventilation to avoid condensation. Do not store materials directly on grade. Protect pipe, tube, and fitting ends so they are not damaged. Where end caps are provided or specified, take precautions so the caps remain in place. Protect fittings, flanges, and unions by storage inside or by durable, waterproof, above ground packaging.
- C. Offsite storage agreements will not relieve the contractor from using proper storage techniques.
- D. Storage and protection methods must allow inspection to verify products.

1.08 DESIGN CRITERIA

- A. Use only new material, free of defects, rust and scale, and meeting the latest revision of ASTM specifications as listed in this specification.
- B. Construct all piping for the highest pressures and temperatures in the respective system in accordance with ANSI B31, but not less than 125 psig unless specifically indicated otherwise.
- C. Where weld fittings or mechanical grooved fittings are used, use only long radius elbows having a centerline radius of 1.5 pipe diameters.

- D. Where ASTM A53 type F pipe is specified, ASTM A53 grade A type E or S, or ASTM A53 grade B type E or S may be substituted at Contractor's option. Where ASTM A53 grade A pipe is specified, ASTM A53 grade B pipe may be substituted at Contractor's option. Where the grade or type is not specified, Contractor may choose from those commercially available.
- E. Where ASTM B88, type L hard temper copper tubing is specified, ASTM B88, type K hard temper copper tubing may be substituted at Contractor's option.

1.09 WELDER QUALIFICATIONS

- A. Before any metallic welding is performed, the Contractor shall submit his Standard Welding Procedure Specifications, Procedure Qualification Records and Qualification Test Records for each Welder along with associated continuity records to demonstrate compliance with ASME Section IX, paragraph QW-322.
- B. The Contractor shall maintain a complete set of welder qualification documents at the jobsite, including Test Records and Continuity Records for each welder.
- C. The A/E reserves the right to test the work of any welder employed on the project, at the Contractor's expense. Testing will include a visual examination of the pipe and weld and may include radiography of any suspect welds. If the work of the welder is found to be unsatisfactory, the welder shall be prevented from doing further welding on the project. Any welds deemed unacceptable will be repaired at the contractor's expense.

PART 2 - PRODUCTS

2.01 HEATING HOT WATER

- A. 2" and Smaller: ASTM A53, type F, standard weight (schedule 40) black steel pipe with ASTM A126/ANSI B16.4, class 125, standard weight cast iron threaded fittings or ASTM F3226 carbon steel press-connect fittings with EPDM or FKM sealing element, stainless steel separator and grip ring, and smart connect technology suitable for 200 psig working pressure at 250°F (Viega MegaPress).
- B. 2-1/2" and Larger: ASTM A53, standard weight (schedule 40) black steel pipe with ASTM A234 grade WPB/ANSI B16.9 standard weight, seamless, carbon steel weld fittings or ASTM F3226 carbon steel press-connect fittings (2½" to 4") with EPDM or FKM sealing element, stainless steel separator and grip ring, and smart connect technology suitable for 200 psig working pressure at 250°F (Viega MegaPress).
- C. Contractor may use ASTM B88 seamless, type L, hard temper copper tube in lieu of steel pipe for all sizes with ANSI B16.22 wrought copper solder-joint fittings or ASME B16.51/ASTM F3226 copper or bronze press-connect fittings (½" to 4") with EPDM sealing element, stainless steel separator and grip ring, and smart connect technology suitable for 300 psig working pressure at 250°F (Viega ProPress). Mechanically formed tee fittings may be used in lieu of wrought copper solder-joint tee fittings for branch takeoff up to one-half (1/2) the diameter of the main.

2.02 CHILLED WATER

- A. 2" and Smaller: ASTM A53, type F, standard weight (schedule 40) black steel pipe with ASTM A126/ANSI B16.4, class 125, standard weight cast iron threaded fittings or ASTM F3226 carbon steel press-connect fittings with EPDM or FKM sealing element, stainless steel separator and grip ring, and smart connect technology suitable for 200 psig working pressure at 250°F (Viega MegaPress).
- B. 2-1/2" and Larger: ASTM A53, standard weight (schedule 40) black steel pipe with ASTM A234 grade WPB/ANSI B16.9 standard weight, seamless, carbon steel weld fittings or ASTM F3226 carbon steel press-connect fittings (2½" to 4") with EPDM or FKM sealing element, stainless steel separator and grip ring, and smart connect technology suitable for 200 psig working pressure at 250°F (Viega MegaPress).
- C. Contractor may use ASTM B88 seamless, type L, hard temper copper tube in lieu of steel pipe for all sizes with ANSI B16.22 wrought copper solder-joint fittings or ASME B16.51/ASTM F3226 copper or bronze press-connect fittings (½" to 4") with EPDM sealing element, stainless steel separator and grip ring, and smart connect technology suitable for 300 psig working pressure at 250°F (Viega ProPress). Mechanically formed tee fittings may be used in lieu of wrought copper solder-joint tee fittings for branch takeoff up to one-half (1/2) the diameter of the main.

2.03 COOLING COIL CONDENSATE

- A. ASTM B88, type L hard temper copper tubing with ASTM B145/ANSI B16.23 cast red bronze or ASTM B75/ANSI B16.29 wrought solder-type drainage fittings.
- B. Schedule 40 PVC may be used in accordance with WI Admin. Code at Contractor's option.

2.04 UNIONS AND FLANGES

- A. 2" and Smaller: ASTM A197/ANSI B16.3 malleable iron unions with brass seats. Use black malleable iron on black steel piping and galvanized malleable iron on galvanized steel piping. Use ANSI B16.18 cast copper alloy unions on copper piping. Use unions of a pressure class equal to or higher than that specified for the fittings of the respective piping service but not less than 250 psi.
- B. 2-1/2" and Larger: ASTM A181 or A105, grade 1 hot forged steel flanges of threaded, welding and of a pressure class compatible with that specified for valves, piping specialties and fittings of the respective piping service. Flanges smaller than 2-1/2" may be used as needed for connecting to equipment and piping specialties. Use raised face flanges ANSI B16.5 for mating with other raised face flanges on equipment with flat ring or full face gaskets. Use ANSI B16.1 flat face flanges with full face gaskets for mating with other flat face flanges on equipment.
- C. Unions and flanges for servicing or disconnect are not required on installations using grooved joint couplings. The couplings shall serve as disconnect points.

2.05 GASKETS

- A. Water and Glycol Systems: Branded, compressed, non-asbestos sheet gaskets. Klingersil C4401, Garlock 3000, JM Clipper 978 or approved equal.

2.06 MECHANICAL GROOVED PIPE CONNECTIONS

- A. Manufacturers: Victaulic, Anvil Corp., or Tyco/Grinnell.
- B. Mechanical grooved pipe couplings and fittings may be used with steel pipe on the systems indicated below. Either cut-groove or equivalent roll-groove products are acceptable providing the system temperature and pressure requirements are met. Where ductile iron fittings are indicated, they shall conform to ASTM A536. Where forged steel fittings are indicated, they shall conform to ASTM A234, Grade WPB. Where factory-fabricated steel fittings are indicated, they shall be manufactured from pipe conforming to ASTM A53, type F in sizes 3/4" through 1-1/2" and type E or S, grade B in sizes 2" through 20". Do not use fabricated fittings where malleable iron or forged steel fittings are available. Gaskets in all cases shall be EPDM suitable for temperatures to 230°F.
- C. The following services may use mechanical grooved pipe connections within the building in mechanical spaces and above accessible ceilings. Mechanical chases are not considered accessible unless approved by the Engineer.
- Heating Hot Water
 - Chilled Water
- D. Mechanical grooved pipe connections shall not be used in below grade utility distribution systems.
- E. Mechanical grooved pipe connections shall not be used in chilled water piping between the cooling coil and the isolation valve for that cooling coil.
- F. Fittings and couplings must be suitable for the temperature and pressure involved. In no case is the final system to have a pressure rating of less than 250 psig at the design temperature of the fluid.
- G. Acceptable fittings and couplings are listed below, based on Victaulic. When used on galvanized piping, fittings and couplings shall be galvanized. When used on black steel piping, fittings and couplings shall have an enamel coating.
1. Ductile iron standard couplings: Manufactured in two segments of cast ductile iron, conforming to ASTM A-536, Grade 65-45-12, with pressure-responsive elastomer gasket conforming to ASTM D-2000, and zinc-electroplated carbon steel bolts and nuts conforming to ASTM A-449 and ASTM A-183. Couplings shall comply with ASTM F1476.
 2. Rigid Type: Coupling housings 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 107H/107N (Quick-Vic™). Installation ready rigid coupling for direct stab installation without field disassembly. Gasket shall be Grade "EHP" EPDM designed for operating temperatures from -30 deg F to +250 deg F.
 3. 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, for each connector, shall be placed in close proximity to the vibration source. Victaulic Installation-Ready Style 177 or Style 77.

4. Victaulic AGS Mechanical Couplings, 14 inch (DN350) through 60 inch (DN1500): Couplings shall consist of two housing segments with lead-in chamfer on the housing key, a wide elastomer pressure responsive FlushSeal gasket. Victaulic Style W07 (rigid) and Style W77 (flexible).
- H. Couplings: Reducing couplings are not acceptable.
- I. Flanges: Ductile iron Style 741 / W741 or 743 except at lug type butterfly valves where standard welding flanges shall be used.
- J. Fittings: Ductile iron elbows and tees of the manufacturer's standard line may be used in all sizes except bullhead tees will not be accepted. Factory-fabricated steel fittings may be used in all sizes where fitting wall thickness conforms to standard weight pipe. Mechanical-T Style 920/920N fittings with ductile iron housings may be used for up to 2" outlet size.

PART 3 - EXECUTION

3.01 ERECTION

- A. Carefully inspect all pipe, fittings, valves, equipment and accessories before installation. Any items that are unsuitable, cracked or otherwise defective shall be rejected and removed from the job site immediately. Excluding minor surface rust, piping that exhibits significant oxidation or corrosion will be rejected.
- B. Exercise care at every stage of storage, handling, laying and erecting to prevent entry of foreign matter into piping, fittings, valves, equipment and accessories. Do not erect or install any item that is not clean.
- C. Remove all loose dirt, scale, oil, chips, burrs and other foreign material from the internal and external surfaces of all pipe and piping components prior to assembly, including debris associated with cutting, threading and welding.
- D. During fabrication and assembly, remove slag and weld spatter from internal pipe surfaces at all joints by peening, chipping and wire brushing.
- E. During construction, until system is fully operational, keep all openings in piping and equipment closed except when actual work is being performed on that item of the system. Use plugs, caps, blind flanges or other items designed for this purpose.
- F. Furnish and install all flanges, caps, bypasses, drains, valves, etc. required to facilitate flushing and draining all heating and cooling system piping.
- G. Unions and flanges for servicing or disconnect are not required on installations using grooved joint couplings. The couplings shall serve as disconnect points.
- H. Install all piping parallel to building walls and ceilings and at heights which do not obstruct any portion of a window, doorway, stairway, or passageway. Where interferences develop in the field, offset or reroute piping as required to clear such interferences. In all cases, consult drawings for exact location of pipe spaces, ceiling heights, door and window openings, or other architectural details before installing piping.
- I. Mitered ells, notched tees, and orange peel reducers are not acceptable. On threaded piping, bushings are not acceptable.

- J. "Weldolets" and "Threadolets" may be used for branch takeoffs up to one-half (1/2) the diameter of the main.
- K. Install drains throughout the systems to permit complete drainage.
- L. Do not route piping through transformer vaults or above transformers, panelboards, or switchboards, including the required service space for this equipment, unless the piping is serving this equipment
- M. Install all valves, control valves, and piping specialties, including items furnished by others, as specified and/or detailed. Make connections to all equipment installed by others where that equipment requires the piping services indicated in this section.

3.02 WELDED PIPE JOINTS

- A. Make all welded joints by fusion welding in accordance with ASME Codes, ANSI B31, and State Codes where applicable.
- B. All pipe welding shall be completed by Qualified Welders in accordance with the Contractor's Procedure Specifications.
- C. Contractor will ensure that these steps are followed where pipe sections will be joined by welding:
 - 1. Cleaning – Welding surfaces will be clean and free of defects.
 - 2. Alignment – Inside diameter of piping components will be aligned as accurately as possible. Internal misalignment shall not exceed 1/16".
 - 3. Spacing – Pipe sections will be spaced to allow deposition of weld filler material through the entire weld joint thickness.
 - 4. Girth Butt Welds:
 - a. Girth butt welds shall be complete penetration welds.
 - b. Concavity will not exceed 1/32"
 - c. Under cuts will not exceed 1/32"
 - d. As welded surfaces are permitted however surfaces will be free from coarse ripples, grooves, abrupt ridges and valleys.
- D. Electrodes shall be Lincoln, or approved equal, with coating and diameter as recommended by the manufacturer for the type and thickness of work being done.

3.03 THREADED PIPE JOINTS

- A. Use a Teflon based thread lubricant or Teflon tape when making joints; no hard setting pipe thread cement or caulking will be allowed.

3.04 MECHANICAL GROOVED PIPE CONNECTIONS

- A. Use pipe factory grooved in accordance with the coupling manufacturer's specifications or field grooved pipe in accordance with the same specifications using specially designed tools available for the application.
- B. Lubricate pipe and coupling gasket, align pipe, and secure joint in accordance with the coupling manufacturer's specifications.
- C. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove.
- D. Gaskets shall be verified as suitable for the intended service prior to installation. Gaskets shall be molded and produced by the coupling manufacturer.
- E. The grooved coupling manufacturer's factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and installation of grooved joint products. The manufacturer's representative shall periodically visit the jobsite and review installation. Contractor shall remove and replace any joints deemed improperly installed.
- F. Support pipe as indicated in Section 23 05 29 of these specifications except as modified below. Support each horizontal pipe section at least once between couplings and whenever a change in direction of line flow takes place. Support vertical pipe at every other floor or every other pipe length, whichever is most frequent. Set the base of the riser or the base fitting on a pedestal or foundation.
- G. Follow coupling manufacturer's installation recommendations if they are more stringent than the above requirements.

3.05 COPPER PIPE JOINTS

- A. Remove all slivers and burrs remaining from the cutting operation by reaming and filing both pipe surfaces. Clean fitting and tube with emery cloth or sandpaper. Remove residue from the cleaning operation, apply flux, and assemble joint. Use 95-5 solder or brazing to secure joint as specified for the specific piping service.
- B. Press-Connect Joints for Copper Tubing: Join copper tube and press-connect fittings with tools recommended by fitting manufacturer.
 - 1. Pipe ends must be marked at the required location, using a manufacturer-supplied gauge, to ensure full insertion into the coupling or fitting during assembly.
 - 2. Pipe shall be square cut, properly deburred, and cleaned.
 - 3. Utilize press tool approved by fitting manufacturer.
- C. Where mechanically formed tee fittings are allowed, form mechanically extracted collars in a continuous operation, consisting of drilling a pilot hole and drawing out the tube surface to form a collar having a height of not less than three times the thickness of the tube wall. Use an adjustable collaring device. Notch and dimple the branch tube. Braze the joint, applying heat properly so that pipe and tee do not distort; remove distorted connections.

3.06 COOLING COIL CONDENSATE

- A. Trap each cooling coil drain pan connection with a trap seal of sufficient depth to prevent conditioned air from moving through the piping. Extend drain piping to nearest code approved drain location. Construct trap with plugged tee for cleanout purposes as detailed.

3.07 UNIONS AND FLANGES

- A. Install a union or flange, as required, at each automatic control valve and at each piping specialty or piece of equipment which may require removal for maintenance, repair, or replacement. Where a valve is located at a piece of equipment, locate the flange or union connection on the equipment side of the valve. Concealed unions or flanges are not acceptable.

3.08 GASKETS

- A. Store horizontally in cool, dry location and protect from sunlight, water and chemicals. Inspect flange surfaces for warping, radial scoring or heavy tool marks. Inspect fasteners, nuts and washers for burrs or cracks. Replace defective materials.
- B. Align flanges parallel and perpendicular with bolt holes centered without using excessive force. Center gasket in opening. Lubricate fastener threads, nuts and washers with lubricant formulated for application.
- C. Draw flanges together evenly to avoid pinching gasket. Tighten fasteners in cross pattern sequence (12 – 6 o'clock, 3 – 9 o'clock, etc.), one pass by hand and four passes by torque wrench at 30% full torque, 60% full torque and two passes at full torque per ASME B16.5.

3.09 PIPING SYSTEM LEAK TESTS

- A. Verify that the piping system being tested is fully connected to all components and that all equipment is properly installed, wired, and ready for operation. If required for the additional pressure load under test, provide temporary restraints at expansion joints or isolate them during the test. Verify that hangers can withstand any additional weight load that may be imposed by the test.
- B. Provide all piping, fittings, blind flanges, and equipment to perform the testing.
- C. Conduct pressure test with test medium of air or water unless specifically indicated. Minimum test time is indicated in the table below; additional time may be necessary to conduct an examination for leakage. Each test must be witnessed by the Owner or Owner's representative. If leaks are found, repair the area with new materials and repeat the test; caulking will not be acceptable.
- D. Do not insulate pipe until it has been successfully tested.
- E. For hydrostatic tests, use clean water and remove all air from the piping being tested by means of air vents or loosening of flanges/unions. Measure and record test pressure at the high point in the system.

- F. For air tests, gradually increase the pressure to not more than one half of the test pressure; then increase the pressure in steps of approximately one-tenth of the test pressure until the required test pressure is reached. Examine all joints and connections with a soap bubble solution or equivalent method. The piping system exclusive of possible localized instances at pump or valve packing shall show no evidence of leaking. After testing is complete, slowly release the pressure in a safe manner.

System	Pressure	Medium	Duration
Heating Hot Water	100 psig	Water	8 hr
Chilled Water	100 psig	Water	8 hr

- G. All pressure tests are to be documented on the form included in this specification.
- H. On piping that cannot be tested because of connection to an active line, provide temporary blind flanges and hydrostatically test new section of piping. After completion of test, remove temporary flanges and make final connections to piping. Do not penetrate test pass weld or x-ray the piping that was not hydrostatically tested up to the active system

3.10 HYDRONIC PIPING SYSTEM FLUSHING

- A. All new chilled water and heating hot water system piping shall be flushed thoroughly before the systems are put in to operation. Subsequent to executing the chemical cleaning processes specified in Section 23 25 00 – HVAC WATER TREATMENT, and prior to adding scale and corrosion inhibitors, flush all piping and components with a clean source of water until the discharge from the system is clean. Discharge shall be from drains provided at all low points in the piping, ends of headers and as otherwise necessary to flush and drain the entire system.
- B. Project specific procedures shall be established prior to flushing. Before beginning flushing operations, submit proposed flushing procedures to the Owner's Project Representative for review and approval. Provide sufficient notice to the Owner to allow the flushing operations to be observed.
- C. A clean water source shall be tapped into the system downstream of the main circulation pump(s). Contractor shall identify proposed clean water source along with the method/location of drain discharge and review with the Owner and A/E prior to installing flushing connections to water source and drain outlets. Provide code required temporary backflow prevention for the clean water source if needed. Provide all temporary taps, valves, piping, bypasses and hoses as needed to accomplish flushing procedures.
- D. Flushing sequence for hot water and chilled water systems is as follows:
1. Close isolation valves at all coils and wall fin.
 2. Open the temporary bypasses that connect the ends of supply and return mains.
 3. Flush mains by turning on flushing water source and sequentially opening drains on mains on each floor until the discharge is clean. This will flush the mains without forcing water/debris into the branches and run out pipes.
 4. Close isolation valves located downstream of coils/wall fin.
 5. Open isolation valves located upstream of coils/wall fin.
 6. Open individual drain valves upstream of coils/wall fin until the discharge is clean. This will flush the supply branch and run out lines between the mains and the coils/wall fin without running water/debris through the TCV or coils/wall fin.
 7. Close the individual drain valves upstream of coils/wall fin.
 8. Open drain valves at low points in the return piping mains.

9. Open the individual isolation valves located downstream of the coils/wall fin. This will flush the return branch and run out lines located between the coils/wall fin and the mains back into the mains and out the drains on the return mains. The water going through the coil/wall fin should be already be clean since this section was flushed previously.
 10. Repeat steps 1-3 to clean debris from the mains.
- E. Isolate all coils while flushing risers and mains. Flush the mains on each floor individually, starting at the top of the building and working down towards the basement level. After risers and mains have been flushed clean, individually open the drain valves in each branch circuit to discharge any debris that may have accumulated in the branch piping.
 - F. As directed by Owner, the Contractor will be required to open drain valves at selected locations in the system to verify the effectiveness of flushing procedures. If sediment or debris is identified in the system, it will be flushed again and reinspected at no expense to the Owner.
 - G. After flushing operations are complete, drain and/or blow out any residual water, clean and replace all strainers, and add scale and corrosion inhibitors as specified in Section 23 25 00. Leave flushing connections/valves in place and cap.
 - H. All flushing procedures shall be documented by completing and submitting the report form included at the end of this Section.

3.11 INITIAL FILL AND VENT

- A. Fill hydronic systems with appropriate working fluids as specified. All system fluids shall be chemically treated as specified in Section 23 25 00 – HVAC WATER TREATMENT.
- B. For closed piping systems, all air trapped at high points shall be relieved through the manual air vents prior to notifying T&B Contractor that the systems are ready to be tested and balanced.

3.12 PIPING SYSTEM TEST REPORT

Date Submitted: _____

Project Name: _____

Location: _____ Project No: _____

Contractor: _____

- HVAC
- Refrigeration
- Controls
- Power Plant
- Plumbing
- Sprinkler

Test Medium: Air Water Other _____

Test performed per specification section No. _____

Specified Test Duration _____ Hours Specified Test Pressure _____ psig

System Identification: _____

Describe Location: _____

Test Date: _____	
Start Test Time: _____	Initial Pressure: _____ psig
Stop Test Time: _____	Final Pressure: _____ psig

Tested By: _____ Witnessed By: _____

Title: _____ Title: _____

Signed: _____ Signed: _____

Date: _____ Date: _____

Comments: _____

3.13 PIPING SYSTEM FLUSH REPORT

Date Submitted: _____

Project Name: _____

Location: _____ **Project No:** _____

Contractor: _____

System Identification (check one):

- Heating Hot Water Chilled Water Heat Pump Water
 Heat Reclaim Process Chilled Water Other _____

Describe Procedure: _____

Flush Date: _____ **Start Time:** _____ **Stop Time:** _____

Pressure of Water Source: _____ psig

Describe water source and method of connection to source: _____

Flushed By: _____ **Witnessed By:** _____

Title: _____ **Title:** _____

Company: _____ **Company:** _____

Signed: _____ **Signed:** _____

Date: _____ **Date:** _____

Describe results: _____

END OF SECTION

Clark County Courthouse, Branch 1 & 2 Courtroom Remodel
Neillsville, WI

**SECTION 23 25 00
HVAC WATER TREATMENT**

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Scope. This section includes specifications for chemical treatment of all water, steam, and condensate systems. Included are the following topics:
- B. PART 1 - GENERAL
 - 1. Scope
 - 2. Reference
 - 3. Related Work
 - 4. Quality Assurance
 - 5. Submittals
 - 6. Operation and Maintenance Data
 - 7. Design Criteria
 - 8. Maintenance Service
- C. PART 2 - Products
 - 1. Manufacturers
 - 2. System Cleaner
 - 3. System Inhibitor
 - 4. Algaecides
 - 5. Glycol
 - 6. Closed Water System Treatment
 - 7. Treatment Equipment
- D. PART 3 - EXECUTION
 - 1. Preparation
 - 2. Cleaning Sequence
 - 3. Glycol Water Systems
 - 4. Closed Water Systems
 - 5. Pipe Cleaning and Treatment Report

1.02 REFERENCE

- A. Applicable provisions of Division 1 shall govern work under this Section.

