

PROJECT MANUAL ISSUED FOR BID

BUILDING M-04 RENOVATION & ADDITION CAMP DODGE, JOHNSTON, IOWA

Project No. 19082943
Contract No. C442N4260

SEPTEMBER 9, 2026



ARCHITECTS
ENGINEERS

219 Eighth Street, Suite 100, Des Moines, IA 50309

www.bbsae.com



BBS Project No.: 23067



IOWA ARMY NATIONAL GUARD

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PROJECT MANUAL

BUILDING M-04 RENOVATION & ADDITION CAMP DODGE, JOHNSTON, IOWA

For The
IOWA ARMY NATIONAL GUARD

Project No. 19082943
Contract No. C442N4260

SEPTEMBER 9, 2026

*THE ARMORY BOARD
DEPARTMENT OF PUBLIC DEFENSE (MILITARY DIVISION)*

*THE ADJUTANT GENERAL
Major General STEPHEN E. OSBORN
CHAIRMAN OF THE ARMORY BOARD*

ISSUED BY:

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CONSTRUCTION & FACILITIES MANAGEMENT OFFICE:

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DOCUMENT 00 01 05

CERTIFICATIONS

	I hereby certify that the portion of this technical submission described below was prepared by me or under my direct supervision and responsible charge. I am a duly registered Architect under the laws of the State of Iowa. _____, 20____ Matthew A. Cole, AIA License number: 5829 _____ My license renewal date is June 30, 2028 Discipline <u>Architectural</u> _____ Specification Divisions covered: <u>Divisions 01 thru 12</u> _____ Date issued <u>SEPTEMBER 9, 2026</u> _____

	I hereby certify that this engineering document was prepared by me or under my direct supervision and that I am a duly licensed Professional Engineer under the laws of the State of Iowa. _____, 20____ Holly H. Elbert, P.E. License number: 17968 My license renewal date is December 31, 2027 Discipline <u>Mechanical Engineering</u> _____ Specification Divisions covered: <u>Divisions 22 thru 23</u> _____ Date issued <u>SEPTEMBER 9, 2026</u> _____

	I hereby certify that this engineering document was prepared by me or under my direct supervision and that I am a duly licensed Professional Engineer under the laws of the State of Iowa. _____, 20____ Robert A. Hedgepeth, P.E License number: 14212 My license renewal date is December 31, 2027 Discipline <u>Electrical Engineering</u> _____ Specification Divisions covered: <u>Divisions 26 thru 27</u> _____ Date issued <u>SEPTEMBER 9, 2026</u> _____

	I hereby certify that this engineering document was prepared by me or under my direct supervision and that I am a duly licensed Professional Engineer under the laws of the State of Iowa. _____, 20____ Justin Strom, P.E License number: P24140 My license renewal date is December 31, 2027 Discipline <u>Civil Engineering</u> Specification Divisions covered: <u>Divisions 31 thru 33</u> Date issued <u>SEPTEMBER 9, 2026</u>

END OF DOCUMENT 00 01 05

TABLE OF CONTENTS

Number	Title
DIVISION 0 – BIDDING AND CONTRACTING REQUIREMENTS	
INTRODUCTORY INFORMATION	
Document 00 01 01	Project Title Page
Document 00 01 02	Project Design Team
Document 00 01 05	Certifications
Document 00 01 10	Table of Contents
BIDDING REQUIREMENTS	
Document 00 11 00	Advertisement For Bids
Document 00 21 00	Instructions to Bidders
Document 00 31 00	Geotechnical Exploration Report
Document 00 41 00	Form of Bid
Document 00 43 16	Supplement D - Targeted Small Business Form
Document 00 43 25	Supplement F - Substitution Request Form (Bidding Phase)
Document 00 43 36	Supplement G - Proposed Subcontractor Form
Document 00 43 46	Supplement J – 889 Representation Form
CONTRACTING REQUIREMENTS	
Document 00 52 00	Form of Agreement Between the Owner and Contractor
Document 00 61 00	Performance and Payment Bond
Document 00 62 10	Application and Certificate for Payment
Document 00 72 00	General Conditions
Document 00 73 00	Supplementary Conditions
DIVISION 1 - GENERAL REQUIREMENTS	
Section 01 10 00	Summary
Section 01 14 00	General Requirements
01 14 01	Submittal Review / Comment Form
Section 01 22 00	Unit Prices
Section 01 31 19	Project Meetings
Section 01 32 16	Construction Progress Schedule
Section 01 33 05	Electronic Submittal Procedures
Section 01 73 29	Cutting And Patching
Section 01 74 19	Construction Waste Management And Disposal
Section 01 77 20	Closeout Procedures
Section 01 78 00	Closeout Submittals
DIVISION 2 – EXISTING CONDITIONS	
Section 02 41 00	Selective Demolition
DIVISION 3 - CONCRETE	
Section 03 01 35	Cleaning and Resurfacing of Cast-in-Place Concrete
Section 03 30 00	Cast-In-Place Concrete
Section 03 48 00	Precast Concrete Splash Blocks

DIVISION 4 - MASONRY

Section 04 01 27	Masonry Repointing
Section 04 20 00	Unit Masonry

DIVISION 5 – METALS

Section 05 50 00	Metal Fabrications

DIVISION 6 – WOOD, PLASTICS, AND COMPOSITES

Section 06 10 00	Rough Carpentry
Section 06 20 23	Interior Finish Carpentry
Section 06 61 13	Solid Surface Fabrications

DIVISION 7 – THERMAL AND MOISTURE PROTECTION

Section 07 21 00	Thermal Insulation
Section 07 21 26	Blown In Insulation
Section 07 25 00	Weather Barriers
Section 07 31 13	Asphalt Shingles
Section 07 46 46	Fiber Cement Siding
Section 07 62 00	Sheet Metal Flashing and Trim
Section 07 90 00	Joint Sealers

DIVISION 8 - OPENINGS

Section 08 11 13	Hollow Metal Doors and Frames
Section 08 14 16	Flush Wood Doors
Section 08 31 13	Access Doors and Frames
Section 08 52 13	Metal-Clad Wood Windows
Section 08 71 00	Door Hardware
Section 08 80 00	Glazing
Section 08 91 19	Fixed Louvers

DIVISION 9 - FINISHES

Section 09 06 00	Schedule of Finishes
Section 09 21 16	Gypsum Board Assemblies
Section 09 30 13	Ceramic Tiling
Section 09 51 00	Acoustical Ceilings
Section 09 65 13	Resilient Base and Trim
Section 09 68 13	Tile Carpeting
Section 09 90 00	Painting And Coating

DIVISION 10 – SPECIALTIES

Section 10 14 00	Interior Signage
Section 10 21 19	Plastic Toilet Compartments
Section 10 26 13	Corner Guards
Section 10 28 00	Toilet Room Accessories
Section 10 44 00	Fire Protections Specialties

DIVISION 12 – FURNISHINGS

Section 12 21 13	Horizontal Louver Blinds

DIVISION 22 – PLUMBING

Section 22 05 01	Selective Plumbing Demolition and Remodeling
Section 22 05 17	Sleeves and Sleeve Seals for Plumbing Piping
Section 22 05 19	Meters And Gages For Plumbing Piping
Section 22 05 29	Hangers and Supports for Plumbing Piping and Equipment
Section 22 05 53	Identification For Plumbing Piping And Equipment
Section 22 07 19	Plumbing Piping Insulation
Section 22 11 16	Domestic Water Piping
Section 22 11 19	Domestic Water Piping Specialties
Section 22 13 16	Sanitary Waste and Vent Piping
Section 22 13 19	Sanitary Waste Piping Specialties
Section 22 30 00	Plumbing Equipment
Section 22 40 00	Plumbing Fixtures

DIVISION 23 – HEATING, VENTILATING, AND AIR CONDITIONING

Section 23 05 01	Selective Mechanical Demolition and Remodeling
Section 23 05 19	Meters And Gages for HVAC Piping
Section 23 05 29	Hangers and Supports for HVAC Piping and Equipment
Section 23 05 48	Vibration Controls for HVAC
Section 23 05 53	Identification for HVAC Piping and Equipment
Section 23 05 93	Testing, Adjusting, and Balancing for HVAC
Section 23 07 13	Duct Insulation
Section 23 07 19	HVAC Piping Insulation
Section 23 09 23	Direct Digital Control System for HVAC
Section 23 21 13	Hydronic Piping
Section 23 21 14	Geothermal Wellfield
Section 23 21 16	Hydronic Piping Specialties
Section 23 21 23	Hydronic Pumps
Section 23 25 13	Water Treatment for Close Loop Hydronic Systems
Section 23 31 13	Metal Ducts
Section 23 33 00	Air Duct Accessories
Section 23 37 13	Diffusers Registers and Grilles
Section 23 52 16	Condensing Boilers
Section 23 74 33	Dedicated Outdoor Air Units
Section 23 81 46	Water-Source Unitary Heat Pumps
Section 23 82 39	Unit Heaters

DIVISION 26 - ELECTRICAL

Section 26 05 01	Selective Electrical Demolition
Section 26 05 11	Requirements for Electrical Installations
Section 26 05 13	Medium-Voltage Cables
Section 26 05 19	Low-Voltage Electrical Power Conductors and Cables
Section 26 05 26	Grounding and Bonding for Electrical System
Section 26 05 29	Hangers and Supports for Electrical Systems
Section 26 05 33	Raceways and Boxes for Electrical Systems
Section 26 05 44	Sleeves and Sleeve Seals for Electrical Raceways and Cabling
Section 26 05 53	Identification for Electrical Systems
Section 26 09 14	Electrical Power Monitoring
Section 26 09 23	Lighting Control Devices
Section 26 12 19	Pad-Mounted, Liquid-Filled Medium-Voltage Transformers
Section 26 24 16	Panelboards
Section 26 27 26	Wiring Devices
Section 26 51 00	Interior Lighting