1.03 RELATED WORK

- A. Section 23 05 15 - Piping Specialties

1.04 QUALITY ASSURANCE

- A. Refer to Division 1, General Conditions, Equals and Substitutions.

1.05 SUBMITTALS

- A. Refer to Division 1, General Conditions, Submittals.
- B. Required for all equipment and chemicals specified including data concerning dimensions, capacities, materials of construction, weights, operating sequence, composite wiring diagrams and appropriate identification. Chemical data to include the description of the chemical, its composition, its function, and the associated material safety data sheet.

1.06 OPERATION AND MAINTENANCE DATA

- A. Provide for the services of the manufacturer's trained representative to approve the installation and instruct the Owner in the operation of each system.
- B. Include data on chemical feed pumps, agitators, and other equipment including spare parts lists, procedures, and treatment programs. Include step by step instructions on test procedures including target concentrations.

1.07 DESIGN CRITERIA

- A. Recommend a periodic test procedure and chemical treatment program for each system.
- B. Treat the following systems:
 - Chilled water
 - Hot water
- C. Provide the initial chemical treatment for all systems based on a complete system fluid analysis prior to the equipment installation. The initial chemical treatment supply of chemicals for each system shall be adequate for the start-up and testing period, for the time the systems are being operated by the Contractor for temporary heating and cooling, and for one year after start-up of the system.
- D. The chemicals used in the condenser water treatment system shall use only liquid chemicals and shall contain no phosphates or chromates.
- E. Provide electrical devices, motors, wiring and conduit in accordance with the applicable sections of the Electrical Specifications.

1.08 MAINTENANCE SERVICE

- A. Furnish service and maintenance of treatment systems for one year from date of substantial completion.
- B. Provide monthly technical service visits to perform field inspections and make water analysis on site. Detail findings in writing on proper practices, chemical treating requirements, and corrective actions needed. Submit two copies of field service report after each visit.
- C. Provide laboratory and technical assistance services for the warranty period.
- D. Include two hour training course for operating personnel, instructing them on installation, care, maintenance, testing, and operation of the treatment systems. Arrange course at startup of systems.

- E. Provide site inspection of equipment during scheduled shutdown to evaluate success of the treatment program. Make recommendations in writing based on these inspections.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Betz Entac, Dearborn Div. - W. R. Grace & Co., Fremont Industries, Mitco Water Labs, Mogul Corporation, Nalco Chemical Co., Rhomar Water Management, Western Water Management, or approved equal.

2.02 SYSTEM CLEANER

- A. Blend of organic alkaline penetrants, emulsifiers, surfactants and corrosion inhibitors that remove grease and petroleum products from the interior of piping systems. Cleaners that contain trisodium phosphate are specifically not acceptable.

2.03 SYSTEM INHIBITOR

- A. Scale and corrosion inhibitor consisting of boron nitrite, benzol thiazol, benzotriazole, mercapto-benzo-thiazole, and tolyltrizole silicates.

2.04 ALGAECIDES

- A. Chlorine release agents such as sodium hypochlorite or calcium hypochlorite, or microbiocides such as quaternary ammonia compounds, tributyl tin oxide, methylene bis (thiocyanate), or isothiazolones, all in a liquid format.

2.05 GLYCOL

- A. Inhibited propylene glycol based material specifically designed for use in closed heat transfer systems. Dow Chemical DOWFROST, Union Carbide UCAR Thermofluid, Fremont 9134FG, or approved equal. Glycol to provide system protection to 10°F burst/20°F freeze at 20% glycol volume/80% water volume, and -20°F burst/10°F freeze at 30% glycol volume/70% water volume.
- B. Inhibited ethylene glycol based material specifically designed for use in closed heat transfer systems. Dow Chemical Dowtherm SR-1, Union Carbide UCAR Thermofluid, Fremont 9132, or approved equal. Glycol to provide system protection to -60°F burst/5°F freeze at 30% glycol volume/70% water volume.

2.06 CLOSED WATER SYSTEM TREATMENT

- A. Sequestering agent to reduce deposits and adjust pH: polyphosphate.
- B. Corrosion inhibitors: boron-nitrite, sodium nitrite and borax, sodium tolyltriazole, low molecular weight polymers, phosphonates, sodium molybdate, or sulphites.
- C. Conductivity enhancers: phosphates or phosphonates.

2.07 TREATMENT EQUIPMENT

- A. Bypass Feeder: 5 gallon minimum capacity, 125 psig working pressure, either a screw type cover or a valved funnel opening to feed chemical into the system, prime coat of paint.
- B. Solution Metering Pump: Positive displacement, diaphragm pump with adjustable flow rate, thermoplastic construction, continuous-duty fully enclosed electric motor and drive, and relief valve.
- C. Solution Tanks: [30] [50] gallon capacity, polyethylene, self-supporting, [1] [5] gallon graduated markings; molded fiberglass cover with recess for mounting pump, agitator, and liquid level switch.
- D. Agitator: Totally enclosed electric motor; stainless steel clamp, motor mount, and propeller.
- E. Liquid Level Switch: Polypropylene housing with integrally mounted polyvinylchloride air trap, receptacles for connection to metering pump, and low level alarm contact.
- F. Sample Cooler: Neptune Chemical Pump Co., Sentry Equipment Corp., or approved equal. Shell and coil heat exchanger specifically designed for sample cooling; constructed of 300 series stainless steel coil and shell; not less than one square foot of heat exchange surface; suitable for tube side conditions of pressure to 600 psig and temperature to 600°F with shell side conditions of 200 psig of cooling water at temperatures to 200°F maximum; removable shell for inspection and/or cleaning of the heat exchange surfaces; connections for cooling water inlet and outlet, steam inlet, and cooled condensate outlet.
- G. Conductivity Controller: Packaged monitor controller with solid state circuiting, five percent accuracy, linear dial adjustment, built-in calibration switch, on-off switch and light, control function light, output to control circuit.
- H. Water Meter: Displacement type cold water meter with sealed, tamper-proof magnetic drive, bronze housing, 125 psig minimum working pressure, impulse contact register when required by the sequence, single pole double throw dry contact switch. Meters must be capable of being used with remote readout heads and capable of being sealed to prevent tampering.
- I. Solenoid Valves: Forged brass body, globe pattern, normally open or closed as required, general purpose solenoid enclosure unless another type is recommended for the specific application, and continuous duty coil with voltage compatible with the remainder of the system components. Use stainless steel body and trim in lieu of brass if brass is not compatible with valves installed in the lines handling the chemical treatment.
- J. PACKLESS, GASKETED, TELESCOPING TYPE EXPANSION JOINT: Expansion joint with grooved end telescoping body, suitable for axial end movement to 3". 350 psi (2410 kPa). Equal to Victaulic Style 150 Mover Timers: Electronic timers, infinitely adjustable over full range of 150 seconds to five minutes, mounted together in cabinet with hand-off-automatic switches and status lights.
- K. Hand Pump: Rotary hand pump for dispensing fluid from shipping drums, corrosion resistant housing, steel suction pipe, polyethylene or polyvinylchloride discharge pipe, threaded fitting for connection to a 2" bung opening on the drum head. Hand pump to be capable of pumping against a head of 75 feet.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Prior to cleaning, verify that systems are operational, filled, started, and vented. Use water meter to record capacity in each system.
- B. Place terminal control valves in the full-open position.

3.02 CLEANING SEQUENCE

- A. General:
 - 1. Systems are to be cleaned before they are used for any purpose except conduct pressure test before cleaning. Add cleaner to closed systems at concentrations as recommended by the manufacturer. Remove water filter elements from the system before starting circulation. For steam systems, fill boilers only, using the water and cleaner solution.
 - 2. Use neutralizer agents on recommendation of the system cleaner supplier and approval of the Architect/Engineer.
 - 3. Flush open systems with clean water for one hour minimum. Drain completely and refill.
 - 4. Remove, clean, and replace strainer screens.
 - 5. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.
 - 6. Use the form included in this specification to document system cleaning, flushing, and proper startup.
- B. Hot Water Heating Systems: Add cleaner to the system water until the M alkalinity value is 250 above that of the initial fill water. Verify the M alkalinity level before and after the addition of the cleaner by means of chemical tests that are observed by the Owner's construction representative; include results of all tests in the Operating and Maintenance manuals. Apply heat while circulating, slowly raising temperature to 160°F and maintain for 12 hours minimum; vent all high points to assure 100% system circulation. Remove heat and circulate to 100°F or less; drain system as quickly as possible and refill with clean water. Circulate for 6 hours at design temperature, vent air at all high points, then drain. Refill with clean water and repeat until the system cleaner is removed and the M alkalinity level returns to normal. Remove and clean all strainers. Re-vent the system and install clean filter elements in water filters. Treat with scale and corrosion inhibitors before using the system for building heating.
- C. Chilled Water Systems: Add cleaner to the system water until the M alkalinity value is 250 above that of the initial fill water. Verify the M alkalinity level before and after the addition of the cleaner by means of chemical tests that are observed by the Owner's construction representative; include results of all tests in the Operating and Maintenance manuals. Circulate for 48 hours, then drain system as quickly as possible. Refill with clean water, circulate for 24 hours, then drain. Refill with clean water and repeat until system cleaner is removed and the M alkalinity level returns to normal. Remove and clean all strainers. Re-vent the system and install clean filter elements in water filters. Treat with scale and corrosion inhibitors before using the system for building cooling.

- D. Glycol Water Systems: Clean and flush as indicated above for hot water heating systems. Verify complete drainage by measuring amount of water used for the initial fill versus the amount actually drained to assure complete removal of the cleaning solution. Remove all traces of chloride from the system; test to verify this removal and submit test results.

3.03 GLYCOL WATER SYSTEMS

- A. The Chilled Water system is a glycol water system.
- B. Completely flush all traces of cleaning chemicals before adding the glycol water mixture to the system. Verify this by chemical test.
- C. Premix the glycol water solution in a 55 gallon polyethylene drum to a concentration of 35% (Verify with existing chilled water system) by volume. Use distilled water to make the solution. Use a hand pump to fill system from the mixing tank. Circulate fluid for several hours, vent all high points where air may collect, add more solution to the system if needed, and test the system for proper concentration of glycol; include copy of test report in the Operating and Maintenance manuals.

3.04 CLOSED WATER SYSTEMS

- A. Install a separate bypass type feeder at the pumps for each closed hot water heating and chilled water cooling system. Provide a separate set of supply and return lines from each pump in the system and install ball valves in each of these lines. Locate the system connection that supplies the feeder upstream of the discharge shutoff valve for the pump. Locate the system connection that returns treatment back to the system at a convenient point downstream of the pump discharge shutoff valve. Provide a drain valve at the bottom of the feeder.
- B. Install a water meter upstream of the pressure reducing valve in the makeup line to each closed system. Locate the meter on the domestic water side of the pressure reducing valve and in such a manner that the meter can be easily read.

3.05 PIPE CLEANING AND TREATMENT REPORT

Project Number: _____

Date Submitted: _____

Project Name: _____

Location: _____

Contractor: _____

System Tested:

- Hot Water
- Glycol Water
- Chilled Water
- Fuel Oil
- Condenser Water
- Steam
- Condensate

System Volume: _____

Materials Used (Provide MSDS for each)

Cleaner: _____ Quantity Used: _____
Inhibitor: _____ Quantity Used: _____
Sequestering Agent: _____ Quantity Used: _____
Algaecide: _____ Quantity Used: _____
Neutralizer: _____ Quantity Used: _____
Glycol: _____ Quantity Used: _____
Glycol Sol. Water Source: _____ % Glycol by Vol: _____

M Alkalinity

Prior to Cleaning: _____ During Cleaning: _____ After Flushing: _____

System Temperature

Prior to Cleaning: _____ During Cleaning: _____

Duration

Date/Time Start

Date/Time Stop

Initial Circulation	_____	_____
Drain-down	_____	_____
System Refill	_____	_____
Final Circulation	_____	_____
Heating System Warm-up	_____	_____

Component Checklist (Describe procedures performed at each)

Filters: _____
Vents: _____
Drains: _____
Traps: _____
Branch Lines: _____
Terminal Units: _____
Boilers: _____
Chillers: _____

Comments: _____

END OF SECTION

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**SECTION 23 31 00
HVAC DUCTS AND CASINGS**

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Scope. This section includes specifications for all duct systems used on this project. Included are the following topics:
- B. PART 1 - GENERAL
 - 1. Scope
 - 2. Related Work
 - 3. Reference
 - 4. Reference Standards
 - 5. Quality Assurance
 - 6. Submittals
 - 7. Design Criteria
 - 8. Delivery, Storage, and Handling
 - 9. Warranty
- C. PART 2 - Products
 - 1. General
 - 2. Ductwork Pressure Class
 - 3. Materials
 - 4. Low Pressure Ductwork (Maximum 2 inch pressure class)
 - 5. Duct Sealant
 - 6. Gaskets
- D. PART 3 - EXECUTION
 - 1. Installation
 - 2. Ductwork Support
 - 3. Low Pressure Duct (Maximum 2 inch pressure class)
 - 4. Cleaning
 - 5. Leakage Test
 - 6. Structural Test
 - 7. Duct Leakage Test Report
 - 8. Duct Structural Test Report

1.02 RELATED WORK

- A. Section 23 01 30.51 - HVAC Air Duct Cleaning
- B. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC
- C. Section 23 33 00 - Air Duct Accessories

1.03 REFERENCE

- A. Applicable provisions of Division 1 govern work under this section.

1.04 REFERENCE STANDARDS

- A. ANSI SS-EN 485-2 Aluminum and Aluminum Alloys-Sheet, Strip and Plate-Part 2: Mechanical Properties
- B. ASTM B209 Specification for Aluminum and Aluminum-Alloy Sheet and Plate
- C. ASTM A90 Test Method for Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles
- D. ASTM A167 Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
- E. ASTM A623 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process
- F. ASTM A527 Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Lock-Forming Quality
- G. ASTM 924 Standard Specification for General Requirements for Sheet Steel, Metallic-coated by the Hot-dip Method
- H. ASTM C 1071 Specification for Fibrous Glass Duct Lining Insulation
- I. ASTM C 411 Test Method for Hot Surface Performance of High Temperature Thermal Insulation
- J. ASTM E 84 Test Method for Surface Burning Characteristics of Building Materials
- K. ASTM C 1338 Test Method for Determining Fungal Resistance of Insulation Materials and Facings
- L. ASTM G 21 Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi
- M. ASTM C 916 Standard Specification for Adhesives for Duct Thermal Insulation
- N. NFPA 90A Standard for the Installation of Air Conditioning and Ventilating Systems
- O. UL 181 Standard for Safety for Factory Made Air Ducts and Air Connectors

1.05 QUALITY ASSURANCE

- A. Refer to Division 1, General Conditions, Equals and Substitutions.

1.06 SUBMITTALS

- A. Refer to Division 1, General Conditions, Submittals.
- B. Include manufacturer's data and/or Contractor data for the following:
 - Fabrication and installation drawings.
 - Schedule of duct systems including material of construction, gauge, pressure class, system class, method of reinforcement, joint construction, fitting construction, and support methods, all with details as appropriate.
 - Duct sealant and gasket material.

1.07 DESIGN CRITERIA

- A. Construct all ductwork to be free from vibration, chatter, objectionable pulsations and leakage under specified operating conditions.
- B. Use material, weight, thickness, gauge, construction and installation methods as outlined in the following SMACNA publications, unless noted otherwise:
 - HVAC Duct Construction Standards, Metal and Flexible, 3rd Edition, 2005
 - HVAC Air Duct Leakage Test Manual, 2nd Edition, 2012
 - HVAC Systems - Duct Design, 4th Edition, 2006
 - Rectangular Industrial Duct Construction Standard, 2nd Edition, 2004
 - Round Industrial Duct Construction Standards, 2nd Edition, 1999
 - Thermoplastic Duct (PVC) Construction Manual, 2nd Edition, 1995
- C. Use products which conform to NFPA 90A, possessing a flame spread rating of not over 25 and a smoke developed rating no higher than 50.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Promptly inspect shipments to ensure that Ductwork is undamaged and complies with the specification.
- B. Protect Ductwork against damage.
- C. Protect Ductwork by storing inside or by durable, waterproof, above ground packaging. Do not store material on grade. Protect Ductwork from dirt, dust, construction debris and foreign material. Where end caps/packaging are provided, take precautions so caps/packaging remain in place and free from damage.
- D. Offsite storage agreements do not relieve the contractor from using proper storage techniques.
- E. Storage and protection methods must allow inspection to verify products.

1.09 WARRANTY

- A. All non-fibrous, closed cell, outdoor ductwork shall have a 10 year warranty against defects in workmanship and water leakage.
- B. All fabric duct shall have a 5 year non-prorated warranty.

PART 2 - PRODUCTS

2.01 GENERAL

- A. All sheet metal used for construction of duct shall be 24 gauge or heavier except for round and spiral ductwork and spiral duct take-offs 12" and below may be 26 gauge where allowed in SMACNA HVAC Duct Construction Standards, Metal and Flexible, 3rd Edition, 2005.
- B. Duct sizes indicated on plans are net inside dimensions; where duct liner is specified, dimensions are net, inside of liner.

2.02 DUCTWORK PRESSURE CLASS

- A. Minimum acceptable duct pressure class, for all ductwork except transfer ductwork, is 2 inch W.G. positive or negative, depending on the application. Transfer ductwork minimum acceptable duct pressure class is 1 inch W.G. positive or negative, depending on the application. Duct system pressure classes are indicated on the drawings.

2.03 MATERIALS

- A. **GALVANIZED STEEL SHEET:** Use ASTM A 653 galvanized steel sheet of lock forming quality. Galvanized coating to be 1.25 ounces per square foot, both sides of sheet, G90 in accordance with ASTM A90. Provide "Paint Grip" finish or galvanneal sheet metal for ductwork that will be painted.

2.04 LOW PRESSURE DUCTWORK (Maximum 2 inch pressure class)

- A. Fabricate and install ductwork in sizes indicated on the drawings and in accordance with SMACNA recommendations, except as modified below.
- B. Construct so that all interior surfaces are smooth. Use slip and drive or flanged and bolted construction when fabricating rectangular ductwork. Use spiral lock seam construction when fabricating round spiral ductwork. Sheet metal screws may be used on duct hangers, transverse joints and other SMACNA approved locations if the screw does not extend more than 1/2 inch into the duct.
- C. Use elbows and tees with a center line radius to width or diameter ratio of 1.5 wherever space permits. When a shorter radius must be used due to limited space, install single wall sheet metal splitter vanes in accordance with SMACNA publications, Type RE 3. Where space will not allow and the C value of the radius elbow, as given in SMACNA publications, exceeds 0.31, use rectangular elbows with turning vanes as specified in Section 23 33 00. Square throat-radius heel elbows will not be acceptable. Straight taps or bullhead tees are not acceptable.
- D. Where rectangular elbows are used, provide turning vanes in accordance with Section 23 33 00.
- E. Provide expanded take-offs or 45 degree entry fittings for branch duct connections with branch ductwork airflow velocities greater than 700 fpm. Square edge 90-degree take-off fittings or straight taps will not be accepted.
- F. Button punch snaplock construction will not be accepted on aluminum ductwork.
- G. Round ducts may be substituted for rectangular ducts if sized in accordance with ASHRAE table of equivalent rectangular and round ducts. No variation of duct configuration or sizes permitted except as permitted by the Architect/Engineer.
- H. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible. Divergence upstream of equipment shall not exceed 30 degrees; convergence downstream shall not exceed 45 degrees.

2.05 DUCT SEALANT

- A. Manufacturer: 3M 800, 3M 900, H.B. Fuller/Foster, Hardcast, Hardcast Peal & Seal, Lockformer cold sealant, Mon-Eco Industries, United Sheet Metal, or approved equal. Silicone sealants are not allowed in any type of ductwork installation.
- B. Install sealants in strict accordance with manufacturer's recommendations, paying special attention to temperature limitations. Allow sealant to fully cure before pressure testing of ductwork, or before startup of air handling systems.

2.06 GASKETS

- A. 2" pressure class and lower: Soft neoprene or butyl gaskets in combination with duct sealant for flanged joints.
- B. 3" pressure class and higher: Butyl gaskets.
- C. Fume Hood Exhaust: Butyl gaskets.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Verify dimensions at the site, making field measurements and drawings necessary for fabrication and erection. Check plans showing work of other trades and consult with Architect in the event of any interference.
- B. Make allowances for beams, pipes or other obstructions in building construction and for work of other contractors. Transform, divide or offset ducts as required, in accordance with SMACNA HVAC Duct Construction Standards, Figure 4-7, except do not reduce duct to less than six inches in any dimension and do not exceed an 8:1 aspect ratio. Where it is necessary to take pipes or similar obstructions through ducts, construct easement as indicated in SMACNA HVAC Duct Construction Standards, Figure 4-8, Fig. E. In all cases, seal to prevent air leakage. Pipes or similar obstructions may not pass through high pressure or fume exhaust ductwork.
- C. Test openings for test and balance work will be provided under Section 23 05 93.
- D. Provide frames constructed of angles or channels for coils, filters, dampers or other devices installed in duct systems, and make all connections to such equipment including equipment furnished by others. Secure frames with gaskets and screws or nut, bolts and washers.
- E. Install duct to pitch toward outside air intakes and drain to outside of building. Solder or seal seams to form watertight joints.
- F. Where two different metal ducts meet, the joint shall be installed in such a manner that metal ducts do not contact each other by using proper seal or compound.
- G. Install all motor operated dampers and connect to or install all equipment furnished by others. Blank off all unused portions of louvers, as indicated on the drawings, with 2" board insulation with galvanized sheet metal backing on both sides.