DIVISION 27 – COMMUNICATIONS

Section 27 00 00	Communications
Section 27 05 26	Grounding and Bonding for Communications Systems
Section 27 05 28	Pathways for Communications Systems

DIVISION 28 – FIRE DETECTION

Section 28 31 11	Digital, Addressable Fire-Alarm Systems

DIVISION 31 – EARTHWORK

Section 31 10 00	Site Clearing
Section 31 23 00	Excavation and Fill
Section 31 23 16	Trench and Backfill
Section 31 23 43	Excavation and Fill for Pipes and Structures
Section 31 25 00	Erosion and Sediment Control

DIVISION 32 – EXTERIOR IMPROVEMENTS

Section 32 13 13	Concrete Paving
Section 32 13 73	Concrete Paving Joint Sealants
Section 32 92 00	Seeding and Soil Supplements

DIVISION 33 – UTILITIES

Section 33 05 00	Common Work Results for Utilities
Section 33 11 00	Water Utility Distribution Piping
Section 33 12 00	Water Utility Distribution Equipment
Section 33 31 13	Sanitary Utility Piping
Section 33 41 00	Storm Utility Drainage Piping

END OF DOCUMENT 00 01 10

ADVERTISEMENT FOR BIDS

PROJECT TITLE:
BUILDING M-04 RENOVATION & ADDITION

BID DATE: SEPTEMBER 24, 2026

PROJECT LOCATION:
CAMP DODGE, JOHNSTON, IOWA

PROJECT NO.: 19082943
CONTRACT NO.: C442N4260

The Iowa Department of Public Defense, on behalf of the Iowa National Guard (IANG), will be receiving bids until **2:00 P.M.** local time for the proposed BUILDING M-04 RENOVATION & ADDITION, CAMP DODGE, JOHNSTON, IOWA. The general scope of work includes, but is not limited to:

Base Bid: Renovation of an existing 3,530 SF, masonry and wood framed structure and a new 737 SF addition to include a new entry vestibule, janitor closet and latrines, including, but not limited to selective demolition, painted gypsum wall board, ceramic tile, painted gypsum ceilings, acoustic ceiling tile, sealed concrete floors, carpet, windows and doors, connection to new electrical service, new concrete sidewalk, masonry repair, electrical, mechanical and plumbing, new masonry walls, concrete foundations, asphalt shingle roof, and new connections to existing water utilities, geothermal wellfields, and geothermal mechanical systems.

Bids received will be opened and read aloud at the time indicated. Late bids cannot be considered. Bids must be uploaded on the State of Iowa IMPACS system. Visit <https://bidopportunities.iowa.gov> and select the project with the contract number listed above. At the bottom of that page, select the 'Sign up here!' link to register and receive emails about the project. Navigate back to the project page and select the IMPACS link at the bottom of the page if you need to register to use that system. THIS IS THE ONLY ALLOWABLE BID SUBMISSION PROCEDURE.

A Teams meeting has been established for interested parties to listen in while the bids are opened and evaluated. Here is the information (this will also be posted as a link on the project page at Bid Opportunities)

Microsoft Teams meeting

Join: <https://teams.microsoft.com/meet/223364708559943?p=C8sEHSn66gcq0RRzYz>

Meeting ID: 223 364 708 559 943

Passcode: bB7De2EK

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[+1 469-998-6043, 354476965#](#) United States, Dallas

[Find a local number](#)

Phone conference ID: 354 476 965#

Bids shall be submitted on the enclosed Form of Bid as set forth in the Instructions to Bidders.

Any construction contractor performing work in Iowa (including out-of-state contractors) must comply with Chapter 91C of Iowa Code

Bidders must comply with all affirmative action/equal employment opportunity provisions of the State of Iowa and the Federal Government. The Iowa Department of Public Defense, Iowa Army National Guard, seeks to provide opportunities for Targeted Small Businesses in accordance with the provisions of Chapter 73 of the Code of Iowa. A listing of certified Targeted Small Businesses can be obtained by

visiting the Iowa Department of Economic Development website at
<https://iowaeda.microsoftcrmporals.com/tsb-search/>

The Iowa Department of Public Defense reserves the right to reject any or all bids, and to waive irregularities and to accept a bid that is deemed in the best interest of the State of Iowa and the IANG.

This project is exempt from Iowa Sales Tax. Davis Bacon Wages **will not** apply to this project, however the Build America Buy America Act **will** apply to this work.

Bidding Documents may be obtained from Beeline and Blue (2507 Ingersoll Avenue, Des Moines, Iowa 50312, (515) 244-1611 or 1-800-347-1610) or they can be found in electronic format on the Bid Opportunities project page.

Bidding Documents may also be viewed online or downloaded at www.beelineandblue.com. Click on "EPLANROOM" and then "PUBLIC PROJECTS". Register and log in, then select the project name or enter the project name in the search window.

The Plan Holders List may be viewed online at www.beelineandblue.com. Navigate to the project as outlined above and click on the "PLAN HOLDERS" tab.

For questions regarding the website, please call (515) 244-1611 or 1-800-347-1610.

A set of the Bidding Documents is also available for review at the Construction and Facilities Management Office, Bldg 3535 (B-61), Camp Dodge.

Award of this contract is dependent on receiving requested Federal and/or State funding. If such funding is not received within the sixty (60) day bid guarantee after the date of receiving bids, all rights and obligations under this agreement are considered null and void.

A Pre-Bid Conference will be held at **10:00 A.M.** local time, **WEDNESDAY SEPTEMBER 16, 2026** in Conference Room 106 of **BUILDING B-61, Camp Dodge**, 7105 NW 70th Avenue, Johnston, Iowa to review the Plans and Project Manual and to answer questions on this project. A Teams meeting has been established for interested parties to attend if they cannot be on site. Here is the information (this will also be posted as a link on the project page at Bid Opportunities)

Microsoft Teams meeting

Join: <https://teams.microsoft.com/meet/298960370188617?p=1pRaDD1lxkuOqN29q6>

Meeting ID: 298 960 370 188 617

Passcode: 6Er32GY9

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Phone conference ID: 206 676 905#

For further information regarding this project please call Brenda Wilder at (515) 205-1033 or Philip Payton at (515) 975-6211.

END OF DOCUMENT 00 11 00

DOCUMENT 00 21 00
INSTRUCTIONS TO BIDDERS

TABLE OF ARTICLES

1. DEFINITIONS
2. RECEIPT AND OPENING OF BIDS
3. BIDDING DOCUMENTS
4. PREPARATION OF BIDS
5. SUBMITTAL OF BIDS
6. MODIFICATION OF BIDS
7. WITHDRAWAL OF BIDS
8. IOWA TARGETED SMALL BUSINESS REQUIREMENTS
9. QUALIFICATION OF BIDDERS
10. SUBCONTRACTORS
11. BIDDERS REPRESENTATION
12. SUBSTITUTIONS
13. ADDENDA AND INTERPRETATIONS
14. BID PREFERENCE
15. METHOD OF AWARD
16. EXECUTION OF CONTRACT
17. IOWA STATE BUILDING CODE
18. TAXES
19. PREBID CONFERENCE
20. POST-BID INFORMATION

ARTICLE 1 - DEFINITIONS

- 1.1** The following definitions add to the list of definitions included in the General Conditions of the Contract and shall be used in conjunction with them as a part of the Bidding Documents.
- 1.2** Bidding Documents include The Bidding Requirements and the proposed Contract Documents:
- 1.3** The Bidding Requirements consists of:
- .1 Advertisement For Bids.
 - .2 Instructions to Bidders.
 - .3 Form of Bid
 - .4 Supplements to Form of Bid:
 - .(1) Supplement D: Targeted Small Business Form(Submit With Form of Bid)
 - .(2) Supplement F: Substitution Request Form (Bidding Phase).
 - .(3) Supplement G: Proposed Subcontractor Form.
 - .(4) Supplement J: 889 Representation Form
- 1.4** The Proposed Contract Documents consists of:
- .1 Form of Agreement between the Owner and Contractor.
 - .2 Conditions of the Contract (General, Supplementary, and other Conditions).
 - .3 Drawings.
 - .4 Specifications.
 - .5 Addenda issued prior to execution of the Contract.
 - .6 Modifications issued after execution of the Contract.
 - .7 Other documents listed in the Agreement.
- 1.5** Definitions set forth in the General Conditions of the Contract for Construction or in other Contract Documents are applicable to the Bidding Documents.
- 1.6** Addenda are a written or graphic instruments issued by the Architect prior to the execution of the Contract which modify or interpret the Bidding Documents by additions, deletions, clarifications, or corrections.
- 1.7** A Bid is a complete and properly executed proposal to do the Work for the sums stipulated therein, submitted in accordance with the Bidding Documents.
- 1.8** The Base Bid is the sum stated in the Bid for which the Bidder offers to perform the Work as described in the Bidding Documents.
- 1.9** An Allowance is a specified monetary sum, specified quantity or time not otherwise defined by the specifications or drawings, but which the contractor is required to include in the bid price.
- 1.10** A Unit Price is an amount stated in the Bid as a price per unit of measurement for materials, equipment or services or a portion of the Work as described in the Bidding Documents.
- 1.11** An Alternate Bid (or Alternate) is an amount stated in the Bid to be added to or deducted from the amount of the Base Bid if the corresponding change in the Work, as described in the Bidding Documents, is accepted.
- 1.12** A Bidder is a person or entity who submits a Bid and who meets the requirements set forth in the Bidding Documents.
- 1.13** A Certifiable Digital Signature is one that is affixed to a document by a program relying on a token or other credential which can be traced as belonging to the individual signing.
- 1.14** 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.