- H. Do not install ductwork through dedicated electrical rooms or spaces unless the ductwork is serving this room or space.
- I. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- J. Provide adequate access to ductwork for cleaning purposes.
- K. Protect diffusers, registers and grilles with plastic wrap or some other approved form of protection to maintain dirt and dust free and to prevent entry of dirt, dust and foreign material into the ductwork.
- L. Install prefabricated grease ductwork assemblies in accordance with manufacturer requirements and NFPA 96.
- M. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.
- N. Ductwork required to be prepared for painting:
 - 1. Surface shall be clean, dry and free from manufacturer's lubricants.
 - 2. Remove dirt and grease from galvanized ductwork with VM&P, Naphtha, or water based commercial detergent and wipe dry with a clean cloth.
 - 3. Surface shall be free of foreign materials that will be adversely affect adhesion or appearance of applied paint coating.

3.02 DUCTWORK SUPPORT

- A. Support ductwork in accordance with SMACNA HVAC Duct Construction Standards, Figure 5-5, except supporting ductwork with secure wire method is not allowed.
- B. Stainless steel air-craft cable hanging systems are allowed on round ductwork under 12" diameter if installed utilizing two fasteners with two cable loops. Support with 3/32", 7 x 7, stainless steel air-craft cable, with matching serrated spring loaded wedge mechanism fasteners rated for actual load. Comply with the manufacturer's installation instructions.

3.03 LOW PRESSURE DUCT (Maximum 2 inch pressure class)

- A. Seal all duct, with the exception of transfer ducts, in accordance with SMACNA seal class "A"; all seams, joints, and penetrations shall be sealed.
- B. Install a manual balancing damper in each branch duct and for each diffuser or grille. The use of splitter dampers, extractors, or grille face dampers will not be accepted for balancing dampers.
- C. Hangers must be wrapped around bottom edge of duct and securely fastened to duct with sheet metal screws or pop rivets. Trapeze hangers may be used at contractor's option.

3.04 CLEANING

- A. Remove all dirt and foreign matter from the entire duct system and clean diffusers, registers, grilles and the inside of air-handling units before operating fans.
- B. Clean duct systems with high power vacuum machines where systems have been used for temporary heat, air-conditioning, or ventilation purposes during construction. Protect equipment that may be harmed by excessive dirt with filters, or bypass during cleaning.

3.05 LEAKAGE TEST

- A. Test all ductwork in accordance with test methods described in Section 5 of SMACNA HVAC Air Duct Leakage Test Manual. Do not insulate ductwork until it has been successfully tested. Test pressure shall be equal to the duct pressure class.
- B. If excessive air leakage is found locate leaks, repair the duct in the area of the leak, seal the duct, and retest.
- C. Leakage rate shall not exceed more than 5% of the system air quantity for low pressure ductwork, determined in accordance with Appendix C of the SMACNA HVAC Air Duct Leakage Test Manual.
- D. Leakage rate shall not exceed more than 1% of the system air quantity for high pressure ductwork, determined in accordance with Appendix C of the SMACNA HVAC Air Duct Leakage Test Manual.
- E. Leakage test for ductwork downstream of air terminal devices may be omitted but will not relieve the contractor from duct sealing requirements.
- F. Submit a signed report to the Owner's Construction Representative, indicating test apparatus used, results of the leakage test, and any remedial work required to bring duct systems into compliance with specified leakage rates.

3.06 STRUCTURAL TEST

- A. Random test all ductwork per A/E direction. Do not insulate ductwork until it has been successfully tested. Test pressure shall be equal to the duct pressure class.
- B. Deflection limits shall not exceed those listed in accordance with Chapter 11 of SMACNA HVAC Duct Construction Standards, 3.0 Performance Requirements.
- C. Submit a signed report to the Owner's Construction Representative, indicating test apparatus used, results of the structural test, and any remedial work required.

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**SECTION 23 33 00
AIR DUCT ACCESSORIES**

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Scope. This section includes accessories used in the installation of duct systems. Included are the following topics:
- B. PART 1 - GENERAL
 - 1. Scope
 - 2. Related Work
 - 3. Reference
 - 4. Reference Standards
 - 5. Quality Assurance
 - 6. Submittals
 - 7. Operation and Maintenance Data
- C. PART 2 - Products
 - 1. Manual Volume Dampers
 - 2. Turning Vanes
 - 3. Control Dampers
 - 4. Access Doors
 - 5. Flexible Duct
 - 6. Duct Lining
 - 7. Duct Flexible Connections
- D. PART 3 - EXECUTION
 - 1. Manual Volume Dampers
 - 2. Turning Vanes
 - 3. Control Dampers
 - 4. Access Doors
 - 5. Flexible Duct
 - 6. Duct Lining
 - 7. Duct Flexible Connections

1.02 RELATED WORK

- A. Section 23 05 29 - Hanger and Supports for HVAC Piping and Equipment
- B. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment
- C. Section 23 31 00 - HVAC Ducts and Casings

1.03 REFERENCE

- A. Applicable provisions of Division 1 govern work under this section.

1.04 REFERENCE STANDARDS

- A. NFPA 90A Standard for Installation of Air Conditioning and Ventilating Systems
- B. SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2nd Edition, 1995

- C. UL 214
- D. UL 555(6th edition) Standard for Fire Dampers and Ceiling Dampers
- E. UL 555S (4th edition) Leakage Rated Dampers for Use in Smoke Control Systems

1.05 QUALITY ASSURANCE

- A. Refer to Division 1, General Conditions, Equals and Substitutions.

1.06 SUBMITTALS

- A. Refer to Division 1, General Conditions, Submittals.
- B. Submit for all accessories and include dimensions, capacities, ratings, installation instructions, and appropriate identification.
- C. Include certified test data on dynamic insertion loss, self-noise power levels, and aerodynamic performance of sound attenuators.
- D. Submit manufacturer's color charts where finish color is specified to be selected by the Architect/Engineer.

1.07 OPERATION AND MAINTENANCE DATA

- A. All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

PART 2 - PRODUCTS

2.01 MANUAL VOLUME DAMPERS

- A. Manufacturers: Ruskin, Vent Products, Air Balance, Pottorff, or approved equal.
- B. Dampers must be constructed in accordance with SMACNA Fig. 2-12, Fig. 2-13, and notes relating to these figures, except as modified below.
- C. Reinforce all blades to prevent vibration, flutter, or other noise. Construct dampers in multiple sections with mullions where width is over 48". Use rivets or tack welds to secure individual components; sheet metal screws will not be accepted. Provide operators with locking devices and damper position indicators for each damper; use an elevated platform on insulated ducts. Provide end bearings or bushings for all volume damper rods penetrating ductwork constructed to a 3" w.c. pressure class or above.

2.02 TURNING VANES

- A. Manufacturers: Aero Dyne, Anemostat, Barber-Colman, Hart & Cooley, or approved equal.
- B. Construct turning vanes and runners for square elbows in accordance with SMACNA Fig. 2-3 and Fig. 2-4 except use only airfoil type vanes. Construct turning vanes for short radius elbows and elbows where one dimension changes in the turn in accordance with SMACNA Fig. 2-5 and Fig. 2-6.

2.03 CONTROL DAMPERS

- A. Control dampers are specified in section 23 09 14.

2.04 ACCESS DOORS

- A. Access door to be designed and constructed for the pressure class of the duct in which the door is to be installed. Doors in exposed areas shall be hinged type with cam sash lock. Hinges shall be steel full length continuous piano type. Doors in concealed spaces may be secured in place with cam sash latches. For both hinged and non hinged doors provide sufficient number of cam sash latches to provide air tight seal when door is closed. Do not use hinged doors in concealed spaces if this will restrict access. Use minimum 1" deep 24 gauge galvanized steel double wall access doors with minimum 24 gauge galvanized steel frames. For non-galvanized ductwork, use minimum 1" deep double wall access door with frame that shall use materials of construction identical to adjacent ductwork. Provide double neoprene gasket that shall provide seals from the frame to the door and frame to the duct. When access doors are installed in insulated ductwork or equipment provide insulated doors with insulation equivalent to what is provided for adjacent ductwork or equipment. Access doors constructed with sheet metal screw fasteners will not be accepted.
- B. Use insulated, 2 hour UL 1978 listed and labeled access doors in kitchen exhaust ducts.

2.05 FLEXIBLE DUCT

- A. Manufacturers: Anco Products, Clevaflex, Thermafex, Flexmaster or approved equal.
- B. Factory fabricated, UL 181 listed as a class 1 duct, and having a flame spread of 25 or less and a smoke developed rating of 50 or under in accordance with NFPA 90A.
- C. Suitable for pressures and temperatures involved but not less than a 180°F service temperature and ± 2 " pressure class, depending on the application.
- D. Duct to be composed of polyester film, aluminum laminate or woven and coated fiberglass fabric bonded permanently to corrosion resistant coated steel wire helix. Two-ply, laminated, and corrugated aluminum construction may also be used.
- E. Where duct is specified to be insulated, provide a minimum 1" fiberglass insulation blanket with maximum thermal conductance of 0.23 K (75°F) and vapor barrier jacket of polyethylene or metalized reinforced film laminate. Maximum perm rating of vapor barrier jacket to be 0.1 perm.

2.06 DUCT LINING

- A. Manufacturers: Manville, Owens-Corning, Knauf, or approved equal.
- B. 1" thick, flexible, mat faced insulation made from inorganic glass fibers bonded with a thermosetting resin with thermal conductivity of .25 Btu inch / hour sq.ft. deg F.
- C. Meet erosion testing per UL 181 or ASTM C 1071 for 5000 fpm maximum air velocity. ASTM C 411 maximum operating temperature rating of 250°F. ASTM E84 flame spread less than 25 and smoke developed less than 50.
- D. Meet requirements of ASTM C 1338 and ASTM G21 for fungi resistance.
- E. Install liner using adhesive conforming to ASTM C 916.

2.07 DUCT FLEXIBLE CONNECTIONS

- A. Material to be fire retardant, be UL 214 listed, and meet the requirements of NFPA 90A.
- B. Connections to be a minimum of 3" wide, crimped into metal edging strip, and air tight. Connections to have adequate flexibility and width to allow for thermal expansion/contraction, vibration of connected equipment, and other movement.
- C. Use coated glass fiber fabric for all applications. Material for inside applications other than corrosive environments, fume exhaust, or kitchen exhaust to be double coated with neoprene, air and water tight, suitable for temperatures between -10°F and 200°F, and have a nominal weight of 30 ounces per square yard. Material used for outdoor applications other than corrosive environments, fume exhaust, or kitchen exhaust to be double coated with Hypalon®, air and water tight, suitable for temperatures between -10°F and 250°F, and have a nominal weight of 26 ounces per square yard.

PART 3 - EXECUTION

3.01 MANUAL VOLUME DAMPERS

- A. Install manual volume dampers in each branch duct and for each grille, register, or diffuser as far away from the outlet as possible while still maintaining accessibility to the damper. Install so there is no flutter or vibration of the damper blade(s).

3.02 TURNING VANES

- A. Install turning vanes in all rectangular, mitered elbows in accordance with SMACNA standards and/or manufacturer's recommendations.
- B. Install double wall, airfoil, 2" radius vanes in ducts with vane runner length 18" or greater and air velocity less than 2000 fpm. Install double wall, airfoil, 4-1/2" radius vanes in ducts with vane runner length 18" or greater and air velocity 2000 fpm or greater.
- C. If duct size changes in a mitered elbow, use single wall type vanes with a trailing edge extension. If duct size changes in a radius elbow or if short radius elbows must be used, install sheet metal turning vanes in accordance with SMACNA Figure 2-5 and Figure 2-6.

3.03 CONTROL DAMPERS

- A. Install dampers in locations indicated on the drawings, as detailed, and according to the manufacturer's instructions. Install blank-off plates or transitions where required for proper mixing of airstreams in mixing plenums. Provide adequate operating clearance and access to the operator. Install an access door adjacent to each control damper for inspection and maintenance.

3.04 ACCESS DOORS

- A. Install access doors where specified, indicated on the drawings, and in locations where maintenance, service, cleaning or inspection is required. Examples include, but are not limited to motorized dampers, fire and smoke dampers, smoke detectors, fan bearings, heating and cooling coils, filters, valves, and control devices needing periodic maintenance.
- B. Size and numbers of duct access doors to be sufficient to perform the intended service. Minimum access door size shall be 8" x 8" size for hand access, 18" x 18" size for shoulder access, or other size as indicated. Install access doors on both inlet and outlet sides of reheat coils as well as other duct mounted coils.
- C. Label fire, smoke and combination fire smoke dampers on the exterior surface of ductwork directly adjacent to access doors using a minimum of 0.5" height lettering reading, "SMOKE DAMPER" or "FIRE DAMPER". Smoke and combination fire smoke dampers shall also include a second line listing the individual damper tag. The tags must be coordinated with the mechanical schedules. Utilize stencils or manufactured labels. All other forms of identification are unacceptable. All labels shall be clearly visible from the ceiling access point.

3.05 FLEXIBLE DUCT

- A. Flexible duct may only be used for final connections of air inlets and outlets at diffuser, register, and grille locations. Where flexible duct is used, it shall be the minimum length required to make the final connections, but no greater than 5 feet in length, and have no more than one (1) 90 degree bend.
- B. Secure inner jacket of flexible duct in place with stainless steel metal band clamp. Secure insulation vapor barrier jacket in place with steel or nylon draw band. Sheetmetal screws and/or duct tape will not be accepted.
- C. Flexible duct used to compensate for misalignment of main duct or branch duct will not be accepted.
- D. Individual sections of flexible ductwork shall be of one piece construction. Splicing of short sections will not be accepted.
- E. Flexible ductwork used as transfer duct shall be sized for a maximum velocity of 300 fpm.
- F. Penetration of any partition, wall, or floor with flexible duct will not be accepted.

3.06 DUCT LINING

- A. Apply lining to ductwork as scheduled.
- B. Do not apply lining to the following ductwork:
 - Outside air ductwork.
- C. Install liner in compliance with the latest edition of NAIMA's Fibrous Glass Duct Liner Standard. Locate longitudinal joints at the corners of duct only. Cut and fit to assure lapped, compressed joints. Coat all transverse and longitudinal joints and edges with adhesive. Provide metal nosing on leading edge where lined duct is preceded by unlined duct. Adhere liner to duct with full coverage area of adhesive. Additionally secure liner to duct using mechanical fasteners spaced as recommended by the liner manufacturer without compressing liner more than 1/8" with the fasteners.

3.07 DUCT FLEXIBLE CONNECTIONS

- A. Install at all duct connections to rotating or vibrating equipment, including air handling units (unless unit is internally isolated), fans, or other motorized equipment in accordance with SMACNA Figure 2-19. Install thrust restraints to prevent excess strain on duct flexible connections at fan inlets and outlets; see Related Work.
- B. For applications in corrosive environments or fume exhaust systems, use a double layer of the Teflon[®] coated fabric when making the connector.

END OF SECTION

**SECTION 23 34 00
HVAC FANS**

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Scope. This section includes specifications for fans that are not an integral part of a manufactured device. Included are the following topics:
- B. PART 1 - GENERAL
 - 1. Scope
 - 2. Related Work
 - 3. Reference
 - 4. Reference Standards
 - 5. Quality Assurance
 - 6. Submittals
 - 7. Operation and Maintenance Data
 - 8. Design Criteria
- C. PART 2 - Products
 - 1. General
 - 2. Backdraft Dampers
 - 3. Power Roof Exhaust Fans
- D. PART 3 - EXECUTION
 - 1. Installation

1.02 RELATED WORK

- A. Section 23 05 13 - Common Motor Requirements for HVAC Equipment
- B. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment
- C. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment

1.03 REFERENCE

- A. Applicable provisions of Division 1 govern work under this section.

1.04 REFERENCE STANDARDS

- A. AMCA 203 AMCA Fan Application Manual - Troubleshooting
- B. AMCA 204 Standard Balance Quality and Vibration Levels for Fans
- C. AMCA 210 Laboratory Method of Testing Fans for Rating
- D. AMCA 211 Certified Ratings Program Product Rating Manual for Fan Air Performance
- E. AMCA 300 Reverberant Room Method for Sound Testing of Fans
- F. AMCA 500-D Laboratory Methods for Testing Dampers for Ratings
- G. ANSI 11 Method of Evaluating Load Ratings of Bearings
- H. NFPA 90A Standard for the Installation of Air Conditioning and Ventilating Systems
- I. NFPA 96 Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations
- J. UL 705 Standard Power Ventilators
- K. UL 705 (SC) Power Roof Ventilators for Restaurant Exhaust Appliances

1.05 QUALITY ASSURANCE

- A. Refer to Division 1, General Conditions, Equals and Substitutions.

1.06 SUBMITTALS

- A. Refer to Division 1, General Conditions, Submittals.
- B. Include dimensions, capacities, fan curves, materials of construction, ratings, weights, motors and drives, sound power levels, appropriate identification and vibration isolation for all equipment. Sound power levels to be based on tests performed in accordance with AMCA Standard 300.
- C. Fan curves shall indicate the relationship of CFM to static or total pressure for various fan speeds. Brake horsepower, recommended selection range, and limits of operation are to also be indicated on the curves. Indicate operating point on the fan curves at design air quantity and indicate the manufacturer's recommended drive loss factor for the specific application. Tabular fan performance data is not acceptable.
- D. For variable air volume application, include data which indicates the effect of capacity control devices on performance.
- E. Submit color selection charts for equipment where applicable.

1.07 OPERATION AND MAINTENANCE DATA

- A. All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

1.08 DESIGN CRITERIA

- A. Tested and certify all fans in accordance with the applicable AMCA test code.
- B. Each fan and motor combination shall be capable of delivering 110% of air quantity scheduled at scheduled static pressure. The motor furnished with the fan shall not operate into the motor service factor when operating under these conditions.
- C. Consider drive efficiency in motor selection according to manufacturer's published recommendation or according to AMCA Publication 203, Appendix L.
- D. Where inlet and outlet ductwork at any fan is changed from that shown on the drawings, provide any motor, drive and/or wiring changes required due to increased static pressure or baffling necessary to prevent uneven airflow or improve mixing.
- E. All internal insulation and other components exposed to the airstream are to meet the flame spread and smoke ratings contained in NFPA 90A.
- F. All roof mounted equipment to be provided with curbs or equipment stands in accordance with specification in Section 23 05 29.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Use fan size, class, type, arrangement, and capacity as scheduled.
- B. Furnish complete with motors, wheels, drive assemblies, bearings, vibration isolation devices, and accessories required for specified performance and proper operation. All single phase motors to have inherent thermal overload protection.
- C. Provide variable pitch sheaves for drives 3 hp and smaller, fixed pitch sheaves for drives 5 hp and larger. Design all drives for 150% of motor rating.
- D. Use OSHA approved belt guards that totally enclose the entire drive. Construct guards of expanded metal to allow for ventilation; provide tachometer openings at shaft locations.
- E. Statically and dynamically balance all fans so they operate without objectionable noise or vibration.
- F. All direct drive fan motors shall be provided with a means for balancing fan speed. E.g., solid state speed controller, potentiometer, VFD, etc.

2.02 BACKDRAFT DAMPERS

- A. Manufacturers: Backdraft dampers shall be provided by the same manufacturer as the specified exhaust fan. Acceptable fan manufacturers are listed under each fan type. Where motorized dampers are indicated, refer to section 23 09 14 and/or 23 33 00 for requirements.
- B. Construction: 18 gauge damper frame, minimum 0.025" thick damper blades with vinyl edge seals, axle, axle bearings and internal linkage. Material and finish shall match duct material where damper is installed, unless otherwise noted.
- C. Performance: Dampers shall have an air leakage rate not greater than 20 cfm/ft² where not less than 24" in either dimension and 40 cfm/ft² where less than 24" in either dimension. The rate of air leakage shall be determined at 1.0" water gauge when tested in accordance with AMCA 500D for such purpose. The dampers shall be labeled by an approved agency.

2.03 POWER ROOF EXHAUST FANS

- A. Manufacturers: Carnes, Greenheck, PennBary, Jenn-Air, Cook, ACME, Twin City Fan, CaptiveAire, or approved equal.
- B. Provide upblast or downblast units as scheduled.

- C. Construction: Fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The spun aluminum structural components shall be constructed of minimum 16 gauge aluminum, bolted to a rigid aluminum support structure. The aluminum base shall have continuously welded curb cap corners for maximum leak protection. The discharge baffle shall have a rolled bead for added strength. A two-piece top cap shall have stainless steel quick release latches to provide access into the motor compartment without the use of tools. An integral conduit chase shall be provided through the curb cap and into the motor compartment to facilitate wiring connections. The motor, bearings and drives shall be mounted on a minimum 14 gauge steel power assembly, isolated from the unit structure with rubber vibration isolators. These components shall be enclosed in a weather-tight compartment, separated from the exhaust airstream. Aluminum bird screen at discharge.
- D. Wheel: Wheel shall be centrifugal backward inclined, constructed of 100% aluminum, including a precision machined cast aluminum hub. Wheel inlet shall overlap an aerodynamic aluminum inlet cone to provide maximum performance and efficiency and minimize noise and turbulence
- E. Motor: AC induction or EC motor as indicated. Motors that are single phase shall have thermal overload protection with integral disconnect switch.
- F. Upblast units handling grease laden vapors to be U.L. listed for conveying such vapors, operating continuously at 300°F. Provide with hinged curb cap and cables, vented curb extension, grease trap with drain connection and absorbent material. No backdraft damper or bird screen allowed in grease applications.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install as shown on the drawings, as detailed, and according to manufacturer's installation instructions.
- B. Install thrust restraints in accordance with the requirements of Section 23 05 48.
- C. Dampers shall be installed in accordance with manufacturer's installation instructions and be installed square and free from racking. Dampers must be accessible to allow inspection, adjustment, and replacement of components. Provide access door as specified under section 23 33 00.
- D. Contractor shall balance blade assembly of destratification fans after installation to assure stable operation.

END OF SECTION

SECTION 23 37 13
DIFFUSERS, REGISTERS & GRILLES

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Scope. This section includes specifications for air terminal equipment. Included are the following topics:
- B. PART 1 - GENERAL
 - 1. Scope
 - 2. Related Work
 - 3. Reference
 - 4. Reference Standards
 - 5. Quality Assurance
 - 6. Submittals
 - 7. Design Criteria
- C. PART 2 - Products
 - 1. Manufacturers
 - 2. Square Ceiling Diffusers - Plaque
 - 3. Side-Wall Registers and Grilles
 - 4. Eggcrate Grille
- D. PART 3 - EXECUTION
 - 1. Installation

1.02 RELATED WORK

- A. Section 23 05 93 – Testing, Adjusting and Balancing for HVAC
- B. Section 23 31 00 - HVAC Ducts and Casings
- C. Section 23 33 00 - Air Duct Accessories

1.03 REFERENCE

- A. Applicable provisions of Division 1 govern work under this section.

1.04 REFERENCE STANDARDS

- A. NFPA 90A - Installation of Air Conditioning and Ventilation Systems.
- B. UL 181 - Factory-Made Air Ducts and Connectors.
- C. ARI-ADC Standard 880.

1.05 QUALITY ASSURANCE

- A. Refer to Division 1, General Conditions, Equals and Substitutions.

1.06 SUBMITTALS

- A. Refer to Division 1, General Conditions, Submittals.
- B. Furnish submittal information including, but not limited to, the following:

- Manufacturer's name and model number
- Identification as referenced in the documents
- Capacities/ratings
- Materials of construction
- Sound ratings
- Dimensions
- Finish
- Color selection charts where applicable
- Manufacturer's installation instructions
- All other appropriate data

1.07 DESIGN CRITERIA

- A. All performance data shall be based on tests conducted in accordance with Air Diffusion Council (ADC) Test Code 1062 GRD 84.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable manufacturers for specific products are listed under each item.

2.02 SQUARE CEILING DIFFUSERS - PLAQUE

- A. Titus model OMNI, Carnes series SFPA/SHPA, Price model ASDP, Tuttle & Bailey series 1100, Metal Aire series 5750, Krueger series PLQ/5PLQ, and Raymon PRO-2.
- B. Aluminum unless otherwise indicated, plaque face furnished with frame type appropriate to installation.
- C. Diffuser shall have throw characteristics of a round diffuser having a 360° horizontal blow pattern.
- D. One-piece removable square face plaque with one-piece backpan.
- E. White, baked enamel finish or powder coat finish, unless otherwise indicated.

2.03 SIDE-WALL REGISTERS AND GRILLES

- A. Titus Series 300 (supply) and Series 350 (return/exhaust), Carnes Model R Series, Price Model 520 (Supply) or 530 (return/exhaust), Metal Aire Series V4000 or H4000, Krueger Series 880, Tuttle & Bailey A54 (supply) and A70D (return/exhaust), Raymon Series RA.
- B. Aluminum unless otherwise indicated, with frame type appropriate to installation.
- C. Fixed blade, 45 degree core return and exhaust registers and grilles unless otherwise indicated.

- D. Opposed blade volume control damper return registers, operable from face, where indicated.
- E. Register and grille sizes as shown on drawings and/or as scheduled.
- F. White, baked enamel finish or powder coat finish, unless otherwise indicated.
- G. Screw holes on surface counter sunk to accept recessed type screws.

2.04 EGGCRATE GRILLE

- A. Titus model 50, Carnes model RAE or RAT, Price model 80, Metal Aire model CC, Krueger model EGC, Tuttle & Bailey CRE 500, or Raymon model ECR.
- B. Aluminum construction with frame type appropriate to installation.
- C. Grille face 1/2" x 1/2" or 1" x 1" grid pattern 1/2" deep with a minimum of 85% free area.
- D. Grille sizes and finishes as shown on drawings and/or as scheduled.
- E. White, baked enamel finish or powder coat finish, unless otherwise indicated.
- F. Screw holes on surface counter sunk to accept recessed type screws.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install grilles, registers and diffusers as shown on drawings and according to manufacturer's instructions.
- B. Unless otherwise indicated, size ductwork drops to diffusers or grilles to match unit collar size.
- C. Seal connections between ductwork drops and diffusers/grilles airtight.
- D. Blank off unused portion of linear slot diffusers and linear bar diffusers and grilles.
- E. Where diffusers, registers and grilles cannot be installed to avoid seeing inside duct, paint inside of duct with flat black paint to reduce visibility.
- F. In clean rooms and animal holding rooms, caulk space between diffuser or grille and ceiling or wall to be air and watertight. Use clear, non-hardening silicone sealant compatible with ceiling or wall surfaces. Sealant shall be resistant to microbiological growth.

END OF SECTION

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**SECTION 23 41 00
PARTICULATE AIR FILTRATION**

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Scope. This section includes specifications for air system filters. Included are the following topics:
- B. PART 1 - GENERAL
 - 1. Scope
 - 2. Related Work
 - 3. Reference
 - 4. Reference Standards
 - 5. Quality Assurance
 - 6. Submittals
 - 7. Operation and Maintenance Data
 - 8. Design Criteria
- C. PART 2 - Products
 - 1. Manufacturers
 - 2. MERV 8 Filters
 - 3. Housings for MERV 8 Filters
 - 4. Filter Gauges
- D. PART 3 - EXECUTION
 - 1. Installation
 - 2. Filter Gauges

1.02 RELATED WORK

- A. Section 23 07 00 - HVAC Insulation
- B. Section 23 73 13 - Modular Indoor Central-Station Air-Handling Units
- C. Section 23 72 00 – Air-to-Air Energy Recovery Equipment

1.03 REFERENCE

- A. Applicable provisions of Division 1 govern work under this section.

1.04 REFERENCE STANDARDS

- A. ASHRAE Standard 52
- B. UL 181 – Standard for Factory-Made Air Ducts and Air Connectors
- C. UL 586 – Standard for High Efficiency Particulate Air Filter Units
- D. UL 900 – Standard for Air Filter Units

1.05 QUALITY ASSURANCE

- A. Refer to Division 1, General Conditions, Equals and Substitutions.

1.06 SUBMITTALS

- A. Refer to Division 1, General Conditions, Submittals.
- B. Include data concerning dimensions, materials, efficiencies, installation instructions and appropriate identification.
- C. Independent test reports verifying filter performance, test procedures and ratings.
- D. Provide two (2) extra sets of filters for each unit that contains filters.

1.07 OPERATION AND MAINTENANCE DATA

- A. All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

1.08 DESIGN CRITERIA

- A. Use UL Class 1 or Class 2 filters unless noted otherwise (Reference applicable UL standard referenced).
- B. Efficiencies indicated in this section are based on ASHRAE Standard 52.
- C. Fan motors have been selected to operate against the resistance of dirty filters as specified in this section.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. American Air Filter, Barnebey-Cheney, Cambridge, Continental, Flanders, Camil-Farr, Mine Safety Appliances, Research Products, BLC Industries or approved equal.

2.02 MERV 8 FILTERS

- A. Use 2" thick, pleated panels, 100% synthetic, self supported media fully bonded and sealed in cardboard frame.
- B. Media nominal rating to be 500 FPM face velocity, 0.20 inch WG initial resistance, 1.0 inches WG recommended final resistance. Average arrestance of filter media shall be 90-92%.
- C. Furnish a side access housing or holding frame as scheduled.
- D. Filter tracks shall be constructed to provide clearance between the pre-filter and final-filter media to facilitate the installation of static pressure tips.

2.03 HOUSINGS FOR MERV 8 FILTERS

- A. Housing or holding frame to be of the same manufacturer as filter media or provided by the air handling unit manufacturer. Contractor fabricated housings or filter racks will not be accepted. Casing and tracks constructed of galvanized or enameled steel or aluminum. Provide access to the media tracks from outside the casing so media and be readily changed. Filter tracks shall be constructed to provide clearance between the pre-filter and final-filter media to facilitate the installation of static pressure tips.

2.04 FILTER GAUGES

- A. Manufacturers: Dwyer, or approved equal.
- B. Direct reading, dial type, diaphragm actuated, in a metal case. Lettering shall be black figures on white background. Provide front recalibration adjustment.
- C. Provide gauges with the following ranges:

<u>Filter Type</u>	<u>Scale Range (inch W.G.)</u>
MERV 8	0.0 to 1.0

- D. Provide one gauge for each filter bank, suitable for flush or surface mounting. Include an air filter gauge accessory package consisting of mounting bracket, aluminum tubing, two static pressure tips, and vent valves for each gauge.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Where air handling equipment is to be used for temporary heating or ventilation of a facility, do not operate the equipment until specified filter media has been installed. Contractor shall be responsible for maintaining the cleanliness of air handling apparatus and air distribution systems during construction through regular inspection and changing of filter media throughout the construction period.
- B. Where air handling apparatus is used during the construction period, install new filter media prior to start of air balancing. Additionally, deliver two new sets of media to the owner prior to substantial completion.
- C. Install units as shown on drawings and details according to manufacturer's instructions.
- D. Reinforce filter holding frames per manufacturer's instructions.
- E. Maintain necessary clearance for changing filters.

3.02 FILTER GAUGES

- A. Install filter gauge static pressure tips upstream and downstream of filters. Mount gauge on outside of filter housing or filter plenum in accessible position outside of the unit housing, install tubing and gauge valves between gauge and sensor tips. Adjust and level each gauge.

END OF SECTION

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SECTION 23 73 12
AIR HANDLING UNIT COILS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Scope. This section contains specifications for coils used in all central station air handling units and field erected air handling units, whether located indoors or outdoors. Included are the following topics:
- B. PART 1 - GENERAL
 - 1. Scope
 - 2. Related Work
 - 3. Reference
 - 4. Reference Standards
 - 5. Quality Assurance
 - 6. Submittals
 - 7. Operation and Maintenance Data
 - 8. Design Criteria
- C. PART 2 - Products
 - 1. Manufacturers
 - 2. Hot Water Coils
 - 3. Chilled Water Coils
- D. PART 3 - EXECUTION
 - 1. Hot Water Coils
 - 2. Chilled Water Coils

1.02 RELATED WORK

- A. Section 23 73 13 - Modular Indoor Central-Station Air-Handling Units
- B. Section 23 82 00 - Convection Heating and Cooling Units

1.03 REFERENCE

- A. Applicable provisions of Division 1 govern work under this section.

1.04 REFERENCE STANDARDS

- A. ARI 410 Forced Circulation Air-Cooling and Air-Heating Coils

1.05 QUALITY ASSURANCE

- A. Refer to Division 1, General Conditions, Equals and Substitutions.

1.06 SUBMITTALS

- A. Refer to Division 1, General Conditions, Submittals.
- B. Including data concerning dimensions, capacities, flow rate, pressure drop, materials of construction, ratings, weights, and appropriate identification at the same time that the air handling equipment in which the coils will be located are submitted.

1.07 OPERATION AND MAINTENANCE DATA

- A. All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

1.08 DESIGN CRITERIA

- A. Select coil sizes, capacities, configuration, and operating characteristics as shown on the plans and/or as scheduled. Coil capacity ratings shall be ARI 410 certified.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Aerofin, Carrier, Daikin, RAE Corporation, Trane, JCI, Marlo, Wing, Dunham Bush, or Control Air.

2.02 HOT WATER COILS

- A. Use galvanized steel casing, end supports, top channel, and bottom channel to produce a rigid frame with allowance for expansion and contraction of the finned tube section.
- B. Construct coils of 0.025 inch tube wall seamless copper tubes of 5/8 inch maximum outside diameter with maximum of 8 aluminum fins per inch suitable for working pressures to 125 psig and temperatures to 250°F. Coil fins may be the continuous serpentine or plate fin type. If more than two rows are required to meet the needed heating capacity at 8 fins per inch, then the fins may be increased up to 12 fins per inch as needed to keep the rows at two maximum.
- C. Coil headers may be constructed of cast iron, steel, or seamless copper. Where cast iron headers are used, expand tubes into the headers. Where steel or copper headers are used braze tubes to header.
- D. Provide coils with bronze spring turbulators where required to provide the capacities indicated.

2.03 CHILLED WATER COILS

- A. Use galvanized steel casing, end supports, top channel, and bottom channel to produce a rigid frame with allowance for expansion and contraction of the finned tube section.
- B. Construct coils of 0.025 inch tube wall seamless copper tubes of 5/8 inch maximum outside diameter with maximum of 8 aluminum fins suitable for working pressures to 200 psig. Coil fins may be the continuous serpentine or plate fin type. If more than eight rows are required to meet the needed cooling capacity at 8 fins per inch, then the fins may be increased up to 12 fins per inch as needed to keep the rows at eight maximum.

- C. Coil headers may be constructed of cast iron, steel, or seamless copper. Where cast iron headers are used, expand tubes into the headers. Where steel or copper headers are used braze tubes to header.
- D. Coils shall be drainable type with drain and vent plugs for each header.

PART 3 - EXECUTION

3.01 HOT WATER COILS

- A. Install in central station air handling unit casings or on structural support frames for field erected units, making allowance for pitching as recommended by the manufacturer. Mount coils in field erected units to allow for individual removal.
- B. Comb bent or crushed fins after installation. Clean dust and debris from each coil to ensure its cleanliness.
- C. Install a separate air vent and drain valve for each coil header in such a manner that the vent and drain valves are located outside of air handling unit casing. Provide offsets in piping to facilitate coil removal.
- D. Unless otherwise specified, pipe coils for counter flow arrangement.
- A. Provide vacuum breaker check valves at coil inlet and outlet.

3.02 CHILLED WATER COILS

- A. Install in central station air handling unit casings or on structural support frames for field erected units, making allowance for pitching as recommended by the manufacturer. Mount coils in field erected units to allow individual removal.
- B. Comb bent or crushed fins after installation. Clean dust and debris from each coil to ensure its cleanliness.
- C. Install a separate air vent and drain valve for each coil header in such a manner that the vent and drain valves are located outside of air handling unit casing. Provide offsets in piping to facilitate coil removal. Unless otherwise specified, pipe coils for counter flow arrangement.
- D. Where coils are installed in ductwork or field erected air handling units, provide a 1-1/2" deep 18 gauge welded stainless steel drain pan as an integral part of the duct or at coil support.
- E. Install condensate drain trap with proper depth from each cooling coil condensate drain to the nearest drain location.

END OF SECTION

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SECTION 23 73 13
MODULAR INDOOR CENTRAL-STATION AIR HANDLING UNITS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Scope. This section includes specifications for indoor central station air handling units. Included are the following topics:
- B. PART 1 - GENERAL
 - 1. Scope
 - 2. Related Work
 - 3. Reference
 - 4. Reference Standards
 - 5. Quality Assurance
 - 6. Submittals
 - 7. Operation and Maintenance Data
 - 8. Design Criteria
- C. PART 2 - Products
 - 1. Manufacturers
 - 2. Casing
 - 3. Access Doors
 - 4. Electrical and Lights
 - 5. Fan Sections
 - 6. Coil Sections
 - 7. Filter Sections
 - 8. Access Sections
 - 9. Filter/Mixing Box Sections
- D. PART 3 - EXECUTION
 - 1. Installation

1.02 RELATED WORK

- A. Section 23 05 13 - Common Motor Requirements for HVAC Equipment
- B. Section 23 05 14 - Variable Frequency Drives
- C. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment
- D. Section 23 31 00 - HVAC Ducts and Casings
- E. Section 23 33 00 - Air Duct Accessories
- F. Section 23 34 00 - HVAC Fans
- G. Section 23 41 00 - Particulate Air Filtration
- H. Section 23 72 00 - Air to Air Energy Recovery Equipment
- I. Section 23 73 12 - Air Handling Unit Coils
- J. Section 23 84 13 - Humidifiers
- K. Division 26 - Electrical

1.03 REFERENCE

- A. Applicable provisions of Division 1 govern work under this section.

1.04 REFERENCE STANDARDS

- A. ARI 430 Standard for Central Station Air Handling Units
- B. NFPA 70 National Electrical Code
- C. NFPA 90A Standard for Installation of Air Conditioning and Ventilation Systems

1.05 QUALITY ASSURANCE

- A. Refer to Division 1, General Conditions, Equals and Substitutions.

1.06 SUBMITTALS

- A. Refer to Division 1, General Conditions, Submittals.
- B. Submit shop drawings including the following information: specific manufacturer and model numbers, submittal equipment identification corresponding to project drawings and schedules, unit dimensional and weight data, materials of construction, capacities and ratings, fan curves, fan type, drive and motor information, vibration isolation, coil performance data, sound power levels, filter information, information for all accessories.
- C. Provide final reviewed submittal information to Division 26 contractor for coordination of motor protection and disconnects.

1.07 OPERATION AND MAINTENANCE DATA

- A. All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

1.08 DESIGN CRITERIA

- A. Furnish factory fabricated modular indoor central-station air handling units complete meeting the configuration shown on drawings and/or as scheduled.
- B. Units to be tested, rated and certified in accordance with ARI Standard 430 and bear ARI certification label.
- C. Units to conform with NFPA 70.
- D. All material shall meet NFPA 90A flame spread and smoke develop rating requirements.
- E. Any revisions made by the Contractor to the inlet and outlet ductwork conditions from that shown on the drawings shall not increase system effect and/or static pressure and shall not decrease mixing efficiencies.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Carrier, Daikin, Trane, JCI, or Dunham Bush.

2.02 CASING

A. WALL/ROOF CONSTRUCTION

1. Construct walls and roof from 2"thick double wall panel assemblies. Panels shall be injected with polyurethane foam insulation and shall have a minimum thermal conductivity (R) of at least 12.5. The outer shell shall be constructed of solid G90 galvanized steel with baked enamel or mill galvanized finish or G40 galvanized steel with gardobond finish. The inner liner shall be constructed of solid G90 galvanized steel or G40 galvanized steel with gardobond finish. Panels shall be gasketed with permanently applied bulb-type gaskets and able to be removed without affecting the integrity of casing structure.
2. Under 55°F supply air temperature and design conditions on the exterior of the unit of 91°F dry bulb and 74°F wet bulb, condensation shall not form on the casing exterior. The AHU manufacturer shall provide tested casing thermal performance for the scheduled supply air temperature plotted on a psychrometric chart. The design condition on the exterior of the unit shall also be plotted on the chart. If tested casing thermal data is not available, AHU manufacturer shall provide, in writing, a guarantee against condensation forming on the unit exterior at the stated design conditions above. The guarantee shall note that the AHU manufacturer will cover all expenses associated with modifying or replacing units should external condensate form on them
3. Wall/Roof panel deflection shall not exceed L/240 ratio at a maximum ±5 inches of static pressure. Deflection shall be measured at the midpoint of the panel.

B. FLOOR CONSTRUCTION

1. Construct floors from 2"thick double wall panel assemblies. Panels shall be injected with polyurethane foam insulation and shall have a minimum thermal conductivity (R) of at least 12.5. The outer shell shall be constructed of solid G90 galvanized steel with baked enamel or mill galvanized finish or G40 galvanized steel with gardobond finish. The inner liner shall be constructed of solid G90 galvanized steel or G40 galvanized steel with gardobond finish. Panels shall be gasketed with permanently applied bulb-type gaskets.
2. Under 55°F supply air temperature and design conditions on the exterior of the unit of 91°F dry bulb and 74°F wet bulb, condensation shall not form on the casing exterior. The AHU manufacturer shall provide tested casing thermal performance for the scheduled supply air temperature plotted on a psychrometric chart. The design condition on the exterior of the unit shall also be plotted on the chart. If tested casing thermal data is not available, AHU manufacturer shall provide, in writing, a guarantee against condensation forming on the unit exterior at the stated design conditions above. The guarantee shall note that the AHU manufacturer will cover all expenses associated with modifying or replacing units should external condensate form on them.
3. Floor panel deflection shall not exceed L/240 ratio based upon a 300 lb concentrated load at the mid-span of the panel.
4. A full perimeter base rail shall be installed at each air handling unit. The base rail shall be constructed from a minimum of 16 gauge G90 galvanized steel and shall be at least 6" high. Panels shall be able to be removed without affecting the integrity of casing structure.

- C. LEAKAGE RATE. Leakage rate shall not exceed 1% of the total system air quantity when subjected to ±5" static pressure.

D. CASING PENETRATIONS

1. Install sealing collars to the interior and exterior of each penetration to prevent air leakage where coil piping, humidifier piping, air vents, drain piping, and electrical conduits penetrate air handling unit casing. Silicone sealants and duct sealants are not acceptable to seal pipe penetrations of the air handling unit casing.
2. Duct sealant and/or gaskets as indicated in specification section 23 31 00 may be utilized to seal duct connections to the air handling unit casing. Silicone sealants are not acceptable.

2.03 ACCESS DOORS

- A. Access doors shall be double wall, of same construction and thickness as casing, hinged, continuously gasketed with bulb type gaskets, reinforced nylon handles with cam type latches, and inspection windows (where indicated). Door swing shall open in direction against pressure of the section. If not possible, safety chains or secondary latches shall be provided along with labels indicating that the access door opens with the pressure of the unit/section. Provide access doors on both sides of casing, or as indicated on drawings, for fan sections, access sections, air to air energy recovery sections, filter sections, damper sections, air blender sections and upstream and downstream of every coil and humidifier.

2.04 ELECTRICAL AND LIGHTS

- A. Electrical receptacles, switches and unit lighting shall be provided by the Division 26 contractor. Wiring and conduit for receptacles, motors, and unit lighting shall be field installed by the Division 26 contractor. Coordinate openings in the casing with the Division 26 contractor. Sealing of openings shall be the responsibility of the Division 26 contractor.

2.05 FAN SECTIONS

- A. Double width, double inlet, housed centrifugal type or single width single inlet plenum type, statically and dynamically balanced fans. For variable speed applications, fan shall be dynamically balanced through entire range of operation. Fan wheels shall be backward inclined, forward curved or airfoil type as specified or required by performance characteristics.
- B. Each fan and motor combination shall be capable of delivering 110% of air quantity scheduled at scheduled static pressure. The motor furnished with the fan shall not operate into the motor service factor when operating under these conditions.
- C. Fans to be fastened to hollow or solid steel shafts and designed for continuous operation at maximum rated static pressure.
- D. Fan bearings shall be self-aligning, pillow block, regreasable ball type selected for a minimum average L-50 life of 200,000 hours. Provide bearing protection grounding rings for motors used on variable frequency drives as specified in Section 23 05 13.
- E. Furnish variable pitch sheaves for drives 3 hp and smaller, fixed pitch sheaves for drives 5 hp and larger. Drives shall be designed for 150% of motor rating. Furnish OSHA approved belt guards for all fans.
- F. Consider drive efficiency in motor selection according to manufacturer's published recommendation or according to AMCA Publication 203, Appendix L.

- G. Furnish a metal access guard at the access door of all plenum fan sections. A wheel guard may be substituted if a metal access guard is not available from the manufacturer.
- H. Fan, drive and motor assembly shall be mounted inside fan casing section and integrally isolated within unit. Vibration isolation shall be in compliance with section 23 05 48. Provide flexible connection and thrust restraints at fan discharge connection to casing.
- I. Furnish galvanized mesh inlet screens for fans without inlet ductwork connections.
- J. Furnish a label inside the fan section that identifies the specifications of the v-belt drive kit. Include motor sheave, drive sheave and belt data.
- K. Fan motors shall be provided in accordance with section 23 05 13.

2.06 COIL SECTIONS

- A. Coils shall be provided in accordance with section 23 73 12.
- B. Air handling unit coils mounted in casing shall be accessible for removal from either side of unit casing without disturbing adjacent sections.
- C. Entire coil frame, headers and U-bends shall be enclosed within air handling unit casing. Extend coil piping connections, air vent and drain connections to exterior of casing.
- D. Support coils along entire length within casing and pitch coil for proper drainage.
- E. Blank off space between coil frames and air handling unit casing.
- F. Fabricate cooling coil drain pans from type 304 stainless steel. Install a drain pan under each cooling coil. Extend drain pans the entire width of each coil, including the header, and from the upstream face of each coil to a distance $\frac{1}{2}$ of the vertical coil height of the bottom coil or 6", whichever is greater, downstream from the downstream face. Pitch drain pans in two directions towards the outlet. Pipe drain pans individually down to the drain pan below using a minimum 1" type 304 stainless steel piping. The bottom drain pan shall be piped to the exterior of the unit base using a minimum of 1.25" type 304 stainless steel piping.