ARTICLE 2 - RECEIPT AND OPENING OF BIDS

- 2.1** The Iowa Department of Public Defense (Military Division), Iowa Army National Guard, hereinafter called the Owner, will receive Bids electronically via the State of Iowa IMPACS system, until the established bid date and time (see Section 00 41 00 - Form of Bid). The Owner will then publicly open and read all properly submitted Bids. A Teams meeting has been established for interested parties to listen in while the bids are opened and evaluated. Here is the information (this will also be posted as a link on the project page at Bid Opportunities)

Microsoft Teams meeting

Join: <https://teams.microsoft.com/meet/223364708559943?p=C8sEHSn66gcq0RRzYz>

Meeting ID: 223 364 708 559 943

Passcode: bB7De2EK

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- 2.2** The Owner will reject and return unopened any Bid received after the time specified for the receipt of Bids. See the advertisement and/or bid form for date/time deadline for bid submission.
- 2.3** **Electronic bids via IMPACS is the ONLY bid submission method. Oral, telephonic, telegraphic, facsimile, mailed or other physically transmitted bids will not be considered.**
- 2.4** Each Bidder shall be solely responsible for the delivery of their Bid to the Owner before the time specified.
- 2.5** The Owner acknowledges the responsibility of the Iowa Public Bidding Requirements in advertising and receiving bids for this project.

ARTICLE 3 - BIDDING DOCUMENTS

- 3.1** Bidders may obtain complete sets of the Bidding Documents from the issuing entity designated in the Advertisement for Bid.
- 3.2** Bidders and Sub-bidders shall use complete sets of Bidding Documents in preparing Bids; neither the Owner nor Architect assumes responsibility for errors or misinterpretations resulting from the use of incomplete sets of Bidding Documents.
- 3.3** The Owner and Architect may make copies of the Bidding Documents available on the above terms for the Purpose of obtaining Bids on the Work. No license or grant of use is conferred by issuance of copies of the Bidding Documents.

ARTICLE 4 - PREPARATION OF BIDS

- 4.1** Prepare Bids on an exact copy of the "Form of Bid" included in these documents. Fill in all applicable blank spaces, typewritten or in ink. The amount must be in both words and figures. If words and figures do not agree, the amount as written in words shall govern.
- 4.2** All requested Alternates shall be bid. If no change in the Base Bid is required, enter "No Change".
- 4.3** The person signing the Bid must initial all erasures or corrections.

- 4.4** Bids must indicate the full name of the Bidder, must be signed in the firm or corporate name of the Bidder, and must bear the longhand or certifiable digital signature of a principal duly authorized to execute contracts for the Bidder. Bids signed by an agent of the Bidder must be accompanied by evidence of the agent's authority to execute contracts for the Bidder. Type or print below the signature the name of each person signing the Bid.

ARTICLE 5 - SUBMITTAL OF BIDS

- 5.1** Bids must be uploaded on the State of Iowa IMPACS system. Visit <https://bidopportunities.iowa.gov> and select the project with the contract number listed elsewhere in this manual. At the bottom of that page, select the 'Sign up here!' link to register and receive emails about the project. Navigate back to the project page and select the IMPACS link at the bottom of the page if you need to register to use that system. THIS IS THE ONLY ALLOWABLE BID SUBMISSION PROCEDURE. Bid packages that are uploaded must include:

1. The Form of Bid (section 00 41 00)
2. Supplement D: Targeted Small Business Form (use provided form).

ARTICLE 6 - MODIFICATION OF BIDS

- 6.1** No modification of submitted Bids in any way or form will be permitted after the date/time submission deadline.

ARTICLE 7 - WITHDRAWAL OF BIDS

- 7.1** Any Bid may be withdrawn and resubmitted prior to the time set for the receipt of Bids provided that they are then fully in conformance with these Instructions to Bidders.
- 7.2** No bid may be withdrawn for a period of sixty (60) calendar days after the time set for the receipt of Bids.

ARTICLE 8 - IOWA TARGETED SMALL BUSINESS REQUIREMENTS

- 8.1** PROGRAM DESCRIPTION AND REQUIREMENTS:

- 8.1.1** On construction contracts bid competitively for which a participation goal is indicated, each Bidder who is not a Targeted Small Business and who will be using a Certified Targeted Small Business Subcontractor or supplier must:

- .1 Submit with the Form of Bid: Supplement D: Targeted Small Business Form provided herein.
- .2 Comply with all relevant provisions of the Iowa Civil Rights Act, Chapter 601A; Executive Order #11, 1984, and #15, 1973, as appended by Executive Order #34, dated July 22, 1988; Federal Executive Order #11245, 1965, as amended by Federal Executive Order #11375, 1967; the Equal Employment Opportunity Act of 1972; and Iowa Code Section 19B.7.
- .3 Comply with all provisions of the State of Iowa relevant to fair employment practices, and furnish all information and submit all reports requested by these provisions.
- .4 Continue to use the Iowa Targeted Small Business certification guidelines as set out in 481-Chapter 25 of the Iowa Administrative Code for the purpose of identifying Targeted Small Businesses for participation in the award of general and subcontracts.

- 8.1.2** The mandatory set-aside requirements and bid preferences required by Iowa Code Sections 73.16 to 73.21 are not currently in effect. Use the following guidelines to encourage Targeted Small Business participation.

- 8.1.3** DEFINITIONS:

- .1 Actively manage means exercising the power to make policy decisions affecting the business.

- .2 Minority person means an individual who is black, Hispanic, Pacific Island native, American Indian, or Alaskan Native.
 - .3 Operated means actively involved in the day-to-day management of the business.
 - .4 Small Business means any enterprise which is located in this State, which is operated for profit under a single management, and which has either fewer than twenty employees or an annual gross income of less than three million dollars computed as an average of the three previous years.
- 8.2** The Department of Public Defense (Military Division), Iowa Army National Guard (IAARNG), seeks to provide opportunities for Targeted Small Businesses in the awarding of contracts. The IAARNG may award contracts to Targeted Small Businesses under the terms of the Iowa Small Business Procurement Act of 1986 and the Iowa Administrative Code. The IAARNG is also authorized to establish certified Targeted Small Business participation requirements for construction contracts.
- 8.3** When entering into this contract with the IAARNG, the General Contractor will take documented steps to encourage participation from Targeted Small Businesses for the purpose of subcontracting or supplying of materials. This project has a Targeted Small Business participation goal of ten percent (10%).
- 8.4** If a prime contractor fails to meet the Targeted Small Business participation goal indicated, the prime contractor shall still be required to submit with the Form of Bid (on the Targeted Small Business Form provided herein) the names of Targeted Small Businesses contacted.
- 8.5** If the Bidder intends to subcontract with a certified Targeted Small Business in the absence of a stated Targeted Small Business participation goal, the Bidder should inform the State Comptroller Office of this intent by submitting a Targeted Small Business Form so that they may receive credit for this participation.

ARTICLE 9 - QUALIFICATION OF BIDDERS

- 9.1** Bidders must be registered with the Iowa Labor Commissioner. The Bidders must include an Iowa registration number as provided for on the Form of Bid.
- 9.2** Non-resident corporations submitting Bids must be in compliance with Section 490.1501 of the Code of Iowa and legally authorized thereby to carry on such business in the State of Iowa as is required by the Contract Documents.
- 9.3** Non-resident corporations certify by submittal of a Bid that the corporation shall comply with Chapter 73 of the Iowa Code.
- 9.4** The Owner may make such investigations as deemed necessary to determine the ability of the Bidder to perform the Work, and the Bidder must furnish to the Owner all such information and data for these purposes as the Owner may request. The Owner reserves the right to reject any Bid if the evidence submitted by, or investigation of, such Bidder fails to satisfy the Owner that such Bidder is properly qualified to carry out the obligations of the Contract and to complete the Work described herein.
- 9.5** The Owner gives preference to Iowa domestic labor in the constructing or building of any public improvement. By virtue of statutory authority, preference is given to products and provisions produced or grown within the State of Iowa.
- 9.6** Bidders and all Subcontractors shall be prepared to represent post-bid whether they do or do not use prohibited telecommunications equipment or services in accordance with Section 889 Part B of the FY 2019 National Defense Authorization Act (NDAA). Refer to Article 22 – Post-Bid Information

ARTICLE 10 - SUBCONTRACTORS

- 10.1** In accordance with Iowa law, the successful Bidder must furnish in writing to the Owner a list of the names of subcontractors who will work on the project as described in Article 22.
- 10.2** The Bidder is specifically advised that any person, firm, or other party to whom it is proposed to award a subcontract under this Contract must (1) be registered in the State of Iowa and have contractor's registration number, and (2) be acceptable to the Owner.

ARTICLE 11 - BIDDERS REPRESENTATION

- 11.1** Each Bidder by submitting a Bid represents that:
 - 11.1.1** The Bidder has read and completely understands the Bidding Requirements and Contract Documents.
 - 11.1.2** The bidder has become familiar with the local conditions under which the Work is to be performed, including availability and cost of labor and materials, and has carefully correlated personal observations with the requirements of the Contract Documents.
 - .1** A tour of the site will be conducted following the Pre-Bid Conference identified in the Advertisement for Bids. Bidders shall arrange for other site visits in advance by contacting Brenda Wilder at (515) 205-1033.
 - 11.1.3** The Bid is based upon the materials, equipment and systems required by the Bidding Documents without exception.
 - 11.1.4** The Bidder has familiarized himself/herself with Federal, State, and Local laws, ordinances, rules, and regulations affecting performance of the Work.
 - 11.1.5** The Bidder agrees that the Contract Time will begin upon receipt of a Notice to Proceed from the Owner, and will achieve Substantial Completion of all the Work within the Contract Time stated on the Bid Form, excepting for delays covered in Article 8 of the General Conditions of the Contract.
 - 11.1.6** The Bidder has given preference to use of Iowa domestic labor and products and provisions produced or grown within the State of Iowa.
- 11.2** Failure of the selected Bidder to fulfill the provisions of this Article in no way relieve the obligation of the Bidder to furnish all materials and labor necessary to carry out the provisions of the Contract, nor shall such failure constitute grounds for extra compensation over the price stated in the accepted Bid.

ARTICLE 12 - SUBSTITUTIONS

- 12.1** The materials, products and equipment described in the Bidding Documents establish a standard of required function, dimension, appearance, and quality to be met by any proposed substitution.
- 12.2** No substitution will be considered during the bidding period unless written request has been submitted to the Architect for approval, on the form provided herein, at least 5 days prior to the bid date. Each such request must include the name of the material, product or equipment for which it is to be substituted and a complete description of the proposed substitution including drawings, cuts, performance and test data, and any other data or information necessary for a complete evaluation. The burden of proof of the merit of the proposed substitution is upon the proposer.

- 12.3** Request for approval of a substitution will not be considered if Substitution Request Form provided herein is not completely filled out.
- 12.4** If the Architect approves any proposed substitution, such approval is not official until set forth in an addendum. Do not include any substitutions not confirmed by written addenda.
- 12.5** Substitutions after the Contract Award may be considered only as provided for in the Conditions of the Contract and Division 1 of the Project Manual.

ARTICLE 13 - ADDENDA AND INTERPRETATIONS

- 13.1** Bidders must carefully examine and compare the Bidding Documents, examine the site and local conditions and at once report any ambiguity, inconsistency, or error discovered. Bidders and Sub-bidders requiring clarification or interpretation of the Bidding Documents shall make written request to the Architect for interpretation or correction. Such requests must reach the Architect at least seven (7) days prior to the bid date.
- 13.2** The Architect will issue any and all interpretations, corrections, revisions, and amendments to all holders of Bidding Documents in the form of written addenda. Addenda will be transmitted at least forty-eight (48) hours prior to the time set for the receipt of Bids to all who are known by the issuing office to have received a complete set of Bidding Documents. Copies of Addenda will be made available for inspection wherever Bidding Documents are on file for that purpose. Each Bidder is responsible to ascertain prior to submitting a Bid that the Bidder has received all Addenda issued. All addenda issued shall become part of the Contract Documents and Bidders must acknowledge them in the Form of Bid.
- 13.3** Only those interpretations, corrections, revisions, and amendments confirmed by written addenda are binding. Bidders are cautioned to refrain from including in their Bid any interpretations, corrections, revisions, or amendments which are not confirmed by written addenda.
- 13.4** Any question relating to the technical specifications may be directed to the individuals identified on Document 00 01 02 – Project Design Team.

ARTICLE 14 - BID PREFERENCE

- 14.1** All Bidders must certify their state or foreign country of residence by completing the official address section of the Form of Bid.
- 14.2** Under Iowa law, as described in the Iowa Administrative Code, resident Bidders on public improvements are allowed a preference equal to the preference given or required by the state or foreign country in which the nonresident Bidder is a resident. "Resident Bidder" means a person or firm authorized to transact business in this State, and having a place of business at which it is and has conducted business for at least six months prior to the first advertisement for the public improvement and, in the case of a corporation, at least fifty percent (50%) of the common stock is owned by residents of this State.

ARTICLE 15 - METHOD OF AWARD

- 15.1** It is the intent of the Owner to award a Contract to the lowest qualified Bidder provided the Bid has been submitted in accordance with the requirements of the Bidding Documents and does not exceed the funds available. The Owner may reject any or all Bids, waive any irregularities, informalities, or technicalities in any Bid, and accept any Bid in whole or in part which it deems to be in the Owner's best interests.
- 15.2** All requested Alternates shall be bid. The Owner reserves the right to accept Alternates in any order or combination, and to determine the low Bidder on the basis of the sum of the Base Bid and Alternate(s) accepted.

- 15.3** Generally, all Bids received by the Owner which require allocation of appropriated Government funding are subject to the acceptance of the issuing department for the State of Iowa. Each prime Bidder, subcontractor, and material supplier on this project agrees to guarantee their Bid for a period of sixty (60) calendar days after the time set for the receipt of Bids.
- 15.4** Award of this contract is dependent on receiving requested Federal and/or State funding. If such funding is not received within the sixty (60) day Bid guarantee after the date of receiving Bids, all rights and obligations to enter into a contract are considered null and void.
- 15.5** The Owner sending a "Notice of Award" to the selected Bidder constitutes award of the Contract.

ARTICLE 16 - EXECUTION OF CONTRACT

- 16.1** Selected Bidder must, within ten (10) calendar days after receiving Notice of Award, enter into a written contract with the Owner on the Form of Agreement prescribed in these documents.
- 16.2** The Contract, when duly executed, represents the entire agreement between parties.
- 16.3** Simultaneously with the delivery of the executed Contract, the Contractor must furnish a performance and payment surety bond in the amount of 100% of the Contract Sum as security for faithful performance of the Contract and for the payment of all persons performing labor and furnishing materials for the work, or evidence of eligibility for waiver of the bond requirements. The bond shall be on the form prescribed in these documents (electronic submission only). The surety on such bond shall be by a corporation duly authorized to do business in the State of Iowa, and said bond shall be signed or countersigned by an Iowa Resident Agent. Attorneys-in-fact who sign surety bonds must file with each bond a certified and effectively dated copy of their power of attorney.
- 16.4** Completed Contract and Contract Performance and Payment Bond must be dated the same and executed as per State contracting instruction procedures.
- 16.5** The Owner will maintain a contract administration system ensuring that contractors perform in accordance with the terms, conditions, and specification of their Contract Document.

ARTICLE 17 - IOWA STATE BUILDING CODE

- 17.1** All construction under this Contract must conform to the requirements of the Iowa State Building Code. Adhere to the provisions of the Iowa State Building Code which takes precedence over local governmental bodies' regulations. Perform work not regulated by the Iowa State Building Code in accordance with other applicable local regulations.

ARTICLE 18 - TAXES

- 18.1** This project is TAX EXEMPT. Refer to Article 3.6 of the General Conditions (as modified by the Supplementary Conditions) and Article 20.3 of the Instructions To Bidders.

ARTICLE 19 - PREBID CONFERENCE

- 19.1** The Owner invites Bidders to attend a pre-bid conference on the date, time, and location specified in the Advertisement for Bids.

ARTICLE 20 - POST-BID INFORMATION

- 20.1** Prior to consideration for Award of Contract, the Apparent Low Bidder shall submit for the general contractor and ALL subcontractors a completed:
- 20.1.1** Supplement J: 889 Representation Form.

- .1 Failure of the bidding entity to successfully meet the requirements of Section 889 Part B of the 2019 NDAA, either through non-use of the prohibited equipment or meeting the mitigation requirements as outlined in Supplement J, will result in the bid being rejected. Failure to meet these requirements by a proposed subcontractor will result in their rejection and trigger the actions outlined in Section 20.2.1 below.
- 20.2** The Awarded Bidder shall, within forty eight (48) hours of notification of selection for the award of a Contract for the Work, submit:
 - 20.2.1** Supplement G - Proposed Subcontractor Form:
 - .1 Include the following:
 - (1). A designation of the Work to be performed by the Bidder with his/her own forces.
 - (2). A list of names of the subcontractors or other persons or entities (including those who are to furnish materials or equipment fabricated to a special design) proposed for each principal portion of the Work including but not limited to Mechanical Work, Electrical Work, Masonry Work, and Telecommunication Work (as applicable).
 - (3). The list must include Iowa Contractor's registration numbers for all Subcontractors.
 - .2 The Bidder will be required to establish to the satisfaction of the Architect and the Owner the reliability and responsibility of the proposed subcontractors or other persons or entities to furnish and perform the Work described in the Bidding Documents.
 - .3 Prior to the execution of the Contract, the Architect will notify the Bidder in writing if either the Owner or the Architect, after due investigation, has reasonable objection to any subcontractor, person or entity on such list. If the Owner or Architect has a reasonable objection to any subcontractor, person or entity on such list, the Bidder may, at the Bidder's option:
 - (1). Withdraw the Bid.
 - (2). Submit an acceptable substitute subcontractor, person or entity with an adjustment in the Base Bid or Alternate Bid to cover the difference in cost occasioned by such substitution. The Owner may, accept the adjusted bid price or disqualify the Bidder.
 - .4 Subcontractors and other persons and entities proposed by the Bidder and to whom the Owner and the Architect have made no reasonable objection must be used on the Work for which they were proposed and shall not be changed except with the written consent of the Owner and the Architect.
- 20.3** The Awarded Bidder shall, within one week following the Pre-Construction meeting and prior to purchasing any materials for the Work, submit a completed 'Sales Tax Exempt Application Form'. The Owner will email an electronic copy of the form to the General Contractor shortly after the Pre-Construction Meeting.

END OF DOCUMENT 00 21 00

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GEOTECHNICAL EXPLORATION REPORT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Geotechnical Exploration Report.

1.2 RELATED SECTIONS

- A. Document 00 21 00 - Instructions to Bidders: Site Examination.

1.3 GEOTECHNICAL EXPLORATION REPORT

- A. A copy of a geotechnical exploration report, with respect to the building site, is included herein:
 - 1. Title: M4 ADDITION
Geotechnical Engineering Report
 - 2. Dated: April 12, 2024
 - 3. Prepared by: Terracon
- B. This report identifies properties of below grade conditions at a limited number of boring locations, offers recommendations for design, and was prepared primarily for the use of the Architect/Engineer. This report is not considered part of the Drawings, Specifications, or Contract Documents.
- C. The Owner is making this report available to Bidders as information only and assumes no responsibility for its accuracy. This report, by its nature, cannot reveal all conditions existing on the site and any data indicated on the subsurface conditions are not intended as representations or warranties of the continuity of such conditions between soil borings. No claim will be considered if the Bidder relies on the information provided in this report in their bidding or their construction operations and subsequently finds that it is inaccurate.
- D. Should subsurface conditions be found to vary substantially from this report based on testing and inspection or Contractor observation, the Contractor shall promptly notify the Architect/Engineer in accordance with the General Conditions of the Contract. Should changes in design and/or construction be required, such changes will be described by the Architect/Engineer and equitable adjustment in the Contract Sum or Contract Time, or both will be made in accordance with the General Conditions of the Contract.