2.07 FILTER SECTIONS

- A. Filter box section may be furnished by air handling unit manufacturer in accordance with specification requirements of section 23 41 00. Provide static pressure taps that are arranged to prevent damage to the filter elements during replacement. Provide gap between final and prefilters for static pressure probes.

2.08 ACCESS SECTIONS

- A. Provide access sections where shown on drawings.

2.09 FILTER/MIXING BOX SECTIONS

- A. Filters shall be horizontal V-bank arrangement and shall meet specification requirements of section 23 41 00.
- B. The damper blades shall be arranged so that the air streams are directed at one another to facilitate mixing.

- C. Reference drawings for damper arrangement.
- D. Reference section 23 09 14 for damper construction and damper actuation requirements.

2.10

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install all air handling units and accessories as indicated on drawings and/or as scheduled and according to manufacturer's installation instructions.
- B. Mount units at appropriate height above floor to insure proper condensate trap depth and condensate drainage.
- C. Install air-handling unit to provide for adequate service access. Coordinate with other trades to assure air handling unit does not infringe upon access or service clearances of other equipment.
- D. Lubricate fan bearings. Verify fan isolators have proper deflection.
- E. Upon completion of installation of air handling units, start-up and operate equipment to demonstrate capability and compliance with requirements. Field correct malfunctioning components, then retest to demonstrate compliance.
- F. Furnish one spare set of fan drive belts and three reinforced nylon access door handles.
- G. Installing Contractor shall train the Owner on equipment and accessories as indicated in Section 23 05 00 regarding operations, maintenance, and troubleshooting.

END OF SECTION

SECTION 26 01 00

BASIC ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1.01 SCOPE OF PROJECT

- A. This project consists of (2) remodeled court rooms and associated jury rooms, along with HVAC work and shall include all material to provide for the completion of all work associated with the following, but not be limited to the following:
1. Minor demolition work.
 2. Low voltage conduit and wire.
 3. Starters and disconnects.
 4. Wiring Devices.
 5. Interior lighting.
 6. Voice and data wiring (rough-in only).
 7. Sound system (rough-in only).
 8. A/V system (rough-in only).
 9. Access control (rough-in only).

1.02 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this and the other sections of Division 26.

1.03 REQUIREMENTS OF REGULATORY AGENCIES AND STANDARDS

- A. Equipment, fixtures, material and installation shall conform to the requirements of the local Building Department, the serving utility companies, the National Electrical Code, National Electrical Safety Code, Life Safety Code, Occupational Safety and Health Act, and applicable national, state, and local codes, ordinances, and regulations.
- B. All equipment shall be equal to, or exceed, the minimum requirements of NEMA, IEEE, and UL.
- C. Should any change in Drawings or Specifications be required to comply with governmental regulations, the Contractor shall notify Architect/Engineer prior to execution of the Work. The work shall be carried out according to the requirements of such code in accordance with the instruction of the Architect/Engineer and at no additional cost to the Owner.
- D. The provisions of Standards, Codes, Laws, Ordinances, etc., shall be considered minimum requirements. In case of conflict between their published requirements, the Owner's Representative shall determine which is to be followed and his decision shall be binding. Specific requirements of this specification or the drawings, which exceed the published requirements, shall take precedence over them.

1.04 QUALITY ASSURANCE

- A. Work under this Division shall be supervised by a person who holds a certification issued by the Wisconsin Department of Safety and Professional Services as a certified electrical contractor, certified electrical contractor-restricted or certified master electrician.
- B. Work under this Division shall be executed by a person who holds a certification issued by the Wisconsin Department of Safety and Professional Services as a certified electrical contractor, certified electrical contractor-restricted, certified master electrician, certified journeyman electrician or certified beginning electrician.

1.05 FEES

- A. All local fees, permits, and services of inspection authorities shall be obtained and paid for by the Contractor. The Contractor shall cooperate fully with local utilities with respect to their services. The Owner shall pay fees, service charges, tap charges, meter charges, and special fees assessed by the local utilities.

1.06 SCOPE OF WORK

- A. Electrical Installations: This division of the specifications covers the electrical systems of the project. It includes work performed by the electrical trades as well as trades not normally considered as electrical trades.
- B. Provide all incidentals, equipment, appliances, services, hoisting, scaffolding, supports, tools, supervision, labor consumable items, fees, licenses, etc., necessary to provide complete systems. Perform start-up and checkout on each item and system to provide fully operable systems.
- C. Examine and compare the Electrical Drawings with these specifications, and report any discrepancies between them to the Architect/Engineer and obtain from him written instructions for changes necessary in the work. At time of bid the most stringent requirements must be included in the bid.
- D. Examine and compare the Electrical Drawings and Specifications with the Drawings and Specifications of other trades, and report any discrepancies between them to the Architect/Engineer and obtain from him written instructions for changes necessary in the work. At time of bid, the most stringent requirements must be included in said bid.
- E. Install and coordinate the electrical work in cooperation with other trades installing interrelated work. Before installation, make proper provisions to avoid interferences in a manner approved by the Architect/Engineer. All changes required in the work of the Contractor, caused by his neglect to do so, shall be made by him at his own expense.
- F. It is the intent of the Drawings and Specifications to provide a complete workable system ready for the Owner's operation. Any item not specifically shown on the Drawings or called for in the Specifications, but normally required to conform with the intent, are to be considered a part of the Contract.
- G. All materials furnished by the Contractor shall be new and unused (temporary lighting and power products are excluded) and free from defects. All materials used shall bear the Underwriter's Laboratory, Inc. label provided a standard has been established for the material in question.

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- H. Except for conduit, conduit fittings, outlet boxes, wire and cable, all items of equipment or material shall be the product of one manufacturer throughout the entire project. Multiple manufacturers will not be permitted.

1.07 DEFINITIONS

- A. "PROVIDE" means to furnish, install, purchase, transport, place, erect, connect, wire, test, and turn over to Owner, complete and ready for regular operation, the particular Work referred to.
- B. "INSTALL" means to set in place, join, unite, fasten, link, attach, wire, set up, or otherwise connect together before testing and turning over to Owner, complete and ready for regular operation, the particular Work referred to.
- C. "FURNISH" means to purchase, supply, and deliver to job site, all materials, equipment, testing apparatus, controls, tests, accessories, and all other items customarily required for the proper and complete application for the particular Work referred to.
- D. "WIRE", "WIRING" means the inclusion of all raceways, fittings, conductors, connectors, tape, junction and outlet boxes, connections, splices, and all other items necessary and/or required in connection with such Work.
- E. "CONDUIT" means the inclusion of all fittings, hangers, supports, sleeves, etc
- F. "AS DIRECTED" means as directed by the Architect/Engineer, or his representative.
- G. "CONCEALED" means embedded in masonry or other construction, installed behind wall furring or within double partitions, or installed above hung ceilings.

1.08 COORDINATION OF THE WORK

- A. Certain materials will be provided by other trades. Examine the Contract Documents to ascertain these requirements.
- B. Carefully check space requirements with other trades and the physical confines of the area to insure that all material can be installed in the spaces allotted thereto including finished suspended ceilings and the spaces within the existing building. Make modifications thereto as required and approved.
- C. Transmit to other trades all information required for work to be provided under their respective Sections in ample time for installation.
- D. Wherever work interconnects with work of other trades, coordinate with other trades to insure that all trades have the information necessary so that they may properly install all the necessary connections and equipment. Identify all items of work that require access so that the ceiling trade will know where to install access doors and panels.
- E. Coordinate, project and schedule work with other trades in accordance with the construction sequence.

- F. The Drawings show only the general run of raceways and approximate location of outlets. Any significant changes in location of outlets, cabinets, etc., necessary in order to meet field conditions shall be brought to the immediate attention of the Architect/Engineer and receive his approval before such alterations are made. All such modifications shall be made without additional cost to the Owner.
- G. Obtain from the Architect/Engineer in the field the location of such outlets or equipment not definitely located on the Drawings.
- H. Circuit "tags" are used to show the circuit number and the panel designation for wiring devices and luminaires. Equipment circuits are indicated on equipment connection schedule. Show the actual circuits numbers on the finished record drawings and on panel directory card. Where circuiting is not indicated, Electrical Subcontractor must provide required circuiting in accordance with the loading indicated on the drawings and/or as directed.
- I. Adjust location of conduits, panels, equipment, pull boxes, fixtures, etc. to accommodate the work to prevent interferences, both anticipated and encountered. Determine the exact route and location of each raceway prior to fabrication.
 - 1. Right-of-Way
 - a. Lines that pitch have the right-of-way over those that do not pitch. For example: steam, condensate, and plumbing drains normally have right-of-way. Lines whose elevations cannot be changed to have right-of-way over lines whose elevations can be changed.
 - b. Make offsets, transitions and changes in direction in raceways as required to maintain proper headroom in pitch of sloping lines whether or not indicated on the Drawings.
- J. Wherever the work is of sufficient complexity, prepare additional Detail Drawings to scale similar to that of the bidding Drawings of the same size as the Contract Drawings. With these layouts, coordinate the work with the work of other trades. Such detailed work to be clearly identified on the Drawings as to the area to which it applies. Submit for review Drawings clearly showing the work and its relation to the work of other trades before commencing shop fabrication or erection in the field.
- K. Coordinate with the local Electric Utility Company and the local Telephone Company as to their requirements for service connections and provide all necessary materials, labor and testing.
- L. Coordinate with contractors for work under other Divisions of this specification for all work necessary to accomplish this contractor's work.

1.09 PROGRESS OF WORK

- A. The Contractor shall order the progress of his work to conform to the progress of the work of other trades and shall complete the entire installation as soon as the conditions of the building will permit. Any cost resulting from the defective or ill-timed work performed under this section shall be borne by the Contractor.

1.10 DELIVERY, STORAGE AND HANDLING

- A. Ship and store all products and materials in a manner that will protect them from damage, weather and entry of debris. If items are damaged, do not install, but take immediate steps to obtain replacement or repair. Any such repairs shall be subject to review and acceptance of the manufacturer and Architect/Engineer.
- B. Deliver materials in manufacturer's unopened container fully identified with manufacturer's name, trade name, type, class, grade, size and color.
- C. Store materials suitably sheltered from the elements, but readily accessibly for inspection by the Architect/Engineer until installed. Store all items subject to moisture damage in dry, heated spaces.

1.11 EQUIPMENT ACCESSORIES

- A. Provide supports, hangers and auxiliary structural members required for support of the work.
- B. Furnish and set all sleeves for passage of raceways through structural, masonry and concrete walls of floors and elsewhere as will be required for the proper protection of each raceway passing through building surfaces.
- C. Wall mounted equipment may be directly secured to wall by means of steel bolts. Maintain at least 1" air space between equipment and supporting wall. Groups or arrays of equipment may be mounted on adequately sized steel angles, channels, or bars. Prefabricated steel channels providing a high degree of mounting flexibility, such as those manufactured by Kindorf, Glob-Strutt and Unistrut, may be used for mounting arrays of equipment.

1.12 OPERATIONS AND MAINTENANCE MANUALS

- A. General: Provide operations & maintenance (O&M) manuals in accordance with the Contract Documents.
 - 1. Provide two (2) copies of each manual.
 - 2. Manuals shall be 8-1/2 inches X 11 inches in hard cover 3-ring loose-leaf binders.
 - 3. Manuals shall be complete and in Owner's hands prior to turning building over to Owner and at least 10 days prior to instruction to operating personnel.
- B. Provide manufacturer's literature as regularly published by the respective manufacturers for proper preventative and comprehensive maintenance.
- C. Provide O&M manuals including but not limited to the following:
 - 1. Alphabetical list of all system components, with the name, address, and 24-hour phone number of the company responsible for servicing each item during the first year of operation.
 - 2. Operating instructions for complete system including:
 - a. Normal starting, operating, and shut-down.
 - b. Emergency procedures for fire or failure of major equipment.

- c. Summer and winter special procedures, if any.
- d. Day and night special procedures, if any.
- 3. Maintenance instruction including:
 - a. Proper lubricants and lubricating instructions for each piece of equipment, and date when lubricated.
 - b. Necessary cleaning, replacement and/or adjustment schedule.
- 4. Manufacturer's data for each piece of equipment including:
 - a. Installation instructions.
 - b. Drawings and specifications.
 - c. Parts list, including recommended items to be stocked.
 - d. Complete wiring diagrams.
 - e. Marked or changed prints locating all concealed parts and all variations from the original system design.
 - f. Test and inspection certificates.

D. Refer to individual specification sections for additional O&M requirements.

1.13 RECORD DOCUMENTS

- A. Prepare record ("as-built") documents in accordance with the requirements in Division 1. In addition to the requirements specified in Division 1, indicate installed conditions for:
 - 1. Major raceway systems, size, and location, for both exterior and interior; locations of control devices; distribution and branch electrical circuitry; and fuse and circuit breaker size and arrangements.
 - 2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
 - 3. Approved substitutions, contract modifications, and actual equipment and materials installed.

1.14 GUARANTEE

- A. Guarantee all material and workmanship for a period of one (1) year from date of final acceptance by the Owner, except that where guarantees or warranties for longer terms are specified elsewhere, such longer term to apply. Within 24 hours after notification, correct any deficiencies that occur during the guarantee period at no additional cost to the Owner, all to the satisfaction of the Owner and Architect/Engineer. Obtain similar guarantees from subcontractors, manufacturers, suppliers and subtrade specialists.
- B. See Division 1 – Closeout Procedures, for additional warranty requirements.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Applicable equipment and materials shall be listed by Underwriters' Laboratories and Manufactured in accordance with ASME, NEMA, ANSI or IEEE standards, and as approved by local authorities having jurisdiction as mentioned in Division 1.
- B. If products and materials are specified or indicated on the Drawings for a specific item or system, use those products or materials. If products and materials are not listed in either of the above, use first class products and materials, subject to approval of Shop Drawings where Shop Drawings are required or as approved in writing where Shop Drawings are not required.
- C. All equipment capacities, etc. are listed for job site operating conditions. All equipment sensitive to altitudes or ambient temperatures to be derated and method of derating shown on Shop Drawings. Where operating conditions shown differ from the laboratory test conditions, the equipment to be derated and the method of derating shown on Shop Drawings.

2.02 SUBSTITUTION OF MATERIALS OR EQUIPMENT

- A. All requests for substitution of materials or equipment shall be made in writing. The request for prior approval must be in the Engineers office not less than 10 days prior to the bid date. Samples of proposed substitute materials or equipment shall be submitted to the Engineer for review whenever they are requested. Bids shall be based only upon the specified materials and equipment, or substitutes that have received written acceptance from the Engineer prior to the bid.
- B. Wherever the words "for approval" or "approved" are used in regard to manufactured specialties, or wherever it is desired to substitute a different make or type of apparatus for that specified, submit all information pertinent to the adequacy and adaptability of the proposed apparatus, and secure Architect/Engineer's acceptance before apparatus is ordered.
- C. Wherever quantities or a definite make and size of apparatus are specified, the make and size of apparatus which is proposed must conform substantially (in regard to the operating results) to that specified or implied. Same shall apply to important dimensions relating to operation of apparatus in coordination with the rest of the system, or to properly fitting it into available space conditions. Any substitution of equipment or apparatus shall include all necessary revisions, as required to complete the installation.
- D. Acceptance of substitutions, for equipment specified herein, will not be given merely upon submission of manufacturer's names and will be given only after receipt of complete and satisfactory performance data covering the complete range of operating conditions in tabular and graphical form. Furnish complete and satisfactory information relative to equipment dimensions, weight, etc. Acceptance of all equipment specified or shown on the Drawings, or substitutions submitted for that specified or shown on the Drawings, will be granted if such equipment, in the opinion of the Architect/Engineer, conforms to the performance requirements, space conditions, weight requirements and quality requirements. Any additional construction and design costs incurred as a result of any accepted substitution shall be borne by the Contractor. The opinion and judgment of the Architect/Engineer shall be final, conclusive, and binding.

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2.03 SUBMITTALS

- A. Submit through General or Prime Contractor. Refer to Division 1 – Section ‘Submittals’.
- B. Prepare and submit one (1) electronic copy of Shop Drawings for materials, systems, and equipment as listed herein, including locations and sizes of all openings in floor decks, walls, and floors.
- C. The Work described in any Shop Drawing submission shall be carefully checked for all clearances (including those required for maintenance and servicing), field conditions, maintenance of architectural conditions, and proper coordination with all trades on the job. Each submitted Shop Drawing shall include a certification that all related job conditions have been checked and that no conflict exists.
- D. All drawings shall be submitted sufficiently in advance of field requirements to allow ample time for checking and resubmitting as may be required. All submittals shall be complete and contain all required and detailed information.
- E. Acceptance of any submitted data or Shop Drawings for material, equipment apparatus, devices, arrangements, and layout shall not relieve Contractor from responsibility of furnishing same of proper dimensions and weight, capacities, sizes, quantity, quality and installation details, to efficiently perform the requirements and intent of the Contract. Such acceptance shall not relieve Contractor from responsibility for errors, omissions, or inadequacies of any sort on submitted data or Shop Drawings.
- F. Each Shop Drawing shall contain the following information.
 - 1. Provide general information on each copy of the submittal.
 - a. Project title.
 - b. Reference to the applicable drawing and specification article.
 - c. Identify each device per the schedules and drawings.
 - d. Contractor and supplier identification, addresses and telephone numbers.
 - e. Submittal Date.
 - f. Tab each submittal with its specification section. Do not supply a complete submittal without breaking out each specification section.
 - 2. Certification that the contractor has reviewed the submittal.
 - 3. Refer to individual specification sections for additional information requirements.
- G. Shop Drawing submittals shall be provided for each specific material, system, or equipment as identified herein.
 - 1. As a minimum, make submittals on the following items:
 - a. Raceways, conduit & wire
 - b. Wiring devices and plates
 - c. Disconnect switches
 - d. Lighting fixtures, lamps
 - 2. Refer to individual specification sections for additional submittal requirements.

END OF SECTION

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SECTION 26 01 10

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Requirements specified in Division 26 Section "Basic Electrical Requirements" apply to this Section.
- C. This Section includes limited scope general construction materials and methods for application with electrical installations as follows:
 - 1. Joint sealers for sealing around electrical materials and equipment; and for sealing penetrations in fire and smoke barriers, floors, and foundation walls.
 - 2. Cutting, patching, and repairing.
 - 3. Excavation, trenching, and backfill.
 - 4. Waterproofing.
 - 5. Supports.
 - 6. Fastenings.
 - 7. Testing equipment and materials.
 - 8. Cleaning up.

1.02 DEFINITIONS

- A. The following definitions apply to excavation operations:
 - 1. Additional Excavation: Where excavation has reached required subgrade elevations, if unsuitable bearing materials are encountered, continue excavation until suitable bearing materials are reached. The Contract Sum may be adjusted by an appropriate Contract Modification.
 - 2. Subbase: As used in this Section refers to the compacted soil layer used in pavement systems between the subgrade and the pavement base course material.
 - 3. Subgrade: As used in this Section refers to the compacted soil immediately below the slab or pavement system.
 - 4. Unauthorized excavation: Consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction from the Engineer.

1.03 DELIVERY, STORAGE, AND HANDLING

- A. Deliver joint sealer materials in original unopened containers or bundles with labels informing about manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multi-component materials.
- B. Store and handle joint sealer materials in compliance with the manufacturers' recommendations to prevent their deterioration and damage.

PART 2 PRODUCTS

2.01 JOINT SEALERS

- A. General: Joint sealers, joint fillers, and other related materials compatible with each other and with joint substrates under conditions of service and application.
- B. Colors: As selected by the Engineer from manufacturer's standard colors.
- C. Elastomeric Joint Sealers: Provide the following types:
 - 1. One-part, nonacid-curing, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for masonry, glass, aluminum, and other substrates recommended by the sealant manufacturer.
 - 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. One-Part, Nonacid-Curing, Silicone Sealant
 - b. "Chem-Calk N-Cure 2000", Bostic Construction Products Division.
 - c. "Dow Corning 790", Dow Corning Corporation.
 - d. "Silglaze N SCS 2501", General Electric Company.
 - e. "Silpruf SCS 2000", General Electric Company.
 - f. "864", Pecora Corporation.
 - g. "Rhodorsil 5C", Rhone-Poulenc, Inc.
 - h. "Spectrum 1", Tremco, Inc.
 - i. "Spectrum 2", Tremco, Inc.
- D. Fire-Resistant Joint Sealers: Two-part, foamed-in-place, silicone sealant formulated for use in through-penetration fire-stopping around cables, conduit, pipes, and duct penetrations through fire-rated walls and floors. Sealants and accessories shall have fire-resistance ratings indicated, as established by testing identical assemblies in accordance with ASTM E 814, by Underwriters' Laboratories, Inc., or other testing and inspection agency acceptable to authorities having jurisdiction.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. "Dow Corning Fire Stop Foam", Dow Corning Corp.
 - b. "Pensil 851", General Electric Co.

2.02 INSTALLATION

- A. Examine substrates, area, and condition, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting installation and application of joint sealers and access panels. Do not proceed with installation until unsatisfactory conditions have been corrected.
- B. Preparation for Joint Sealers.
 - 1. Surface Cleaning for Joint Sealers: Clean surfaces of joints immediately before applying joint sealers to comply with recommendations of joint sealer manufacturer.
 - 2. Apply joint sealer primer to substrates as recommended by joint sealer manufacturer. Protect adjacent areas from spillage and migration of primers, using masking tape. Remove tape immediately after tooling without disturbing joint seal.
- C. Application of Joint Sealers
 - 1. General: Comply with joint sealer manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.
 - a. Comply with recommendations of ASTM C 962 for use of elastomeric joint sealants.
 - b. Comply with recommendations of ASTM C 790 for use of acrylic emulsion joint sealants.
 - 2. Installation of Fire-Stopping Sealant: Install sealant, including forming, packing, and other accessory materials, to fill openings around electrical services penetrating floors and walls, to provide fire-stops with fire- resistance ratings indicated for floor or wall assembly in which penetration occurs. Comply with installation requirements established by testing and inspecting agency.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Follow manufacturer's instructions for installing, connecting, and adjusting all equipment. Provide a copy of such instructions at the equipment during any work on the equipment. Provide all special supports, connections, wiring, accessories, etc.
- B. Use mechanics skilled in their trade for all work.

- C. Rough-in:
1. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
 2. Refer to equipment specifications in Divisions 2 through 26 for rough-in requirements.
- D. Electrical Installations: Sequence, coordinate, and integrate the various elements of electrical systems, materials, and equipment. Comply with the following requirements:
1. Coordinate electrical systems, equipment, and materials installation with other building components.
 2. Verify all dimensions by field measurements.
 3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for electrical installations.
 4. 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.
 5. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing in the building.
 6. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
 7. Coordinate connection of electrical systems with exterior underground utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.
 8. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect/Engineer.
 9. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
 10. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.

11. Install access panel or doors where units are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "ACCESS DOORS".
12. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

3.02 CUTTING, PATCHING, AND REPAIRING

- A. The work shall be carefully laid out in advance. Where cutting, channeling, chasing or drilling of floors, walls, partitions, ceilings or other surfaces is necessary for the proper installation, support or anchorage of raceway, outlets or other equipment, the work shall be carefully done. Any damage to the building, piping, equipment or defaced finish plaster, woodwork, metalwork, etc. shall be repaired by skilled mechanics of the trades involved at no additional cost to the Owner.
- B. Where conduits, mounting channels, outlet, junction, or pull boxes are mounted on a painted surface, or a surface to be painted, they shall be painted to match the surface. Whenever support channels are cut, the bare metal shall be cold galvanized.
- C. Perform cutting and patching in accordance with Division 01 Section "CUTTING AND PATCHING". In addition to the requirements specified in Division 01, the following requirements apply:
 1. Perform cutting, fitting, and patching of electrical equipment and materials required to:
 - a. Uncover work to provide for installation of ill-timed work.
 - b. Remove and replace defective work.
 - c. Remove and replace work not conforming to requirements of the Contract Documents.
 2. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
- D. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
- E. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.
- F. Patch finished surfaces and building components using new materials specified for the original installation and experienced installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched.

3.03 SUPPORTS

- A. Support work in accordance with the best industry practice and the following.
- B. Include supporting frames or racks extending from building structure for work indicated as being supported from walls where the walls are incapable of supporting the weight. In particular, provide such frames or racks in electric closets.
- C. Include supporting frames or racks for equipment, intended for vertical surface mounting, which is required in a free standing position.
- D. Supporting frames or racks shall be of standard angle, standard channel or specialty support system steel members. They shall be rigidly bolted or welded together and adequately braced to form a substantial structure. Racks shall be of ample size to assure a workmanlike arrangement of all equipment mounted on them.
- E. Nothing, (including outlet, pull and junction boxes and fittings) shall depend on electric conduits, raceways, or cables for support, except that threaded hub type fittings having a gross volume not in excess of 100 cubic inches may be supported from heavy wall conduit, where the conduit is securely supported from the structure within five inches of the fitting on two opposite sides.
- F. Nothing shall rest on, or depend for support on, suspended ceilings media (tiles, lath, plaster, as well as splines, runners, bars and the like in the plane of the ceiling).
- G. Provide required supports and hangers for conduit, equipment, etc., so that loading will not exceed allowable loadings of structure.

3.04 FASTENINGS

- A. Fasten electric work to building structure in accordance with the best industry practice and the following.
- B. Floor or pad mounted equipment shall not be held in place solely by its own dead weight. Include anchor fastening in all cases.
- C. For items which are shown as being ceiling mounted at locations where fastening to the building construction element above is not possible, provide suitable auxiliary channel or angle iron bridging, tying to the building structural elements.

3.05 TESTING EQUIPMENT AND MATERIALS

- A. The Contractor shall provide all testing instruments, equipment and all materials, connections, labor, etc., required to perform tests.
- B. Test all circuits, fixtures, equipment, and systems for proper operation and freedom from grounds, shorts and open circuits before acceptance is requested.
- C. Measure voltage at panelboards and outlets after the building is fully occupied. Make final transformer tap adjustments based on these measurements.

- D. Perform all tests required by local authorities, such as tests of life safety systems, in addition to tests specified herein.
- E. Perform tests required by other specification sections.

3.06 CLEANING UP

- A. Contractor shall take care to avoid accumulation of debris, boxes, crates, etc., resulting from the installation of his work. Contractor shall remove from the premises each day all debris, boxes, etc., and keep the premises clean.
- B. Contractor shall clean up all fixtures and equipment at the completion of the project.
- C. All switchboards, panelboards, wireways, trench ducts, cabinets and enclosures shall be thoroughly vacuumed clean prior to energizing equipment and at the completion of the project. Equipment shall be opened for observation by the Architect/Engineer as required.

END OF SECTION

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SECTION 26 05 01

MINOR ELECTRICAL DEMOLITION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Electrical demolition.

1.02 RELATED REQUIREMENTS

- A. Division 1 - Execution and Closeout Requirements: Additional requirements for alterations work.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. Materials and equipment for patching and extending work: As specified in individual sections.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify field measurements and circuiting arrangements are as shown on Drawings.
- B. Verify that abandoned wiring and equipment serve only abandoned facilities.
- C. Demolition drawings are based on casual field observation and existing record documents.
- D. Report discrepancies to Architect before disturbing existing installation.
- E. Beginning of demolition means installer accepts existing conditions.
- F. It shall be the contractor's responsibility to visit the existing project site, become acquainted with all existing conditions, and ascertain the extent of work involved in installing equipment, conduit, devices, controls and all other appurtenances pertaining to the above. The contractor shall provide all labor, materials, etc., required for the complete, new installation required for the completion of the project. By the act of submitting a price; or in the case of time and material project, begin work, the contractor shall be deemed to have performed such an examination, to have accepted such conditions, and to have made allowances therefore preparing his price and resolving questions regarding work required.

3.02 PREPARATION

- A. Disconnect electrical systems in walls, floors, and ceilings to be removed.
- B. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.
- C. Make temporary connections to maintain service in areas adjacent to work area.

3.03 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

- A. Remove, relocate, and extend existing installations to accommodate new construction.
- B. Remove all abandoned wiring to source of supply.
- C. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.
- D. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets that are not removed.
- E. Disconnect and remove abandoned panelboards and distribution equipment.
- F. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
- G. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.
- H. Repair adjacent construction and finishes damaged during demolition and extension work.
- I. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.
- J. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.

3.04 CLEANING AND REPAIR

- A. Clean and repair existing materials and equipment that remain or that are to be reused.
- B. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.
- C. Luminaires: Remove existing luminaires for cleaning. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps, ballasts and broken electrical parts.

END OF SECTION

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SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Wire and cable for 600 volts and less.
- B. Wiring connectors and connections.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 53 - Identification for Electrical Systems.

1.03 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Contracting; National Electrical Contractors Association; 2015.
- B. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association; 2017.
- C. NFPA 70 - National Electrical Code; National Fire Protection Association; 2017.

1.04 SUBMITTALS

- A. See Division 01 - Submittal Procedures.
- B. Test Reports: Indicate procedures and values obtained.
- C. Design Data: Indicate voltage drop and ampacity calculations for aluminum conductors substituted for copper conductors. Use of aluminum conductors requires written approval from Engineer.
- D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency.
- E. Project Record Documents: Record actual locations of components and circuits.

1.05 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience and with service facilities within 100 miles (160 km) of Project.
- C. Products: Furnish products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

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PART 2 PRODUCTS

2.01 WIRING REQUIREMENTS

- A. Concealed Dry Interior Locations: Use only building wire in raceway, building wire with Type THHN, THWN, XHHW insulation in raceway, armored cable, or metal clad cable. See permitted use in 3.03 Installation for AC and MC cable.
- B. Exposed Dry Interior Locations: Use only building wire in raceway, building wire with Type THHN, THWN, XHHW insulation in raceway, armored cable, or metal clad cable. See permitted use in 3.03 Installation for AC and MC cable.
- C. Above Accessible Ceilings: Use only building wire in raceway, building wire with Type THHN, THWN, or XHHW insulation in raceway, armored cable, or metal clad cable. See permitted use in 3.03 Installation for AC and MC cable.
- D. Wet or Damp Interior Locations: Use only building wire with Type THWN or XHHW insulation in raceway.
- E. Exterior Locations: Use only building wire with Type THWN or XHHW insulation in raceway, direct burial cable, service-entrance cable.
- F. Underground Installations: Use only building wire with Type THWN or XHHW insulation in raceway.
- G. Use stranded conductors for control circuits.
- H. Use conductor not smaller than 12 AWG for power and lighting circuits.
- I. Use conductor not smaller than 16 AWG for control circuits.
- J. Use 10 AWG conductors for 20 ampere, 120 volt branch circuits longer than 75 feet (25 m).
- K. Conductor sizes are based on copper.

2.02 WIRE MANUFACTURERS

- A. Cerro Wire Inc.
- B. Industrial Wire & Cable, Inc.
- C. Southwire Company.
- D. Encore.
- E. Substitutions: See Division 01 - Product Requirements.

2.03 BUILDING WIRE

- A. Description: Single conductor insulated wire.
- B. Conductor: Copper.
 - 1. For Sizes Smaller Than 4 AWG: Copper.
 - 2. For Sizes 4 AWG and Larger: Copper.
- C. Insulation Voltage Rating: 600 volts.
- D. Insulation: NFPA 70, Type THW, THHN, THWN, XHHW.
- E. Insulation: Thermoplastic material rated 60 degrees C.

2.04 ARMORED CABLE (See Permitted Use in 3.03 Installation)

- A. Description: NFPA 70, Type AC.
- B. Conductor: Copper.
 - 1. For Sizes Smaller Than 4 AWG: Copper.
 - 2. For Sizes 4 AWG Through 1 AWG: Copper.
- C. Insulation Voltage Rating: 300 volts.
- D. Insulation Temperature Rating: 60 degrees C.
- E. Insulation Material: Thermoplastic.
- F. Conductor Assembly Covering: Lead.

2.05 METAL CLAD CABLE (See Permitted Use in 3.03 Installation)

- A. Description: NFPA 70, Type MC.
- B. Conductor: Copper.
 - 1. For Sizes Smaller Than 4 AWG: Copper.
 - 2. For Sizes 4 AWG and Larger: Copper.
- C. Insulation Voltage Rating: 600 volts.
- D. Insulation Temperature Rating: 60 degrees C.
- E. Insulation Material: Thermoplastic.
- F. Armor Material: Steel.
- G. Armor Design: Interlocked metal tape.
- H. Jacket: PVC; use in locations indicated.

2.06 WIRING CONNECTORS

- A. Split Bolt Connectors:
 - 1. Not acceptable.
- B. Solderless Pressure Connectors:
 - 1. High copper alloy terminal. May be used only for cable termination to equipment pads or terminals.
 - 2. Substitutions: See Division 01 - Product Requirements.
- C. Spring Wire Connectors:
 - 1. Solderless spring type pressure connector with insulating covers for copper wire splices and taps. Use for conductor sizes 10 AWG and smaller.
 - 2. Substitutions: See Division 01 - Product Requirements.
- D. Compression Connectors:
 - 1. Long barrel; seamless, tin-plated electrolytic copper tubing; internally beveled barrel ends. Connector shall be clearly marked with the wire size and type and proper number and location of crimps.
 - 2. Substitutions: See Division 01 - Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that interior of building has been protected from weather.
- B. Verify that mechanical work likely to damage wire and cable has been completed.
- C. Verify that raceway installation is complete and supported.
- D. Verify that field measurements are as indicated.

3.02 PREPARATION

- A. Completely and thoroughly swab raceway before installing wire.

3.03 INSTALLATION

- A. Install wire and cable securely, in a neat and workmanlike manner, as specified in NECA 1.
 - 1.
- B. Route wire and cable as required to meet project conditions.
 - 1. Wire and cable routing indicated is approximate unless dimensioned.
 - 2. Where wire and cable destination is indicated and routing is not shown, determine exact routing and lengths required.

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3. Include wire and cable of lengths required to install connected devices within 10 ft of location shown.
- C. Use wiring methods indicated.
- D. Pull all conductors into raceway at same time.
- E. Use suitable wire pulling lubricant for building wire 4 AWG and larger.
- F. Protect exposed cable from damage.
- G. Support cables above accessible ceiling, using spring metal clips or metal cable ties to support cables from structure or ceiling suspension system. Do not rest cable on ceiling panels.
- H. Use suitable cable fittings and connectors.
- I. Neatly train and lace wiring inside boxes, equipment, and panelboards.
- J. Clean conductor surfaces before installing lugs and connectors.
- K. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
- L. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and larger.
- M. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.
- N. Identify and color code wire and cable under provisions of Section 26 05 53. Identify each conductor with its circuit number or other designation indicated.
- O. AC and MC cable permitted uses:
 1. **Flexible connections less than 4'**.
 2. Light fixture connections above suspended ceiling. **Length shall be 6' or less.** Not approved for fixture to fixture wiring.
 3. Conductor to last device on branch circuits installed in walls.
 4. Control and signal circuits.

3.04 FIELD QUALITY CONTROL

- A. Perform field inspection and testing in accordance with Division 01.
- B. Inspect and test in accordance with NETA STD ATS, except Section 4.
- C. Perform inspections and tests listed in NETA STD ATS, Section 7.3.2.

END OF SECTION

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SECTION 26 05 23

CONTROL-VOLTAGE ELECTRICAL POWER CABLES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Furnishing and installing cabling for remote-control, signaling and power-limited circuits.

1.02 RELATED REQUIREMENTS

- A. Applicable provisions of Division 1 govern work under this Section.
- B. Section 26 05 33 – Raceway and Boxes for Electrical Systems.
- C. Section 26 05 53 – Identification for Electrical Systems.

1.03 REFERENCE STANDARDS

- A. NFPA 70 - National Electrical Code 2017.

1.04 SUBMITTALS

- A. Submit product data: Provide for each cable assembly type.
- B. Submit manufacturer's installation instructions. Indicate application conditions and limitations of use stipulated by product testing agency.

1.05 PROJECT CONDITIONS

- A. Verify that field measurements are as shown on Drawings.
- B. Wire and cable routing shown on Drawings is approximate unless dimensioned. Route wire and cable as required to meet Project Conditions.
- C. Where wire and cable routing is not shown, and destination only is indicated, determine exact routing and lengths required.

PART 2 PRODUCTS

2.01 GENERAL

- A. All wire shall be new, delivered to the site in unbroken cartons and shall be less than one year old out of manufacturer's stock.
- B. All conductors shall be copper.
- C. Insulation shall have a 600 volt rating.

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- D. All conductors shall be suitable for the application intended. Conductors #12 and smaller may be solid or stranded with the following requirements or exceptions:
 - 1. All conductors terminated with crimp type devices shall be stranded.
 - 2. Stranded conductors shall be terminated with an approved ETL Listed type terminations or methods: e.g. stranded conductors shall not be wrapped around a terminal screw but shall be terminated with a crimp type device or in an approved back wired method.

2.02 REMOTE CONTROL AND SIGNALING CABLE

- A. All other systems cabling shall meet the requirements of NEC Article 725 and the following:
 - 1. Cable for Class 1 Remote-Control, Signaling and Power-Limited Circuits: 600 volt insulation, individual conductors twisted together, shielded, and covered with an overall PVC jacket. Cable shall be Listed, temperature rated, and suitable Type (general purpose, riser or plenum) for the application as required in the National Electrical Code.
 - 2. Cable for Class 2 or Class 3 Remote-Control, Signaling and Power-Limited Circuits shall be Listed, temperature rated, and suitable Type (general purpose, riser or plenum) for the application as required in the National Electrical Code.

2.03 WIRING CONNECTORS

- A. Split Bolt Connectors: Not acceptable.
- B. Spring Wire Connectors: Solderless spring type pressure connector with insulating covers for copper wire splices and taps. Use for conductor sizes 10 AWG and smaller.
- C. All wire connectors used in underground or exterior pull boxes shall be gel filled twist connectors or a connector designed for damp and wet locations.

PART 3 EXECUTION

3.01 GENERAL WIRING METHODS

- A. Control-voltage cables shall be installed in conduit.
- B. Control cables for controlling HVAC and lighting equipment connected to emergency power shall be routed in raceway.
- C. Do not use wire smaller than 14 AWG for control wiring greater than 60 volts, or 18 AWG for voltages less than 60 volts, all sizes subject to NEC 725 requirements.
- D. Splice only in junction boxes.
- E. Identify wire per section 26 05 53.
- F. Neatly train and lace wiring inside boxes, and equipment.

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3.02 WIRING INSTALLATION

- A. Pull all conductors into a raceway at the same time. Use Listed wire pulling lubricant for pulling conditions when necessary.
- B. Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work likely to injure conductors has been completed.

3.03 WIRING CONNECTIONS AND TERMINATIONS

- A. Splice only in accessible junction boxes (except splices to low voltage occupancy sensor power packs and terminations to temperature control devices).
- B. All splices shall be so made that they have an electrical resistance not in excess of two feet (600 mm) of the conductor.
- C. Use solderless spring type pressure connectors with insulating covers for wire splices and taps, 10 AWG and smaller.
- D. Thoroughly clean wires before installing lugs and connectors.
- E. At all splices and terminations, leave tails long enough to cut splice out and completely re-splice.

END OF SECTION

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SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Conduit and equipment supports.
- B. Anchors and fasteners.

1.02 REFERENCE STANDARDS

- A. NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting; National Electrical Contractors Association; 2015.
- B. NFPA 70 - National Electrical Code; National Fire Protection Association; 2017.

1.03 SUBMITTALS

- A. See Division 01 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's catalog data for fastening systems.
- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.04 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Hangers, Supports, Anchors, and Fasteners - General: Corrosion-resistant materials of size and type adequate to carry the loads of equipment and conduit, including weight of wire in conduit.
- B. Supports: Fabricated of structural steel or formed steel members; galvanized.
- C. Anchors and Fasteners:
 - 1. Do not use powder-actuated anchors, spring clips, or beam clamps.
 - 2. Obtain permission from Architect before using powder-actuated anchors.

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3. Concrete Structural Elements: Use precast inserts, expansion anchors, powder-actuated anchors, or preset inserts.
4. Steel Structural Elements: Use beam clamps, steel spring clips, steel ramset fasteners, or welded fasteners.
5. Concrete Surfaces: Use self-drilling anchors or expansion anchors.
6. Hollow Masonry, Plaster, and Gypsum Board Partitions: Use toggle bolts or hollow wall fasteners.
7. Solid Masonry Walls: Use expansion anchors or preset inserts.
8. Sheet Metal: Use sheet metal screws.
9. Wood Elements: Use wood screws.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install hangers and supports as required to adequately and securely support electrical system components, in a neat and workmanlike manner, as specified in NECA 1.
 1. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.
 2. Do not drill or cut structural members.
 3. Obtain permission from Architect before drilling or cutting structural members.
- B. Rigidly weld support members or use hexagon-head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.
- C. Install surface-mounted cabinets and panelboards with minimum of four anchors.
- D. In wet and damp locations use steel channel supports to stand cabinets and panelboards 1 inch off wall.
- E. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.

END OF SECTION

SECTION 26 05 33

RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. This section describes the products and execution requirements relating to furnishing and installing raceways and boxes and related systems as part of a raceway system for electrical, communications, and other low-voltage systems for the project.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 26 – Grounding and Bonding for Electrical Systems.
- B. Section 26 05 29 – Hangers and Supports for Electrical Systems.
- C. Section 26 27 02 – Equipment Wiring Systems.
- D. Section 26 27 26 – Wiring Devices.

1.03 REFERENCE STANDARDS

- A. NFPA 70 – National Electrical Code; National Fire Protection Association, 2017.

1.04 SUBMITTALS

- A. Surface Raceway System - submit product data and catalog sheets for all components.
- B. Boxes - provide product data showing configurations, finishes, dimensions, and manufacturer's instructions.
- C. Conduits in Concrete Slabs Above Grade - provide proposed conduit routing and sizing to Structural Engineer prior to approval of installation to verify structural integrity and fire rating of concrete slab.
- D. Mockups -- Provide on request, mockups for Floor Box and Poke-through Assemblies to demonstrate configuration, capacity and aesthetics and to set quality standards for fabrication and installation. Coordinate with Division 26 and Division 27 requirements as applicable to include all power and communications devices.

PART 2 PRODUCTS

2.01 GENERAL

- A. All steel fittings and conduit bodies shall be galvanized.
- B. All conduit transitional fittings shall be listed for installed application.
- C. No cast metal or split-gland type fittings permitted.

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- D. All conduit covers must be fastened to the conduit body with screws and be of the same manufacture.
- E. Mogul-type condulets 2 inch (50 mm) and larger, shall be permitted.
- F. C-condulets shall not be used in lieu of pull boxes.
- G. All boxes shall be of sufficient size to provide free space for all conductors enclosed in the box and shall comply with NEC requirements.

2.02 RIGID METAL CONDUIT (RMC) AND FITTINGS

- A. Conduit: Heavy wall threaded, galvanized steel.
- B. Fittings and Conduit Bodies: Use all steel threaded fittings and conduit bodies.
- C. Expansion Fittings/Expansion Joints: Expansion Fittings shall be Internal Grounding type and shall not rely on external bonding jumpers to maintain grounding continuity between raceway components.

2.03 PVC COATED RIGID METAL CONDUIT

- A. PVC Externally Coated Conduit: Rigid heavy wall, schedule 40, steel conduit with external 40 mil (0.1 mm) PVC coating. Conduit must be hot dipped galvanized inside and out including threads. The PVC coating bond to the galvanized steel conduit shall be stronger than the tensile strength of the coating itself.
- B. Fittings and Conduit Bodies: Threaded type, material to match conduit. PVC coated fittings and couplings shall have specially formed sleeves to tightly seal to conduit PVC coating. The sleeves shall extend beyond the fitting or coupling a distance equal to the pipe outside steel diameter or two inches (50 mm) whichever is greater.

2.04 INTERMEDIATE METAL CONDUIT (IMC) AND FITTINGS

- A. Conduit: Galvanized Steel, threaded.
- B. Fittings and Conduit Bodies: Use all Steel threaded fittings and conduit bodies.
- C. Expansion Fittings/Expansion Joints: Expansion Fittings shall be Internal Grounding type and shall not rely on external bonding jumpers to maintain grounding continuity between raceway components.

2.05 ELECTRICAL METALLIC TUBING (EMT) AND FITTINGS

- A. Conduit: Steel, Unthreaded thin wall galvanized tubing.
- B. Fittings: All steel, compression or set screw type. No push-on or indenter types permitted.
- C. Transitional fitting: ½-1": All steel and malleable iron.
- D. Conduit Bodies: All steel conduit bodies.

2.06 FLEXIBLE METAL CONDUIT (FMC) AND FITTINGS

- A. Conduit: steel, galvanized, spiral strip.
- B. Fittings and Conduit Bodies: All steel, galvanized or malleable iron (except as allowed in specification 26 51 13).

2.07 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC) AND FITTINGS

- A. Conduit: flexible, steel, galvanized, spiral strip with an outer Liquidtight, nonmetallic, sunlight-resistant jacket.
- B. Fittings and Conduit Bodies: ANSI/NEMA FB 1, compression type. There shall be a metallic cover/insert on the end of the conduit inside the connector housing to seal the cut conduit end.