END OF DOCUMENT 00 31 00

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M4 Addition

Geotechnical Engineering Report

April 12, 2024 | Terracon Project No. 08245039-01

Prepared for:

BBS Architects | Engineers
219 Eighth Street, Suite 100
Des Moines, Iowa 50309



I hereby certify that this engineering document was prepared by me or under my direct personal supervision and that I am a duly licensed Professional Engineer under the laws of the State of Iowa.

Ujwala Manchikanti

4/12/2024

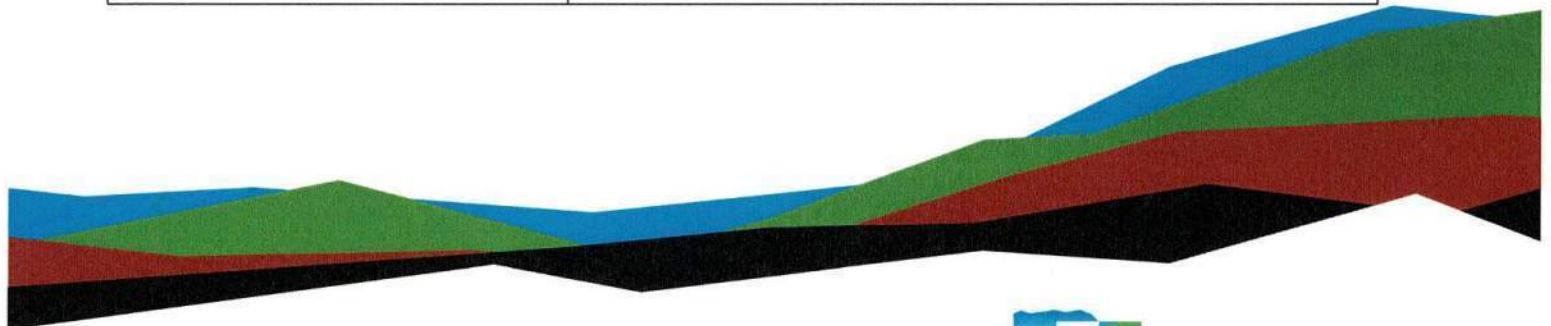
Ujwala Manchikanti, P.E.

Date

License Number P27413

My license renewal date is December 31, 2023.

Pages or sheets covered by this seal: All pages.



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- Materials



600 SW 7th Street, Suite M
Des Moines, IA 50309
P (515) 244-3184
Terracon.com

April 12, 2024

BBS Architects | Engineers
219 Eighth Street, Suite 100
Des Moines, Iowa 50309

Attn: James Elliott, Assoc. AIA
P: 515-365-8206
E: jelliott@bbsae.com

Re: Geotechnical Engineering Report
M4 Addition
Camp Dodge
Johnston, Iowa
Terracon Project No. 08245039-01

Dear James:

We have completed the scope of Geotechnical Engineering services for the above referenced project in general accordance with Terracon Proposal No. P08245039 dated March 6, 2024. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations and floor slabs for the proposed project.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report or if we may be of further service, please contact us.

Sincerely,

Terracon

Ujwala Manchikanti

Ujwala Manchikanti, P.E.
Project Engineer

Theodore D. Bechtum

Theodore D. Bechtum, P.E.
Geotechnical Department Manager

Table of Contents

Introduction.....	1
Project Description.....	1
Site Conditions	2
Geotechnical Characterization	2
Geotechnical Overview	3
Earthwork	4
Demolition	4
Site Preparation.....	5
Subgrade Preparation	5
Soil Stabilization.....	5
Fill Material Types.....	6
Fill Placement and Compaction Requirements	7
Utility Trench Backfill.....	8
Grading and Drainage.....	9
Earthwork Construction Considerations	9
Construction Observation and Testing	10
Shallow Foundations	11
Design Parameters – Compressive Loads	11
Construction Adjacent to Existing Building	12
Foundation Construction Considerations	13
Floor Slabs	14
Floor Slab Design Parameters	14
Floor Slab Construction Considerations.....	15
Frost Considerations.....	15
General Comments	16

Figures

GeoModel

Attachments

Exploration and Testing Procedures

Photography Log

Site Location and Exploration Plans

Exploration and Laboratory Results

Supporting Information

Note: This report was originally delivered in a web-based format. **Blue Bold** text in the report indicates a referenced section heading. The PDF version also includes hyperlinks

Geotechnical Engineering Report

M4 Addition | Johnston, Iowa

April 12, 2024 | Terracon Project No. 08245039-01



which direct the reader to that section and clicking on the  logo will bring you back to this page. For more interactive features, please view your project online at client.terracon.com.

Refer to each individual Attachment for a listing of contents.

Introduction

This report presents the results of our subsurface exploration and Geotechnical Engineering services performed for the proposed addition to the M4 Building in the complex southwest of the intersection of 13th Street and Des Moines Avenue at Camp Dodge in Johnston, Iowa. The purpose of these services was to provide information and geotechnical engineering recommendations relative to:

- Subsurface soil conditions
- Subsurface water conditions
- Site preparation and earthwork
- Foundation design and construction
- Floor slab design and construction
- Frost considerations

The geotechnical engineering Scope of Services for this project included the advancement of two test borings, laboratory testing, engineering analysis, and preparation of this report.

Drawings showing the site and boring locations are shown on the [Site Location](#) and [Exploration Plan](#), respectively. Results of the laboratory testing performed on soil samples obtained from the site during our field exploration are included on the boring logs and as separate graphs in the [Exploration Results](#) section.

Project Description

Our initial understanding of the project was provided in our proposal and was discussed during project planning. Our final understanding of the project conditions is as follows:

Item	Description
Project Description	A building addition on the east side of the existing M4 Building. The addition will include lobby with breakroom area, men's and women's rest rooms and janitor closet.
Proposed Structure	Approximate 600 square foot, single-story, slab-on-grade (no basement) building addition supported on spread footing foundations.
Building Construction	Load-bearing masonry walls, CMU block with brick face and interior slab-on-grade

Item	Description
Finished Floor Elevation	The finished floor of the addition will match the finished floor of the existing building
Maximum Loads (Considered by Terracon)	■ Columns: 50 kips ■ Walls: 3 kips per linear foot (klf) ■ Slabs: 100 pounds per square foot (psf)
Grading/Slopes	Approximately 2 feet of grading is anticipated to develop the proposed building pad subgrade

Terracon should be notified if any of the above information is inconsistent with the planned construction, as modifications to our recommendations may be necessary.

Site Conditions

The following description of site conditions is derived from our site visit in association with the field exploration and our review of publicly available geologic and topographic maps.

Item	Description
Parcel Information	The project is located at Camp Dodge in Johnston, Iowa. The M4 building is located in the complex southwest of the intersection of 13th Street and Des Moines Avenue. Latitude/Longitude 41.7074°, -93.7157° (approximate) See Site Location
Existing Improvements	Existing single-story structures with manicured grass and pavement adjacent to the structures. We understand the storm sewer runs along the east edge of the addition area.
Current Ground Cover	Grass
Existing Topography	The site is relatively flat with an elevation change of about ½ feet between boring locations.

Geotechnical Characterization

We have developed a general characterization of the subsurface conditions based on our review of the subsurface exploration, laboratory data, geologic setting, and our understanding of the project. This characterization, termed GeoModel, forms the basis of

our geotechnical evaluation and recommendations of the site. Conditions observed at each exploration point are indicated on the individual logs. The individual logs can be found in the [Exploration Results](#) and the GeoModel can be found in the [Figures](#) attachment of this report.

As part of our review, we identified the following model layers within the subsurface profile. For a more detailed view of the model layer depths at each boring location, refer to the GeoModel.

Model Layer	Layer Name	General Description
1	Surface	Root zone of approximately 2 inches
2	Existing Fill	Lean clay, trace sand. Observed to a depth of about 1 foot below existing grades within the soil borings.
3	Native Sand	Poorly graded sand with fines. Observed to a depth of about 9½ feet in the soil borings. Loose relative density
4	Native Clay	Lean clay with variable sand and gravel content. Observed to the termination depth of Borings 1 and 2. Medium stiff to very stiff in consistency.

The borings were observed while drilling and shortly after completion for the presence and level of groundwater. Groundwater was observed at a depth of about 15 feet while drilling and at about 17 feet at the completion of drilling in Boring 2. Subsurface water seepage was not observed in Boring 1 for the short duration the boring could remain open. Subsurface water conditions may be different at the time of construction. Mapping by the Natural Resources Conservation Service (NRCS) indicates a seasonal high groundwater level being about 1 foot below the native ground surface. Groundwater conditions may change because of seasonal variations in rainfall, runoff, and other conditions not apparent at the time of drilling. Long-term groundwater monitoring was outside the Scope of Services for this project.

Geotechnical Overview

The site appears suitable for the proposed construction based on geotechnical conditions observed in the test borings, provided the recommendations provided in this report are implemented in the design and construction phases of this project.

Existing fill was encountered in the borings to depths of about 1 foot below existing grades (bgs). Below the existing fill, loose sands were encountered to depths of about 9½ feet bgs, which were underlain by medium stiff to very stiff glacial deposits (sandy lean clays and lean clays). While shallow groundwater was not observed in the borings, the Web Soil Survey indicates seasonal shallow groundwater at depths of about one foot

below the natural ground surface. Lower strength/wet clays and loose sands should be anticipated to be exposed at the base of excavations, and subgrade stabilization may be required.