2.08 RIGID POLYVINYL CHLORIDE CONDUIT (PVC) AND FITTINGS

- A. Conduit: Rigid non-metallic conduit, Schedule 40 PVC minimum, Listed, sunlight resistant, rated for 90°C conductors. Schedule 80 for locations exposed to physical damage or as required.
- B. Fittings and Conduit Bodies: NEMA TC 2, Listed.

2.09 CONDUIT SUPPORTS

- A. See specification Section 26 05 29.

2.10 SURFACE METAL RACEWAY

- A. Description: Sheet metal channel with fitted cover, suitable for use as surface metal raceway.
- B. Size: As shown on Drawing.
- C. Finish: Ivory enamel.
- D. Fittings: Couplings, elbows, and connectors designed for use with raceway system.
- E. Boxes and Extension Rings: Designed for use with raceway systems.

2.11 CONDUIT WATER SEALANT

- A. Description: Conduit sealant used to prevent water from entering buildings via conduits.
- B. Sealant shall seal conduits against water and gas intrusion, such as Polywater® FST™ 250 Foam Duct Sealant, Raychem RDSS Rayplate Duct Sealing System, or approved alternate. Sealant shall be re-enterable, shall be compatible with the conduit and conductor types being used, and shall comply with NEC 225.27, 230.8, and 300.5(G).
- C. Manufacturer names and catalog numbers are used to develop quality and performance requirements only. Products manufactured by others may be acceptable provided they meet or exceed the specifications.

2.12 PULL AND JUNCTION BOXES

- A. Interior Sheet Metal Boxes: code gauge galvanized steel, screw covers, flanged and spot-welded joints and corners.
- B. Interior Sheet Metal Boxes larger than 12 inches (300 mm) in any dimension shall have a hinged cover or a chain installed between box and cover. Boxes 9 square-feet or larger shall have hinged covers and a single cover shall not exceed 10 square-feet.
- C. Interior Sheet Metal Boxes connected to an exterior underground raceway, shall have a drain fitting located in the bottom.
- D. Exterior Boxes and Wet Location Installations: Type 4 and Type 6, flat-flanged, surface-mounted junction box, UL listed as rain-tight. [Galvanized cast iron][Aluminum][PVC] box and cover with ground flange, neoprene gasket, and stainless steel cover screws.
- E. Boxes installed in Parking Ramps shall be Type 4X, flat-flanged, surface-mounted junction box, ETL listed as rain-tight. [Stainless Steel] box and cover with ground flange, neoprene gasket, and stainless steel cover screws.
- F. Box extensions and adjacent boxes within 48 inches of each other are not allowed for the purpose of creating more wire capacity.
- G. Junction boxes 6 inch-by-6 inch or larger size shall be without stamped knock-outs.
- H. Wireways shall not be used in lieu of junction boxes.

2.13 OUTLET BOXES

- A. Sheet Metal Outlet Boxes: galvanized steel, with stamped knockouts.
- B. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 3/8 inch male fixture studs where required.
- C. Concrete Ceiling Boxes: Concrete type.
- D. Cast Boxes: Cast ferroalloy or aluminum, deep type, gasketed cover, threaded hubs.

2.14 OUTLET BOX EXTENDERS

- A. Outlet Box Extenders: Non-Metallic, adjustable depth.
- B. Outlet Box Extenders may only be used in limited applications with the pre-approval of the Engineer. See Part 3 – Execution for examples of applications of where Outlet Box Extenders may be allowed.

2.15 POKE-THROUGH ASSEMBLIES

- A. Description: Assembly comprising of service fitting, poke-through component, fire stops and smoke barriers, and junction box for conduit termination.
- B. Fire Rating: Two-hour rated, or rated to match existing floor.
- C. Type: As indicated on drawings.
- D. Floor Plate: Solid Brass with Brushed Finish. Floor plates shall meet and exceed UL scrub water exclusion requirements for concrete, tile, carpet, and wood covered floors.
- E. Device Plate: Stainless steel or as available from manufacturer.
- F. Configuration: As indicated on drawings.

PART 3 EXECUTION

3.01 CONDUIT SIZING, ARRANGEMENT, AND SUPPORT

- A. EMT is permitted to be used in sizes 4 inch (100 mm) and smaller for power and low-voltage systems. See CONDUIT INSTALLATION SCHEDULE below for other limitations for EMT and other types of conduit.
- B. Size power conductor raceways for conductor type installed. Conduit size shall be 1/2 inch (16 mm) minimum except **all homerun conduits shall be 3/4 inch (21 mm)**, or as specified elsewhere. **Caution: Per the NEC, the allowable conductor ampacity is reduced when more than three current-carrying conductors are installed in a raceway. Contractor must take the NEC ampacity adjustment factors into account when sizing the raceway and wiring system.**
- C. Size communications and other low-voltage systems raceways as follows:
 - 1. Communications, including Equipment Outlet Box: 1 1/4 inch minimum. Conduit used for single device locations (e.g. Wireless Access Point, Video Surveillance Camera, and Wall mounted telephone) may be 3/4 inch minimum.
 - 2. Control, security, signal, and other low-voltage applications (not including AV): 3/4 inch minimum.
 - 3. Floor Box and Poke-Through Assemblies:
 - a. Power: 3/4 inch minimum or as indicated on drawings.
 - b. Low-voltage: (2) 1-1/4 inch minimum or as indicated on drawings.
- D. Provide one raceway from each communications outlet box to above accessible ceiling.
- E. Arrange conduit to maintain 6'-8" clear headroom and present a neat appearance.
- F. Route exposed conduit and conduit above accessible ceilings parallel and perpendicular to walls and adjacent piping.

- G. Maintain minimum 6 inch (150 mm) clearance between conduit and piping. Maintain 12 inch (300 mm) clearance between conduit and heat sources such as flues, steam pipes, and heating appliances.
- H. Arrange conduit supports to prevent distortion of alignment by wire pulling operations. Fasten conduit using galvanized pipe straps, conduit racks (lay-in adjustable hangers), clevis hangers, or bolted split stamped galvanized hangers.
- I. Group conduit in parallel runs where practical and use conduit rack (lay-in adjustable hangers) constructed of steel channel with conduit straps or clamps. Provide space for 25 percent additional conduit.
- J. Do not fasten conduit with wire or perforated pipe straps. Before conductors are pulled, remove all wire used for temporary conduit support during construction.
- K. Support and fasten metal conduit at a maximum of 8 feet (2.4 m) on center.
- L. Supports shall be independent of the installations of other trades, e.g. ceiling support wires, HVAC pipes, other conduits, etc., unless so approved or detailed.
- M. Conceal all conduits except where noted on the drawings or approved by the Architect/Engineer. Contractor shall verify with Architect/Engineer all surface conduit installations except in mechanical rooms.
- N. Changes in direction shall be made with symmetrical bends, cast steel boxes, stamped metal boxes or cast steel conduit bodies.
- O. For indoor and exposed exterior conduits, no continuous conduit run shall exceed 100 feet (30 meters) without a junction box.
- P. For exterior below grade conduits, no continuous conduit run shall exceed 250 feet (75 meters) without hand hole, manhole or pull box.
- Q. All conduits installed in exposed areas shall be installed with a box offset before entering box.

3.02 CONDUIT INSTALLATION

- A. All conduit shall be run overhead unless indicated on the plans.
- B. All raceways shall be routed concealed in finished areas unless authorized by the Architect and Engineer.
- C. Cut conduit square; de-burr cut ends.
- D. Conduit shall not be fastened to the corrugated metal roof deck nor drywall or suspended ceiling grids.
- E. Bring conduit to the shoulder of fittings and couplings and fasten securely.
- F. Use conduit hubs for fastening conduit to cast boxes. Use sealing locknuts or conduit hubs for fastening conduit to sheet metal boxes in damp or wet locations.

- G. Threads cut in the field, and factory threads of conduit and nipples not coated with corrosion protection, shall be coated with an approved electrically conductive compound per NEC 300.6.
- H. Terminate all conduit (except for terminations into conduit bodies) using conduit hubs, or connectors with one locknut, or utilize double locknuts (one each side of box wall).
- I. Provide bushings for the ends of all conduit not terminated in box walls. Refer to Section 26 05 26 – Grounding and Bonding for Electrical Systems for grounding bushing requirements.
- J. Provide insulated bushings where raceways contain 4 AWG or larger conductors.
- K. Communication and Low Voltage systems conduits shall terminate in horizontal plane.
- L. Use pendants supported from swivel hangers in exposed ceiling/ structure locations where necessary to mount boxes supporting luminaires and wiring devices. Installation method shall comply with NEC 314.23 (H).
- M. Install no more than the equivalent of the following for building:
 - 1. Three 90 degree bends between boxes for electrical systems.
 - 2. Two 90 degree bends between boxes for communications and other low voltage systems. Note: Offsets shall be considered 90 degrees.
 - 3. No single bend may exceed 90 degrees.
- N. Use hydraulic one-shot conduit bender or factory elbows for bends in conduit larger than 2 inch (50 mm) size unless sweep elbows are required.
- O. Bend conduit according to manufacturer's recommendations. Torches or open flame shall not be used to aid in bending of PVC conduit.
- P. Use suitable conduit caps or other approved seals to protect installed conduit against entrance of dirt and moisture.
- Q. Provide 1/8 inch (3 mm) nylon pull string in empty conduit, except sleeves and nipples.
- R. Install listed expansion-deflection fitting or other approved means shall be used where a raceway crosses a structural joint for expansion, contraction or deflection, used in buildings, bridges, parking garages or other structures.
- S. **Install expansion joints where direct-buried conduit is subject to Earth Movement by settlement or frost per NEC 300.5(J), especially where conduit exits the ground exposed and enters a box, cabinet, or enclosure attached to a building or structure.**
- T. Install expansion fitting in exterior PVC conduit runs per NEC table 352.44 utilizing a minimum temperature change of 120 degree F.
- U. Avoid moisture traps where possible. Where moisture traps are unavoidable, provide junction boxes with drain fittings at conduit low points.

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- V. Where conduit passes between areas of differing temperatures such as into or out of cool rooms, freezers, unheated and heated spaces, buildings, etc., provide conduit or box with duct seal or other means to prevent the passage of moisture and water vapor through the conduit.
- W. Route conduit through roof openings for piping and ductwork where possible.
- X. Where communication cabling is to be installed in conduit to the wiring hub (e.g. Telecom Room), multiple conduits may be consolidated into fewer, larger conduits. Capacity of shared conduits shall equal the capacity of the individual conduits unless otherwise noted.
- Y. Use NRTL listed metallic grounding clamps when terminating conduit to cable tray.
- Z. Ground and bond conduit under provisions of Section 26 05 26.
- AA. Identify conduit under provisions of Section 26 05 53.
- AB. Clean PVC conduit with solvent, and dry before application of glue. The temperature rating of glue/cement shall match weather conditions. Apply full even coat of cement/glue to entire area that will be inserted into fitting. The entire installation shall meet manufacturer's recommendations.

3.03 CONDUIT INSTALLATION SCHEDULE

- A. Conduit other than that specified below for specific applications shall not be used.
 - Concealed in Concrete Block Walls: Electrical metallic tubing, PVC conduit.
 - Concealed Dry Interior Locations: Rigid metal conduit, Intermediate metal conduit, Electrical metallic tubing, PVC conduit (Ground conductor).
 - Interior Building Grounding Electrode Conductor: Schedule 80 PVC.
 - Exposed Dry Interior Locations: Rigid metal conduit, Intermediate metal conduit, Electrical metallic tubing.
 - Motor and equipment connections: Liquidtight flexible metal conduit (LFMC) in all locations except in Mechanical equipment plenum spaces where Flexible Metal Conduit (FMC) shall be utilized. Minimum length shall be one foot (300 mm); maximum length shall be three feet (900 mm). Conduit must be installed perpendicular to direction of equipment vibration to allow conduit to freely flex.
 - Exposed Dry Interior Locations for HVAC control devices with Conduit Connections: Electrical metallic tubing, Flexible Metal Conduit (FMC). For FMC installations, Minimum length shall be one foot (300 mm), Maximum length shall be three feet (900 mm). Minimum size FMC of 3/8".

- Exposed Dry Interior Locations for HVAC control devices without Conduit Connections: Where HVAC equipment control panels or devices do not provide for the direct connection of conduits, exposed Class 2 wiring may be extended to complete the final connections in dry locations, provided it does not exceed 18 inches in length.
- Light fixtures: Refer to specification section 26 51 13.
- Plenum Spaces: Installation shall comply with requirements of NEC 300.22.

3.04 PVC COATED RIGID METAL CONDUIT INSTALLATION

- A. Installers of PVC Coated Rigid Metal Conduit shall be factory trained and certified in the proper installation methods for this type of conduit. Proof of such certification shall be kept on the project site at all times and shall be produced upon request.

3.05 SURFACE METAL RACEWAY AND MULTI-OUTLET ASSEMBLY INSTALLATION

- A. Use flat-head screws to fasten channel to surfaces every twenty-four (24) inches. Mount plumb and level.
- B. Use suitable insulating bushings and inserts at connections to outlets and corner fittings.
- C. Maintain grounding continuity between raceway components to provide a continuous grounding path under provisions of Section 26 05 26.
- D. Fastener Option: Use clips and straps suitable for the purpose.

3.06 AUXILIARY GUTTERS (WIREWAYS) INSTALLATION

- A. Bolt auxiliary gutter to wall using two-piece hangers or steel channels fastened to the wall or in self-supporting structure.
- B. Gasket each joint in oil-tight gutter.
- C. Mount rain-tight gutter in horizontal position only.
- D. Maintain grounding continuity between raceway components to provide a continuous grounding path under provisions of Section 26 05 26.

3.07 COORDINATION OF BOX LOCATIONS

- A. Provide electrical boxes as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections, and code compliance.
- B. Electrical box locations shown on Contract Drawings are approximate unless dimensioned. Verify location of floor boxes and outlets in offices and work areas prior to rough-in.
- C. No outlet, junction, or pull boxes shall be located where it will be obstructed by other equipment, piping, lockers, benches, counters, etc.

- D. Conduit and boxes shall not be fastened to the metal roof deck. If conduit and boxes are required to be located and installed on roof decks, the conduit and boxes are required to be spaced minimum 1-5/8 inch off the lowest part of the metal roof decking material, per NEC 300.4 (E).
- E. It shall be the Contractor's responsibility to study drawings pertaining to other trades, to discuss location of outlets with workmen installing other piping and equipment and to fit all electrical outlets to job conditions.
- F. In case of any question or argument over the location of an outlet, the Contractor shall refer the matter to the Architect/Engineer and install outlet as instructed by the Architect/Engineer.
- G. The proper location of each outlet is considered a part of this contract and no additional compensation will be paid to the Contractor for moving outlets which were improperly located.
- H. Locate and install boxes to allow access to them. Where installation is inaccessible, coordinate locations and provide 18 inch (450 mm) by 24 inch (600 mm) access doors. Boxes must be installed within 12" from edge of the access door.
- I. Locate and install to maintain headroom and to present a neat appearance.
- J. Install boxes to preserve fire resistance rating of partitions and other elements, using approved materials and methods.
- K. Boxes installed in the building envelop shall be sealed with caulking materials or closed with gasketing systems compatible with the construction materials and locations per IEC 502.4.3.

3.08 PULL AND JUNCTION BOX INSTALLATION

- A. Pull boxes and junction boxes shall be minimum 4 inches square (100 mm) by 2 1/8 inches (54 mm) deep for use with 1 inch (25 mm) conduit and smaller. On conduit systems using 1 1/4 inch (31.75 mm) conduit, minimum junction box size shall be 4 11/16 inches square by 2 1/8 inches deep.
- B. Where used with raceway(s) containing conductors of 4 AWG or larger, pull box shall be sized as required unless otherwise noted on the drawings.
- C. Where used with raceway(s) containing conductors on systems over 600V, size pull box per NEC 314 Part IV unless otherwise noted as larger on the drawings.

Size pull boxes for communications per ANSI/TIA-568-C.
- D. Locate pull boxes and junction boxes above accessible ceilings, in unfinished areas or furnish and install approved access panels in non-accessible ceilings where boxes are installed. All boxes are to be readily-accessible.

- E. Provide Pull and Junction boxes for communications and other low voltage applications (a) in any section of conduit longer than 100 feet, (b) where there are bends totaling more than 180 degrees between pull points or pull boxes and (c) wherever there is a reverse bend in run. Locate boxes on straight section of raceway (e.g. do not use boxes in place of raceway bends).
- F. Support pull and junction boxes independent of conduit.

3.09 OUTLET BOX INSTALLATION

- A. Do not install boxes back-to-back in walls. Provide minimum 6 inch (150 mm) separation, except provide minimum 24 inch (600 mm) separation in acoustic-rated walls.
- B. Power:
 - 1. Recessed (1/4 inch maximum) outlet boxes in masonry, concrete, tile construction, or drywall shall be minimum 4 inch square, with device rings. Device covers shall be square-cut except rounded corner plaster rings are allowed in drywall applications. Angle cut plaster rings are not permitted. Coordinate masonry cutting to achieve neat openings for boxes. A single gang box can be used in drywall and masonry, for a single device location, when a single conduit enters box.
 - 2. Shallow 4 inch square by 1 1/2 inch deep boxes can be used as device boxes for power provided the box and plaster ring is sized for installed device and conductors.
- C. Low Voltage:
 - 1. Recessed (1/4 inch maximum) outlet boxes in masonry, concrete, tile construction or drywall shall be minimum 4 11/16 inch square by 2 1/8 inch deep with single gang device ring (unless noted otherwise on drawings or in companion specifications). Device covers shall be square-cut except rounded corner plaster rings are allowed in drywall applications. Angle cut plaster rings are not permitted. Coordinate masonry cutting to achieve neat openings for boxes.
 - 2. Provide one conduit from each communications Equipment Outlet box. Conduit runs between outlet boxes for communications are not allowed. Terminate conduit above accessible ceiling.
- D. Provide knockout closures for unused openings.
- E. Support boxes independently of conduit except for cast boxes that are connected to two rigid metal conduits, both supported within 12 inches (300 mm) of box.
- F. Install boxes in walls without damaging wall insulation.
- G. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.

- H. Ceiling outlets shall be 4 inch square, minimum 2 1/8 inch (54 mm) deep except that concrete boxes and plates will be approved where applicable. Position outlets to locate luminaires as shown on reflected ceiling plans.
- I. In inaccessible ceiling areas, position outlets and junction boxes within 6 inches (150 mm) of recessed luminaire, to be accessible through luminaire ceiling opening.
- J. Provide recessed outlet boxes in finished areas; secure boxes to interior wall and partition studs, accurately positioning to allow for surface finish thickness. Use stamped steel stud bridges for flush outlets in hollow stud wall, and adjustable steel channel fasteners for flush ceiling outlet boxes.
- K. Align wall-mounted outlet boxes for switches, thermostats, and similar devices.
- L. Provide cast ferroalloy or aluminum outlet boxes in exterior and wet locations.
- M. Surface wall outlets shall be 4 inch (100 mm) square with raised covers for one and two gang requirements. For three gang or larger requirements, use gang boxes with non-overlapping covers.
- N. Outlet Box adjustable ring and depth device applications:
 - Provide box extenders for boxes that are set too far back in the wall due to unanticipated wall finishes. Place the box extender over the existing box face to make the box face flush with the wall finish.

END OF SECTION

SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Nameplates and labels.
- B. Wire and cable markers.
- C. Conduit markers.
- D. Field-painted identification of conduit.

1.02 RELATED REQUIREMENTS

- A. Division 01 - Painting and Coating.

1.03 REFERENCE STANDARDS

- A. NFPA 70 - National Electrical Code; National Fire Protection Association; 2017.

1.04 SUBMITTALS

- A. See Division 01 - Administrative Requirements for submittals procedures.
- B. Product Data: Provide catalog data for nameplates, labels, and markers.
- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Quality Assurance. Include instructions for storage, handling, protection, examination, preparation and installation of product.

1.05 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for purpose specified and shown.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Brady Corporation.
- B. Seton Identification Products.
- C. HellermannTyton.
- D. 3M
- E. Substitutions: See Division 01 - Product Requirements.

2.02 NAMEPLATES AND LABELS

- A. Nameplates: Engraved three-layer laminated plastic, black letters on white background.
- B. Locations:
 - 1. Each electrical distribution and control equipment enclosure.
 - 2. Communication cabinets.
 - 3. Disconnects, starters, and relays.
- C. Letter Size:
 - 1. Use 1/8 inch letters for identifying individual equipment and loads.
 - 2. Use 1/4 inch letters for identifying grouped equipment and loads.
 - 3. Use 1 inch letters for identifying distribution and control equipment enclosures.
- D. Labels: Embossed adhesive tape, with 3/16 inch white letters on black background. Use only for identification of individual wall switches and receptacles, control device stations.

2.03 WIRE MARKERS

- A. Description: Cloth type wire markers.
- B. Locations: Each conductor at panelboard gutters, pull boxes, outlet boxes, and junction boxes each load connection.
- C. Legend:
 - 1. Power and Lighting Circuits: Branch circuit or feeder number indicated on drawings.
 - 2. Control Circuits: Control wire number indicated on schematic and interconnection diagrams on drawings.

2.04 CONDUIT MARKERS

- A. Description: Use tape or paint to mark conduit.
- B. Location: Furnish markers for each conduit longer than 6 feet.

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- C. Spacing: 20 feet on center.
- D. Color:
 - 1. 120/208 Volt System: White.
 - 2. Emergency 120/208: White/Red.
 - 3. Option Standby 120/208: Black/Yellow.
 - 4. Fire Alarm System: Red.
 - 5. Telephone System: Yellow.
 - 6. Data System: Blue.

2.05 UNDERGROUND WARNING TAPE

- A. Description: 4 inch wide plastic tape, detectable type colored red with suitable warning legend describing buried electrical lines.

2.06 WIRING DEVICE IDENTIFICATION

- A. Wall switches, receptacles, occupancy sensors, photocells, poke-through fittings, access floor boxes, and time clocks shall be identified with circuit numbers and panelboard source (ex. Panel ABC-3). In exposed areas, identifications should be made inside of device covers, unless directed otherwise. Use machine-generated adhesive labels, or neatly hand-written permanent marker.

PART 3 EXECUTION

3.01 PREPARATION

- A. Degrease and clean surfaces to receive nameplates and labels.

3.02 INSTALLATION

- A. Install nameplates and labels parallel to equipment lines.
- B. Secure nameplates to equipment front using screws.
- C. Secure nameplates to inside surface of door on panelboard that is recessed in finished locations.
- D. Identify conduit using field painting under provisions of Division 01.
 - 1. Paint colored band on each conduit longer than 6 feet.
 - 2. Paint bands 20 feet on center.

3. Colors:
 - a. 120/208 Volt System: White.
 - b. Emergency 120/208: White/Red.
 - c. Option Standby 120/208: Black/Yellow.
 - d. Fire Alarm System: Red.
 - e. Telephone System: Yellow.
 - f. Data System: Blue.