We recommend existing fill is removed below floor slabs. Even with the recommended construction procedures, there is an inherent risk for the Owner that compressible fill or unsuitable material (e.g., construction debris, old topsoil layers, etc.) within or buried by the fill will not be discovered.

Terracon should be retained to develop a thorough observation and testing program. The testing should be performed prior to and during construction.

The proposed addition can be supported on spread footing foundations, with the foundations bearing on the underlying native sands or on new granular fill that extends to the native sands. Recommendations for overexcavation and backfill procedures are provided in the **Shallow Foundations** section.

The recommendations contained in this report are based on the results of field and laboratory testing (presented in the **Exploration Results**), engineering analyses, and our current understanding of the proposed project. The **General Comments** section provides an understanding of the report limitations.

Earthwork

Earthwork is anticipated to include demolition of any existing utilities, clearing and grubbing, excavations, and structural fill placement. The following sections provide recommendations for use in the preparation of specifications for the work.

Recommendations include critical quality criteria, as necessary, to render the site in the state considered in our geotechnical engineering evaluation for foundations and floor slabs.

Demolition

Existing stormwater intake manholes, as well as any other utilities within the footprint area of the planned addition to the M4 building should be completely removed or properly abandoned. We recommend existing foundations, slabs, and utilities be removed from within the proposed building footprint and at least 5 feet beyond the outer edge of foundations. Uncontrolled backfill of utility trenches can lead to unpredictable settlement of ground surfaces and structural elements. Existing fill associated with utility trenches, low strength soils, and disturbed materials should be completely removed from the excavation prior to structural fill placements. The excavation should be wide enough to accommodate appropriate compaction equipment, and the excavation should be sloped or benched as appropriate. We recommend Terracon is on-site during excavation

and structural fill placement to evaluate the material exposed at the base and perimeter of the excavation and observe structural fill placement.

Demolition of existing utilities and structures should be performed with close construction observation and testing. Any demolition debris should be removed. The demolition Contractor should be aware of project requirements for earthwork (e.g., structural fill placement and compaction recommendations given in this report) so that reworking fill materials placed by demolition Contractor is not necessary prior to construction of new structures. Demolition activities should be observed by Terracon.

Site Preparation

Prior to placing fill, existing vegetation, topsoil, and root mats should be removed. Complete stripping of the topsoil should be performed in the proposed addition area. We recommend Terracon evaluate stripping depths during site preparation.

Subgrade Preparation

Following stripping and removal of existing utilities in conflict with the planned addition, existing fill materials should be removed completely below bottom of floor slab elevation. Following stripping and the undercuts described above, and prior to placement of fill in areas below design grade and after completion of rough grading in cut areas of the site, the exposed subgrade should be scarified to a depth of 9 inches, moisture conditioned, and compacted to the density and water content ranges recommended for structural fill. If space allows, the exposed subgrade materials should then be proofrolled to help delineate soft, disturbed, or low-density fill zones across the project site. Proofrolling should be accomplished using a fully loaded, tandem axle dump truck or other equipment providing an equivalent subgrade loading (minimum gross weight of 25 tons is recommended for the proofrolling equipment). Unstable areas identified by proofrolling should either be undercut to expose stable material and backfilled with structural fill or stabilized as described below.

Soil Stabilization

If the exposed subgrade is unstable during subgrade preparation operations, it could be stabilized using one of the methods outlined below.

- **Scarification and Compaction** - It may be feasible to scarify, dry, and compact the exposed soils. The success of this procedure would depend primarily on favorable weather and sufficient time to dry the soils. Stable subgrades likely would not be achievable if the thickness of the unstable soil is greater than about

1 foot, if the unstable soil is at or near groundwater levels, or if construction is performed during a period of wet or cool weather when drying is difficult.

- **Crushed Stone** - The use of crushed stone or crushed gravel is a common procedure to improve subgrade stability. To limit depths of potential undercuts, the use of a geogrid could also be considered after underground work, such as utility construction, is completed. Equipment should not be operated above the geogrid until one full lift of granular fill is placed above the geogrid. The specifications of the reinforcement product manufacturer should be verified prior to material purchase/delivery and placement at the site.

Further evaluation of the need and recommendations for subgrade stabilization can be provided during construction as the geotechnical conditions are exposed.

Fill Material Types

Reuse of On-Site Soil: The on-site soils, both existing fill materials and the underlying native sands, generally appear suitable for use as low plasticity structural fill. A sample of each material type to be used as structural fill for this project should be submitted to Terracon for evaluation prior to use on this site.

Care should be taken to avoid inter-layering of granular soils and clay soils during fill placement. This could result in perched water conditions and lead to development of frost lenses and loss of subgrade strength both during and after construction. Fine grained materials (e.g., clays) can be difficult to compact in relatively small areas (e.g., excavations for foundations and utilities), and we recommend fine-grained materials are only used where placed with proper equipment during mass grading. Moisture conditioning (e.g., wetting or drying) will be necessary to achieve compaction requirements if fine-grained materials are used as structural fill for the project.

Material property requirements for on-site soil for use as structural fill are noted in the table below:

Property	Structural Fill
Composition	Free of deleterious material
Maximum particle size	3 inches

Property	Structural Fill
Plasticity	Maximum liquid limit of 45 and maximum plasticity index of 23
GeoModel Layer Expected to be Suitable ¹	2, 3, 4

1. Based on subsurface exploration. Actual material suitability should be determined in the field at time of construction.

Imported Fill Materials: Imported fill materials should meet the following material property requirements. Regardless of its source, compacted fill should consist of approved materials that are free of organic matter and debris. Frozen material should not be used, and fill should not be placed on a frozen subgrade.

Soil Type ¹	USCS Classification	Acceptable Parameters (for Structural Fill)
Low Plasticity Cohesive	CL	Maximum liquid limit of 45 and maximum plasticity index of 23
Granular	GW, GP, GM, GC, SW, SP, SM, SC	Less than 6% passing No. 200 sieve

1. Structural and general fill should consist of approved materials free of organic matter and debris. Frozen material should not be used, and fill should not be placed on a frozen subgrade. A sample of each material type should be submitted to Terracon for evaluation prior to use on this site. Additional geotechnical consultation should be provided prior to use of uniformly graded gravel on this site.

Fill Placement and Compaction Requirements

Structural fill should meet the following compaction requirements.

Item	Structural Fill
Maximum Lift Thickness	9 inches or less in loose thickness when heavy, self-propelled compaction equipment is used 4 inches in loose thickness when hand-guided equipment (i.e., jumping jack or plate compactor) is used

Item	Structural Fill	
Minimum Compaction Requirements ^{1,2}	Low plasticity cohesive: 95% Granular: 98%	
Water Content Range ¹	Low plasticity cohesive: -2% to +3% of optimum Granular: -3% to +3% of optimum	

1. Maximum density and optimum water content as determined by the standard Proctor test (ASTM D 698).
2. If the granular material is a coarse sand or gravel, or of a uniform size, or has a low fines content, compaction comparison to relative density may be more appropriate. In this case, granular materials should be compacted to at least 70% relative density (ASTM D 4253 and D 4254). Materials not amenable to density testing should be placed and compacted to a stable condition observed by Terracon.
3. By our definition, low plasticity materials should have a liquid limit of 45 or less and a plasticity index of 23 or less (ASTM D 4318).
4. Moderate to high plasticity cohesive fill should not be imported to the site. Recommendations do not apply to moderate to high plasticity clay.

Utility Trench Backfill

Any soft or unsuitable materials encountered at the bottom of utility trench excavations should be removed and replaced with structural fill or bedding material in accordance with public works specifications for the utility being supported. This recommendation is particularly applicable to utility work requiring grade control and/or in areas where subsequent grade raising could cause settlement in the subgrade supporting the utility.

On-site materials are considered suitable for backfill of utility and pipe trenches from 1 foot above the top of the pipe to the final ground surface, provided the material is free of organic matter and deleterious substances.

Trench backfill should be mechanically placed and compacted as discussed earlier in this report. Compaction of initial lifts should be accomplished with hand-operated tampers or other lightweight compactors. Flooding or jetting for placement and compaction of backfill is not recommended. If utility trenches are backfilled with relatively clean granular materials, they should be capped with at least 18 inches of cohesive structural fill to reduce the infiltration and conveyance of surface water through the trench backfill.

For cohesive subgrades, utility trenches are a common source of water infiltration and migration. Utility trenches penetrating beneath the building addition should be effectively sealed to restrict water intrusion and flow through the trenches, which could migrate below the building. The trench should provide an effective trench plug that extends at least 5 feet from the face of the building exterior. The plug material should consist of cementitious flowable fill or low permeability cohesive soils. The trench plug material should be placed to surround the utility line.

Grading and Drainage

All grades must provide effective drainage away from the building addition during and after construction and should be maintained throughout the life of the structure. Water retained next to the building can result in soil movements greater than those discussed in this report. Greater movements can result in unacceptable differential floor slab and/or foundation movements, cracked slabs and walls, and roof leaks. The roof should have gutters/drains with downspouts that discharge onto splash blocks at a distance of at least 10 feet from the building.

Exposed ground should be sloped and maintained at a minimum 5% away from the building for at least 10 feet beyond the perimeter of the building. Locally, flatter grades may be necessary to transition ADA access requirements for flatwork. After building construction and landscaping have been completed, final grades should be verified to document effective drainage has been achieved. Grades around the structure should also be periodically inspected and adjusted, as necessary, as part of the structure's maintenance program.

Earthwork Construction Considerations

Shallow excavations for the proposed structure are anticipated to be accomplished with conventional construction equipment. Upon completion of filling and grading, care should be taken to maintain the subgrade water content prior to construction of grade-supported improvements such as floor slabs. Construction traffic over the completed subgrades should be avoided. The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations. Water collecting over or adjacent to construction areas should be removed. If the subgrade freezes, desiccates, saturates, or is disturbed, the affected material should be removed, or the materials should be scarified, moisture conditioned, and compacted prior to construction.

The groundwater table could affect overexcavation efforts, especially for overexcavation and replacement of existing fill. A temporary dewatering system consisting of series of sump-pits and pumps may be necessary to achieve the recommended depth of overexcavation, depending on groundwater conditions at the time of construction.

As a minimum, excavations should be performed in accordance with OSHA 29 CFR, Part 1926, Subpart P, "Excavations" and its appendices, and in accordance with any applicable local and/or state regulations.

Construction site safety is the sole responsibility of the contractor who controls the means, methods, and sequencing of construction operations. Under no circumstances shall the information provided herein be interpreted to mean Terracon is assuming responsibility for construction site safety or the contractor's activities; such responsibility shall neither be implied nor inferred.

Excavations or other activities resulting in ground disturbance have the potential to affect adjoining properties and structures. Our Scope of Services does not include review of available final grading information or consider potential temporary grading performed by the contractor for potential effects such as ground movement beyond the project limits. A preconstruction/ precondition survey should be conducted to document nearby property/infrastructure prior to any site development activity. Excavation or ground disturbance activities adjacent or near property lines should be monitored or instrumented for potential ground movements that could negatively affect adjoining property and/or structures.

Construction Observation and Testing

The earthwork efforts should be observed by Terracon. Observation should include documentation of adequate removal of surficial materials (vegetation and topsoil), evaluation and remediation of existing fill materials, as well as proofrolling and mitigation of unsuitable areas delineated by the proofroll.

Each lift of compacted fill should be tested, evaluated, and reworked, as necessary, as recommended by the Geotechnical Engineer prior to placement of additional lifts. Each lift of fill should be tested for density and water content at a frequency of at least one test for every 2,500 square feet of compacted fill in the building area. Where not specified by local ordinance, one density and water content test should be performed for every 100 linear feet of compacted utility trench backfill and a minimum of one test performed for every 12 vertical inches of compacted backfill.

In areas of foundation excavations, the bearing subgrade should be evaluated by Terracon. If unanticipated conditions are observed, the Geotechnical Engineer should recommend mitigation options.

In addition to the documentation of the essential parameters necessary for construction, the continuation of the Geotechnical Engineer into the construction phase of the project provides the continuity to maintain the Geotechnical Engineer's evaluation of subsurface conditions, including assessing variations and associated design changes.

Shallow Foundations

Based on our review, the building addition may be supported on shallow spread footing foundations.

We do not recommend supporting foundations over existing fill at the site. Existing fill depths and lateral limits can be variable and there is knowledge of an existing utility line at the site, which could result in localized existing fill deeper than foundation bearing elevations. Where fill is encountered at or below foundation bearing elevation, we recommend that it be removed. The foundation could be made to bear deeper on suitable native soils or the existing fill could be replaced with granular structural fill, as discussed in **Foundation Construction Considerations** within this section.

If the site has been prepared in accordance with the requirements noted in **Earthwork**, the following design parameters are applicable for shallow foundations. Alternatively, a helical pile foundation support system could be considered to help limit overexcavation and potentially remediation below footings.

Design Parameters – Compressive Loads

Item	Description
Maximum Net Allowable Bearing Pressure ^{1, 2}	1,500 psf
Suitable Bearing materials ³	■ Newly placed granular fill extending to suitable native soils (i.e., an overexcavation and replacement below foundations) ■ Native sands that have been compacted prior to foundation construction
Minimum Foundation Dimensions	Column Footings: 30 inches Continuous Footings: 18 inches
Ultimate Passive Resistance ⁴ (equivalent fluid pressure)	225 pcf
Ultimate coefficient of sliding friction ⁵	0.35 allowable coefficient of friction
Minimum Embedment below Finished Grade ⁶	Exterior footings: 42inches Interior footings in heated areas: 18 inches
Bearing level for new foundations adjacent to existing foundations	Same elevation/depth as the existing foundation

Item	Description
Clear distance between new and existing foundations	At least equal to the base width of the new foundation if additional loads are not to be transferred to existing foundations.
Estimated Total Settlement from Structural Loads ²	Less than about 1 inch
Estimated Differential Settlement ^{2, 7}	About 2/3 of total settlement
1. The maximum net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. 2. Values provided are for maximum loads noted in Project Description. Additional geotechnical consultation will be necessary if higher loads are anticipated. 3. Unsuitable (i.e., existing fill) or soft soils should be overexcavated and replaced per the recommendations presented in Earthwork. 4. Use of passive earth pressures require the sides of the excavation for the spread footing foundation to be nearly vertical and the concrete placed neat against these vertical faces or that footing forms be removed and compacted structural fill be placed against the vertical footing face. Does not consider hydrostatic pressure. 5. Can be used to compute sliding resistance where foundations are placed on suitable soil/materials. 6. Embedment necessary to minimize the effects of frost and/or seasonal water content variations. For sloping ground, maintain depth below the lowest adjacent exterior grade within 5 horizontal feet of the structure. 7. Differential settlements are noted for equivalent-loaded foundations and bearing elevation as measured over a span of 50 feet.	

Construction Adjacent to Existing Building

Differential settlement between the addition and the existing building is expected to approach the magnitude of the total settlement of the addition. Expansion joints should be provided between the existing building and the proposed addition to accommodate differential movements between the two structures. Underground piping between the two structures should be designed with flexible couplings and utility knockouts in foundation walls should be oversized so minor deflections in alignment do not result in breakage or distress.

Care should be taken to avoid undermining adjacent structures and their existing footings, walls, grade-supported slabs, and utilities during any foundation or utility excavations, or any overexcavations. Excavations adjacent to existing structures should not be deeper than the bottom of the existing structural elements unless the existing elements are shored or underpinned. Care should be taken during excavations to protect the existing foundations, utilities, and bearing soils. The foundation systems and bearing elevations of existing structures should be determined prior to the start of construction.

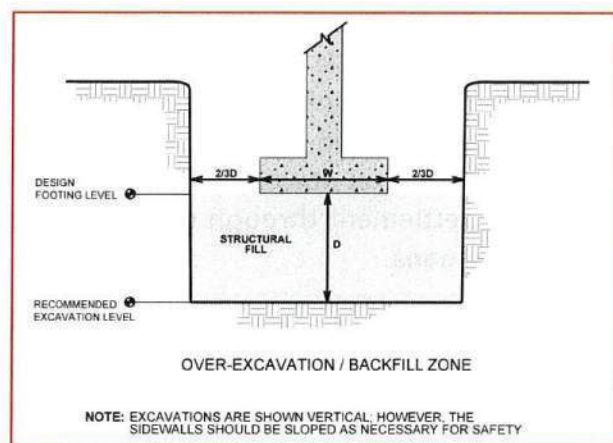
New footings should bear at or near the bearing elevation of immediately adjacent existing foundations. Depending on their locations and current loads on the existing footings, footings for the new addition could cause settlement of adjacent walls. To reduce this concern and risk, clear distances at least equal to the new footing widths should be maintained between the addition's footings and footings supporting the existing building.

Additional loads on the existing foundations could cause other building settlements to occur. The structural capacity of existing foundations should be evaluated by a licensed structural engineer, where increases in loading are planned.

Foundation Construction Considerations

As noted in [Earthwork](#), the footing excavations should be evaluated under the observation of Terracon. Forming of footings may be required due to the granular materials observed. The base of all foundation excavations should be free of water and loose soil, prior to placing concrete. Concrete should be placed soon after excavating to reduce bearing soil disturbance. Care should be taken to prevent wetting or drying of the bearing materials during construction. Excessively wet or dry material or any loose/disturbed material in the bottom of the footing excavations should be removed/reconditioned before foundation concrete is placed.

If unsuitable bearing soils (i.e., existing fill or loose native sands) are observed at the base of the planned footing excavation, corrective measures will be required. The footing excavations should extend completely through any existing fill materials. In addition, the deepened footing excavation should be widened for the structural fill placement below the footings. Overexcavation for structural fill placement below footings should be conducted as shown below. The overexcavation should be backfilled up to the footing base elevation with granular structural fill, placed as recommended in the [Earthwork](#) section.



Floor Slabs

Design parameters for floor slabs consider the requirements for **Earthwork** have been followed. Specific attention should be given to positive drainage away from the structure and positive drainage of the aggregate base beneath the floor slab.

Floor Slab Design Parameters

Item	Description
Floor Slab Support¹	Minimum 4 inches of free-draining granular material At least 12 inches of newly placed structural fill materials should be present below the free-draining granular layer Subgrade compacted to recommendations in Earthwork
Estimated Modulus of Subgrade Reaction ²	120 pounds per square inch per inch (psi/in) for point loads

1. Free-draining granular material should have less than 6 percent fines (material passing the No. 200 sieve), e.g., IaDOT granular subbase (Section 4121).
2. Modulus of subgrade reaction is an estimated value based on our experience with the subgrade condition, the requirements noted in **Earthwork**, and the floor slab support as noted in this table. It is provided for point loads. For large area loads the modulus of subgrade reaction would be lower.

The use of a vapor retarder should be considered beneath concrete slabs on grade covered with wood, tile, carpet, or other moisture sensitive or impervious coverings, when the project includes humidity-controlled areas, or when the slab will support equipment sensitive to moisture. When conditions warrant the use of a vapor retarder, the slab designer should refer to ACI 302 and/or ACI 360 for procedures and cautions regarding the use and placement of a vapor retarder.

Where floor slabs are tied to perimeter walls or turn-down slabs to meet structural or other construction objectives, our experience indicates differential movement between the walls and slabs will likely be observed in adjacent slab expansion joints or floor slab cracks beyond the length of the structural dowels. The Structural Engineer should account for potential differential settlement through use of sufficient control joints, appropriate reinforcing or other means.