- E. Identify underground conduits using underground warning tape. Install one tape per trench at a minimum of 12" above the underground installation.

- F. Label electrical service meters and disconnects per utilities and NEC specifications.

END OF SECTION

SECTION 26 27 17
EQUIPMENT WIRING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Electrical connections to equipment.

1.02 REFERENCE STANDARDS

- A. NEMA WD 1 - General Color Requirements for Wiring Devices; National Electrical Manufacturers Association; 1999 (R 2005).
- B. NEMA WD 6 - Wiring Devices - Dimensional Requirements; National Electrical Manufacturers Association; 2016.
- C. NFPA 70 - National Electrical Code; National Fire Protection Association; 2017.

1.03 SUBMITTALS

- A. See Division 1 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide wiring device manufacturer's catalog information showing dimensions, configurations, and construction.
- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.04 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.05 COORDINATION

- A. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
- B. Determine connection locations and requirements.
- C. Sequence rough-in of electrical connections to coordinate with installation of equipment.
- D. Sequence electrical connections to coordinate with start-up of equipment.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Cords and Caps: NEMA WD 6; match receptacle configuration at outlet provided for equipment.
 - 1. Colors: Conform to NEMA WD 1.
 - 2. Cord Construction: NFPA 70, Type SO, multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.
 - 3. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.
 - 4. Product:
 - 5. Substitutions: See Division 1 - Product Requirements.
- B. Disconnect Switches: As specified in Section 26 28 18 and in individual equipment sections.
- C. Wiring Devices: As specified in Section 26 27 26.
- D. Flexible Conduit: As specified in Section 26 05 34.
- E. Wire and Cable: As specified in Section 26 05 19.
- F. Boxes: As specified in Section 26 05 37.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.02 ELECTRICAL CONNECTIONS

- A. Make electrical connections in accordance with equipment manufacturer's instructions.
- B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.
- C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.
- D. Provide receptacle outlet to accommodate connection with attachment plug.
- E. Provide cord and cap where field-supplied attachment plug is required.
- F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
- G. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.

- H. Install terminal block jumpers to complete equipment wiring requirements.
- I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.
- J. Coolers and Freezers: Cut and seal conduit openings in freezer and cooler walls, floor, and ceilings.

3.03 EQUIPMENT SCHEDULE

- A. Schedule on drawings.

END OF SECTION

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SECTION 26 27 26

WIRING DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Occupancy sensors.
- B. Receptacles.
- C. Device plates and decorative box covers.

1.02 REFERENCE STANDARDS

- A. NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting; National Electrical Contractors Association; 2015.
- B. NEMA WD 1 - General Color Requirements for Wiring Devices; National Electrical Manufacturers Association; 1999 (R 2005).
- C. NEMA WD 6 - Wiring Device -- Dimensional Requirements; National Electrical Manufacturers Association; 2016.
- D. NFPA 70 - National Electrical Code; National Fire Protection Association; 2017.

1.03 SUBMITTALS

- A. See Division 01 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.
- C. Manufacturer's Installation Instructions.

1.04 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- C. Products: Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.05 EXTRA MATERIALS

- A. See Division 01 - Product Requirements, for additional provisions.
- B. Furnish two of each style, size, and finish wall plate.
- C. Provide two protective rings.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Hubbell.
- B. Leviton.
- C. Pass & Seymour.
- D. Substitutions: See Division 01 - Product Requirements.

2.02 OCCUPANCY SENSORS

- A. Provide type as indicated on drawings.

2.03 RECEPTACLES

- A. Receptacles: Heavy duty, complying with NEMA WD 6 and WD 1.
 - 1. Configuration: NEMA WD 6, type as specified and indicated.
- B. Convenience Receptacles: NEMA 5-20R.
- C. Single Convenience Receptacles: NEMA 5-20R.
- D. Duplex Convenience Receptacles: NEMA 5-20R.
- E. GFCI Receptacles: Convenience receptacle with integral ground fault circuit interrupter to meet regulatory requirements.
- F. Provide tamper and arc fault receptacles per NEC and Local codes.

2.04 WALL PLATES

- A. Decorative Cover Plates: Ivory, smooth plastic. (Verify color with Architect/Owner.)
- B. Jumbo Cover Plates: Ivory, smooth plastic. (Verify color with Architect/Owner.)
- C. Weatherproof Cover Plates: Gasketed cast metal with hinge.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that outlet boxes are installed at proper height.
- B. Verify that wall openings are neatly cut and will be completely covered by wall plates.
- C. Verify that floor boxes are adjusted properly.
- D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.
- E. Verify that openings in access floor are in proper locations.

3.02 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean debris from outlet boxes.

3.03 INSTALLATION

- A. Install securely, in a neat and workmanlike manner, as specified in NECA 1.
- B. Install devices plumb and level.
- C. Install receptacles with grounding pole on top.
- D. Connect wiring device grounding terminal to outlet box with bonding jumper.
- E. Install decorative plates on switch, receptacle, and blank outlets in finished areas.
- F. Connect wiring devices by wrapping conductor around screw terminal.
- G. Use jumbo size plates for outlets installed in masonry walls.
- H. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.
- I. Install protective rings on active flush cover service fittings.

3.04 INTERFACE WITH OTHER PRODUCTS

- A. Coordinate locations of outlet boxes provided under Section 26 05 37 to obtain mounting heights specified.
- B. Install convenience receptacle 18 inches above finished floor.
- C. Install convenience receptacle 6 inches above counter.

3.05 FIELD QUALITY CONTROL

- A. Perform field inspection, testing, and adjusting in accordance with Division 01.
- B. Inspect each wiring device for defects.
- C. Operate each wall switch with circuit energized and verify proper operation.
- D. Verify that each receptacle device is energized.
- E. Test each receptacle device for proper polarity.
- F. Test each GFCI receptacle device for proper operation.

3.06 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.

3.07 CLEANING

- A. Clean exposed surfaces to remove splatters and restore finish.

END OF SECTION

SECTION 26 28 18
ENCLOSED SWITCHES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Nonfusible switches.

1.02 RELATED REQUIREMENTS

- A. Section 26 28 13 - Fuses.

1.03 REFERENCE STANDARDS

- A. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association; 2017.
- B. NFPA 70 - National Electrical Code; National Fire Protection Association; 2017.

1.04 SUBMITTALS

- A. See Division 1 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide switch ratings and enclosure dimensions.
- C. Project Record Documents: Record actual locations of enclosed switches.

1.05 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience and with service facilities within 100 miles (160 km) of Project.
- C. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Eaton Electrical/Cutler-Hammer.
- B. ABB.
- C. Square D.
- D. Substitutions: See Division 1 - Product Requirements.

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2.02 COMPONENTS

- A. Nonfusible Switch Assemblies: NEMA KS 1, Type HD enclosed load interrupter knife switch.
 - 1. Externally operable handle interlocked to prevent opening front cover with switch in ON position.
 - 2. Handle lockable in OFF position.
- B. Manual Toggle Controller/Disconnect
 - 1. Hubbell #HBL78 Series.
- C. Enclosures: NEMA KS 1.
 - 1. Interior Dry Locations: Type 1.
 - 2. Exterior Locations: Type 3R.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

3.02 FIELD QUALITY CONTROL

- A. Perform field inspection in accordance with Division 1.
- B. Inspect and test in accordance with NETA STD ATS, except Section 4.
- C. Perform inspections and tests listed in NETA STD ATS, Section 7.5.1.2.

END OF SECTION

SECTION 26 51 00
INTERIOR LIGHTING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Interior luminaires, egress fixtures, and accessories.
- B. Exit signs.
- C. LED Luminaires.
- D. LED Drivers.
- E. Accessories.

1.02 RELATED REQUIREMENTS

- A. Section 23 36 00 - Air Terminal Units: Air distribution accessories for air handling luminaires.

1.03 REFERENCE STANDARDS

- A. ANSI C78.379 - American National Standard for Electric Lamps -- Reflector Lamps -- Classification of Beam Patterns; 2006 (R2015).
- B. ANSI C82.1 - American National Standard for Lamp Ballast - Line Frequency Fluorescent Lamp Ballast; 2004 (R2015).
- C. IESNA LM-63 - ANSI Approved Standard File Format for Electronic Transfer of Photometric Data and Related Information; 2002.
- D. NECA/IESNA 500 - Standard for Installing Indoor Commercial Lighting Systems; National Electrical Contractors Association; 2006.
- E. NECA/IESNA 502 - Standard for Installing Industrial Lighting Systems; National Electrical Contractors Association; 2006.
- F. NEMA WD 6 - Wiring Devices - Dimensional Requirements; National Electrical Manufacturers Association; 2016.
- G. NFPA 70 - National Electrical Code; National Fire Protection Association; 2017.
- H. NFPA 101 - Code for Safety to Life from Fire in Buildings and Structures; National Fire Protection Association; 2018.

1.04 SUBMITTALS

- A. See Division 1 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.
- C. Product Data: Provide dimensions, ratings, and performance data.
 - 1. Photometric Data: Submit on CD or DVD, in IESNA LM-63 standard format.
- D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Quality Assurance. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- E. Operation and Maintenance Data: Instructions for each product.
- F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Division 1 - Product Requirements, for additional provisions.
 - 2. Extra Plastic Lenses: One of type and size.
 - 3. Extra Lamps: One of each type and size.
 - 4. Extra Ballasts: One of type and size.

1.05 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70 and NFPA 101.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- C. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.01 LUMINAIRES

- A. Furnish products as indicated in Schedule on drawings.
- B. Substitutions: See Division 1 - Product Requirements.

2.02 EXIT SIGNS

- A. Manufacturers:
 - 1. Cooper Lighting.
 - 2. Lithonia Lighting.
 - 3. Hubbell.
 - 4. Substitutions: See Division 1 - Product Requirements.
- B. Exit Signs: Exit sign fixture suitable for use as emergency lighting unit.
 - 1. Furnish products as indicated in schedule on drawings.

2.03 LED LUMINAIRES

- A. LED Luminaires shall meet all DesignLights Consortium® (DesignLights.org) Product Qualification Criteria. This does not require that the luminaire be listed on the DesignLights Consortium's® Qualified Products List, but they must meet the Product Qualification Criteria. The technical requirements that the luminaire shall meet for each Application Category are:
 - 1. Minimum Light Output.
 - 2. Zonal Lumen Requirements.
 - 3. Minimum Luminaire Efficacy.
 - 4. Minimum CRI.
 - 5. L70 Lumen Maintenance.
 - 6. Minimum Luminaire Warranty of 5 years (not pro-rated) to include LED driver and all LED components.
- B. Color Consistency: LED manufacturer shall use a maximum 3-step MacAdam Ellipse binning process to achieve consistent luminaire-to-luminaire color for interior luminaires. Exterior luminaires shall use a maximum 5-step MacAdam Ellipse binning process.
- C. Glare Control: Exterior luminaires shall meet DesignLights Consortium's® criteria for Zonal Lumen Distribution requirements or Backlight-Uplight-Glare (BUG) standards for exterior luminaires.
- D. Luminaire shall be mercury-free, lead-free, and RoHS compliant.
- E. Luminaire shall comply with FCC 47 CFR part 15 non-consumer RFI/EMI standards.
- F. Light output of the LED system shall be measured using the absolute photometry method following IES LM-79 and IES LM-80 requirements and guidelines.
- G. Luminaire shall maintain 70% lumen output (L70) for a minimum of 50,000 hours.
- H. Lumen output shall not depreciate more than 20% after 10,000 hours of use.
- I. Luminaire and driver shall be furnished from a single manufacturer to ensure compatibility.
- J. Luminaire Color Rendering Index (CRI) shall be a minimum of 80 for interior luminaires, and a minimum of 70 for exterior luminaires.

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- K. LED luminaire shall be thermally designed as to not exceed the maximum junction temperature of the LED for the ambient temperature of the location the luminaire is to be installed. Rated case temperature shall be suitable for operation in the ambient temperatures typically found for the intended installation. Exterior luminaires to operate in ambient temperatures of -20°F to 122°F (-29°C to 50°C).
- L. Luminaire shall operate normally for input voltage fluctuations of plus or minus 10 percent.
- M. Luminaire shall have a maximum Total Harmonic Distortion (THD) of $\leq 20\%$ at full input power and across specified voltage range.
- N. All connections to luminaires shall be reverse polarity protected and provide high voltage protection in the event connections are reversed or shorted during the installation process.
- O. All luminaires shall be provided with knockouts for conduit connections.
- P. The LED luminaire shall carry a limited 5-year warranty minimum for LED light engine(s)/board array, and driver(s).
- Q. Provide all of the following data on submittals:
 - 1. Delivered lumens
 - 2. Input watts
 - 3. Efficacy
 - 4. Color rendering index.
- R. The failure of one LED shall not affect the operation of the remaining LEDs.

2.04 LED DRIVERS

- A. General:
 - 1. Provide driver type (non-dimmed, step-dimmed, continuous-dimming, etc.) as indicated on the luminaire schedule on the drawings.
 - 2. Minimum Warranty of 5 years (not pro-rated) to include LED driver and all LED components.
 - 3. Driver shall have a rated life of 50,000 hours, minimum.
 - 4. Driver and LEDs shall be furnished from a single manufacturer to ensure compatibility.
 - 5. Driver shall have a minimum power factor (pf) of 0.9 and a maximum crest factor (cf) of 1.5 at full input power and across specified voltage range.
 - 6. Driver shall operate normally for input voltage fluctuations of plus or minus 10 percent.

7. Driver shall have a maximum Total Harmonic Distortion (THD) of $\leq 20\%$ at full input power and across specified voltage range.
 8. Wiring connections to LED drivers shall utilize polarized quick-disconnects for field maintenance.
 9. Fuse Protections: All luminaires shall have built-in fuse protection. All power supply outputs shall be either fuse protected or be Polymeric Positive Temperature Coefficient (PTC)-protected as per Class 2 UL listing.
 10. Provide all of the following data on submittals:
 - a. Input watts
 - b. Power Factor (pf)
 - c. Crest Factor (cf) at full input power
 - d. Total Harmonic Distortion (THD).
- B. Dimming Drivers:
1. LED driver shall be compatible with dimming controls where dimming is indicated on the plans. Dimmable drivers shall use Dimming Constant Current (DCC), Constant Voltage, or Pulse Width Modulation (PWM) operation.
 2. Step-Dimming Drivers: Easily switched from 0% to 50% to 100% output power. Both switch-leg inputs shall control 50% of the luminaire's light output equally.
 3. Continuous Dimming Drivers: LED luminaires shall dim to (10%, 1%, or 0.1%) as specified in the Luminaire Schedule on the plans without visible flicker or "popcorn effect". "Popcorn effect" is defined as the luminaire being on a pre-set dimmed level (less than 100%), and going to 100% prior to returning to the pre-set level when power is returned to the luminaire. Continuous Dimming Drivers shall use 0-10V control.

2.05 ACCESSORIES

- A. Product:
1. Substitutions: See Division 1 - Product Requirements.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install fixtures securely, in a neat and workmanlike manner, as specified in NECA 500 (commercial lighting).
- B. Install suspended luminaires and exit signs using pendants supported from swivel hangers. Provide pendant length required to suspend luminaire at indicated height.
- C. Support luminaires equal to or larger than 2 x 4 foot (600 x 1200 mm) size independent of ceiling framing.

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- D. Locate recessed ceiling luminaires as indicated on reflected ceiling plan.
- E. Install surface mounted luminaires and exit signs plumb and adjust to align with building lines and with each other. Secure to prevent movement.
- F. Exposed Grid Ceilings: Support surface mounted luminaires in grid ceiling directly from building structure.
- G. Exposed Grid Ceilings: Provide auxiliary members spanning ceiling grid members to support surface mounted luminaires.
- H. Exposed Grid Ceilings: Fasten surface mounted luminaires to ceiling grid members using bolts, screws, rivets, or suitable clips.
- I. Install recessed luminaires to permit removal from below.
- J. Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.
- K. Install clips to secure recessed grid-supported luminaires in place.
- L. Install wall mounted luminaires, emergency lighting units, and exit signs at height as indicated on Drawings.
- M. Install accessories furnished with each luminaire.
- N. Connect luminaires and exit signs to branch circuit outlets provided under Section 26 05 34 using flexible conduit.
- O. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.
- P. Bond products and metal accessories to branch circuit equipment grounding conductor.
- Q. Install specified lamps in each emergency lighting unit, exit sign, and luminaire.
- R. Interface with air handling accessories furnished and installed under Section 23 36 00.
- S. 0-to-10V Dimming Control Wiring Installation:
 - 1. Zero-to-10V dimming control conductors are classified by the NEC as Class 2 conductors and shall be kept separate from line-voltage conductors per NEC 725.136(A). Matching the insulation rating of Conductors of Different Systems does not apply to Class 2 conductors per NEC 300.3(C)(1), Informational Note No.1.
 - 2. Wall box dimmers will typically have two conduits: One conduit for line-voltage power, and one conduit or conduit stub for the 0-10V control wiring.

3. At each luminaire, separate openings (either manufactured knock-outs or punched openings) shall be used for the line-voltage power and the 0-10V wiring. The EC shall use a cable connector at the opening for the 0-10V wiring. Zero-to-10V conductors entering and within a luminaire enclosure shall maintain a minimum separation of 6 mm (0.25 in.) per NEC 725.136(D).
4. Exposed 0-10V cables shall be installed in separate conduits from line-voltage conductors.
5. The 0-10V cables may be routed in free air where concealed above accessible ceilings. Cables routed in free air shall observe the following installation requirements:
 - a. The 0-10V cables may be tie-wrapped to the outside of the luminaire power raceway where allowed by NEC 300.11(B)(2). Tie-wraps shall be UL listed for UV resistance. Care should be taken in the use of cable ties to secure and anchor the cabling. Ties shall not be over tightened as to compress the cable jacket. No sharp burrs shall remain where excess length of the cable tie has been cut.
 - b. Cabling shall be neatly run at right angles and be kept clear of other trades work.
 - c. Cabling shall be secured within twelve (12) inches of direction change or termination.
 - d. Cabling shall be supported at a maximum of 5-foot intervals utilizing "J-Hook" or "Bridle Ring" supports anchored to ceiling concrete, piping supports or structural steel beams. If cable sag at mid-span exceeds 12-inches, another support shall be provided. Cable supports shall be installed to maintain cable bend to larger than the minimum bend radius.
 - e. Cabling shall not be attached to or supported by existing cabling, plumbing or steam piping, ductwork, suspended ceiling supports or electrical or communications conduit. Do not place cable directly on the ceiling grid or attach cable in any manner to the ceiling grid wires.
 - f. All cables shall be free of tension at both ends. Nylon strain relief connectors shall be provided at each device and junction box where cables enter. In cases where the cable must bear some stress, Kellum type grips may be used to spread the strain over a longer length of cable.
 - g. Cable manufacturer's minimum bend radius shall be observed in all instances.
 - h. Use suitable cable fittings and connectors.

T. Luminaire Connections – Metal-Clad (MC) Cable:

1. Metal-Clad (MC) type cable that combines power and Class 2 circuits into a single cable may be used for the luminaire wiring where 0-10V dimming control wiring is required. Examples of such products are Encore Wire® MC-LED™ or Southwire® MC-PCS Duo™. Manufacturer's names and catalog numbers are used for quality and performance only. MC Cables manufactured by others shall be equally acceptable provided they meet or exceed in performance and quality as specified.
2. Recessed, including Master-Satellite connections:
 - a. Use a luminaire fixture whip from a J-box for recessed lay-in luminaires. Luminaire fixture whips shall be aluminum or steel AC Cable (Armored Cable) or Flexible Metal Conduit (FMC). Metal Clad (MC) cable that combines power and Class 2 circuits (for 0-10V dimming control) into a single cable may be used as a whip for luminaires that are dimmed.
 - b. Cable/Conduit whips shall be 3/8" (10 mm) minimum diameter, six feet (1.8 m) maximum length.
 - c. Flexible whips or pre-wired systems between master and satellite luminaires may be supported by the ceiling grid wires.
 - d. The flexible connectors shall be steel, galvanized, clamp type with locknut, snap-in type with locknut, or snap-in connector type, including those used on the master-satellite units.
3. Chain or Cable Hung (unfinished spaces):
 - a. Use manufacturer's SO cord or a luminaire fixture whip from a J-box. Luminaire fixture whips shall be aluminum or steel AC Cable (Armored Cable) or Flexible Metal Conduit (FMC). Metal Clad (MC) cable that combines power and Class 2 circuits (for 0-10V dimming control) into a single cable may be used as a whip for luminaires that are dimmed.
 - b. Conduit whips shall be 3/8" (10 mm) minimum diameter. Conduit whip or SO cord shall be cut to length (six feet (1.8 m) maximum) and shall allow movement of the chain/cable/luminaire, but shall not be long enough to "loop" and shall present a neat and workmanlike appearance.
 - c. Luminaire field wired flexible cord installations shall be connected per NEC 410.62.
 - d. The flexible connectors shall be steel, galvanized, clamp type with locknut, snap-in type with locknut, or snap-in connector type, including those used on the master-satellite units.
 - e. Conduit whip slack shall be tie-wrapped to the chain supports. Tie-wraps shall be UL listed for UV resistance.
4. Cable Hung (finished spaces):
 - a. Use manufacturer's SO cord from luminaire to a J-box.
 - b. SO cord shall be cut to length (six feet (1.8 m) maximum) and shall allow movement of the cable/luminaire, but shall not be long enough to "loop" and shall present a neat and workmanlike appearance.

- c. SO cord slack may be tie-wrapped to the cable supports. Tie-wraps shall be UL listed for UV resistance.
 - d. Luminaire field wired flexible cord installations shall be connected per NEC 410.62.
- 5. Surface Mounted (unfinished spaces): Provide direct conduit and box connection.
 - 6. Surface Mounted (finished spaces): Provide direct conduit and box connection. Use surface metal raceway where indicated on drawings. Conceal box and conduit where appropriate. Flexible metal conduit shall not be used where the conduit is exposed.

3.02 FIELD QUALITY CONTROL

- A. Perform field inspection in accordance with Division 1.
- B. Operate each luminaire after installation and connection. Inspect for proper connection and operation.

3.03 ADJUSTING

- A. Aim and adjust luminaires as indicated.
- B. Position exit sign directional arrows as indicated.

3.04 CLEANING

- A. Clean electrical parts to remove conductive and deleterious materials.
- B. Remove dirt and debris from enclosures.
- C. Clean photometric control surfaces as recommended by manufacturer.
- D. Clean finishes and touch up damage.

3.05 CLOSEOUT ACTIVITIES

- A. Demonstrate luminaire operation for minimum of two hours.

3.06 PROTECTION

- A. Relamp luminaires that have failed lamps at Substantial Completion.

3.07 SCHEDULE – On Drawings.

END OF SECTION

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