Settlement of floor slabs supported on existing fill materials cannot be accurately predicted but could be larger than normal and result in some cracking. Mitigation measures, as noted in **Earthwork**, are critical to the performance of floor slabs. In addition to the mitigation measures, the floor slab can be stiffened by adding steel reinforcement, grade beams, and/or post-tensioned elements.

Floor Slab Construction Considerations

Finished subgrade, within and for at least 10 feet beyond the floor slab, should be protected from traffic, rutting, or other disturbance and maintained in a relatively moist condition until floor slabs are constructed. If the subgrade should become damaged or desiccated prior to construction of floor slabs, the affected material should be removed, and structural fill should be added to replace the resulting excavation. Final conditioning of the finished subgrade should be performed immediately prior to placement of the floor slab support course.

Terracon should observe the condition of the floor slab subgrades immediately prior to placement of the floor slab support course, reinforcing steel, and concrete. Attention should be paid to high traffic areas that were rutted and disturbed earlier, and to areas where backfilled trenches are located.

Frost Considerations

The soils on this site are frost susceptible, and small amounts of water can affect the performance of the slabs-on-grade. Exterior slabs should be anticipated to heave during winter months. If frost action needs to be eliminated in critical areas, we recommend the use of non-frost susceptible (NFS) fill or structural slabs (for instance, structural stoops in front of building doors). Placement of NFS material in large areas may not be feasible; however, the following recommendations are provided to help reduce potential frost heave:

- Provide surface drainage away from the building and slabs, and toward the site drainage system.
- Install drains around the perimeter of the building, stoops, below exterior slabs, and connect them to the site drainage system.
- Grade subgrades so groundwater potentially perched in overlying fill or aggregate base layers, slope toward a site drainage system.
- Place NFS fill as backfill beneath slabs critical to the project.
- Place a 3:1 (horizontal to vertical) transition zone between NFS fill and other soils.

As an alternative to extending NFS fill to the full design frost depth, consideration can be made to placing extruded polystyrene or cellular concrete under a buffer of at least 2 feet of NFS material.

General Comments

Our analysis and opinions are based on our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. Variations will occur between exploration point locations or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. Terracon should be retained as the Geotechnical Engineer, where noted in this report, to provide observation and testing services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

Our Scope of Services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

Our services and any correspondence are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third-party beneficiaries intended. Any third-party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance on the services and any work product is limited to our client and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly effect excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety and cost estimating including excavation support and dewatering requirements/design are the responsibility of others. Construction and site development have the potential to affect adjacent properties. Such impacts can include damages due to vibration, modification of groundwater/surface water flow during construction, foundation movement due to undermining or subsidence from excavation, as well as noise or air quality concerns. Evaluation of these items on nearby properties are commonly associated with contractor means and methods and are not addressed in this report. The owner and contractor should consider a preconstruction/precondition survey of surrounding development. If changes in the nature, design, or location of the project are planned, our conclusions and

Geotechnical Engineering Report

M4 Addition | Johnston, Iowa

April 12, 2024 | Terracon Project No. 08245039-01



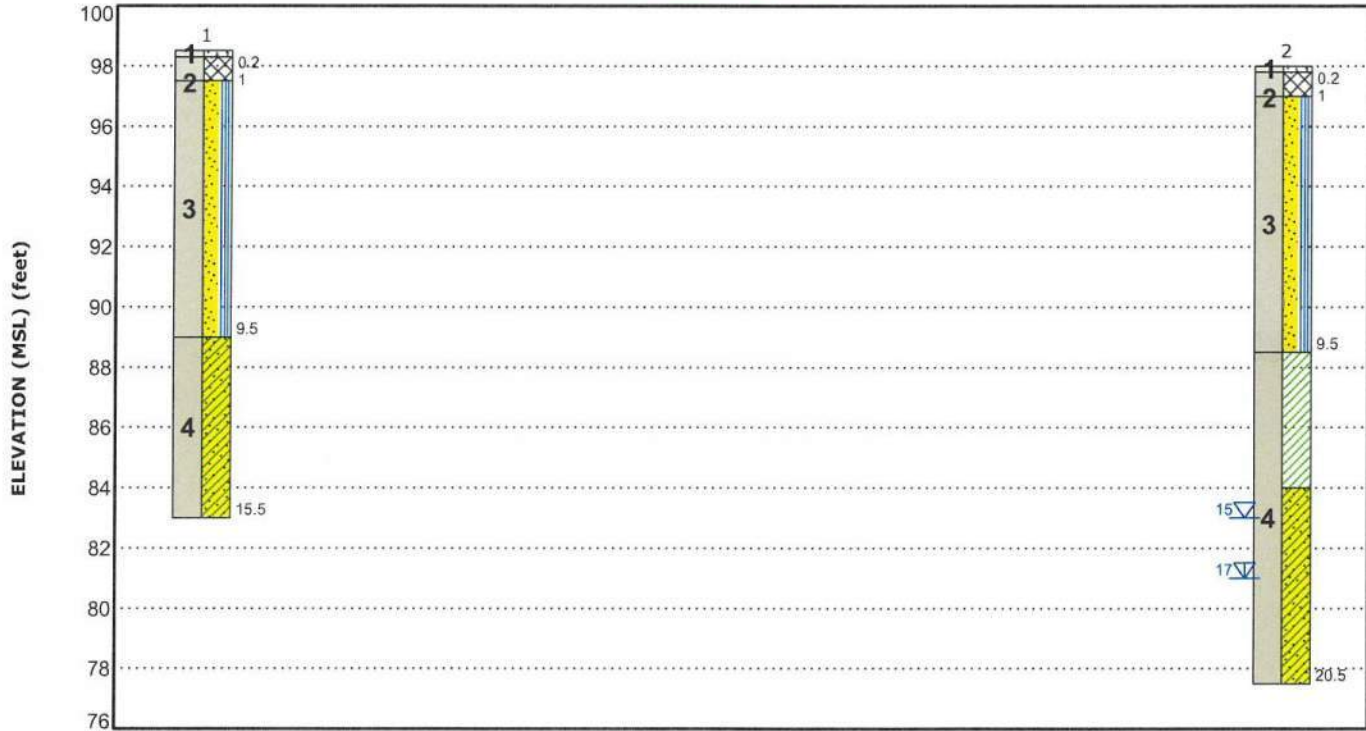
recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

Figures

Contents:

GeoModel

GeoModel



This is not a cross section. This is intended to display the Geotechnical Model only. See individual logs for more detailed conditions.

Model Layer	Layer Name	General Description	Legend
1	Surface	Approximately 2 inches of Root Zone	Topsoil Fill
2	Existing Fill	Lean clay	Poorly-graded Sand with Silt Sandy Lean Clay
3	Native Sand	Sand with fines. Loose relative density.	Lean Clay
4	Native Clay	Lean clay with variable sand and gravel content. Medium stiff to very stiff in consistency.	

- ▽ First Water Observation
- ▽ Second Water Observation

Groundwater levels are temporal. The levels shown are representative of the date and time of our exploration. Significant changes are possible over time.
Water levels shown are as measured during and/or after drilling. In some cases, boring advancement methods mask the presence/absence of groundwater. See individual logs for details.

NOTES:

Layering shown on this figure has been developed by the geotechnical engineer for purposes of modeling the subsurface conditions as required for the subsequent geotechnical engineering for this project.
Numbers adjacent to soil column indicate depth below ground surface.

Geotechnical Engineering Report

M4 Addition | Johnston, Iowa

April 12, 2024 | Terracon Project No. 08245039-01



Attachments

Exploration and Testing Procedures

Field Exploration

Number of Borings	Approximate Boring Depth (feet)	Location
2	15½ to 20½	Building Addition

Boring Layout and Elevations: Terracon personnel provided the boring layout using handheld GPS equipment (estimated horizontal accuracy of about ± 10 feet) and referencing existing site features. Approximate ground surface elevations were obtained by Terracon personnel using a level and rod referencing the North doorway of the existing M4 building.

The locations and elevations of the boring are considered accurate only to the degree implied by the means and methods used to define them. If elevations and a more precise boring layout are desired, we recommend the boring be surveyed.

Subsurface Exploration Procedures: We advanced the borings with a truck-mounted drilling rig using continuous flight solid stem augers. Four samples were obtained in the upper 10 feet of each boring and at intervals of 5 feet thereafter. In the thin-walled tube sampling procedure, a thin-walled, seamless steel tube with a sharp cutting edge is pushed hydraulically into the soil to obtain a relatively undisturbed sample. In the split-barrel sampling procedure, a standard 2-inch outer diameter split-barrel sampling spoon is driven into the ground by a 140-pound automatic hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration is recorded as the Standard Penetration Test (SPT) resistance value. The SPT resistance values, also referred to as N-values, are indicated on the boring logs at the test depths. The samples were placed in appropriate containers and taken to our soil laboratory for testing.

We observed the boreholes while drilling and at the completion of drilling for the presence of subsurface water. The subsurface water levels are shown on the attached boring logs. For safety purposes, the borings were backfilled with auger cuttings and sand after their completion.

Our exploration team prepared field boring logs as part of the drilling operations. These field logs included visual descriptions of the materials observed during drilling and the driller's interpretation of the subsurface conditions between samples. The final boring logs represent the Geotechnical Engineer's interpretation of the field logs and include modifications based on observations and tests of the samples in our laboratory.

Laboratory Testing

The project engineer reviewed the field data and assigned laboratory tests. The laboratory testing program included the following types of tests:

- Water Content
- Unit Weight
- Unconfined Compression
- Grain Size Distribution

The laboratory testing program often included examination of soil samples by an engineer. Based on the results of our field and laboratory programs, we described and classified the soil samples in general accordance with the Unified Soil Classification System.

Site Location and Exploration Plans

Contents:

Site Location

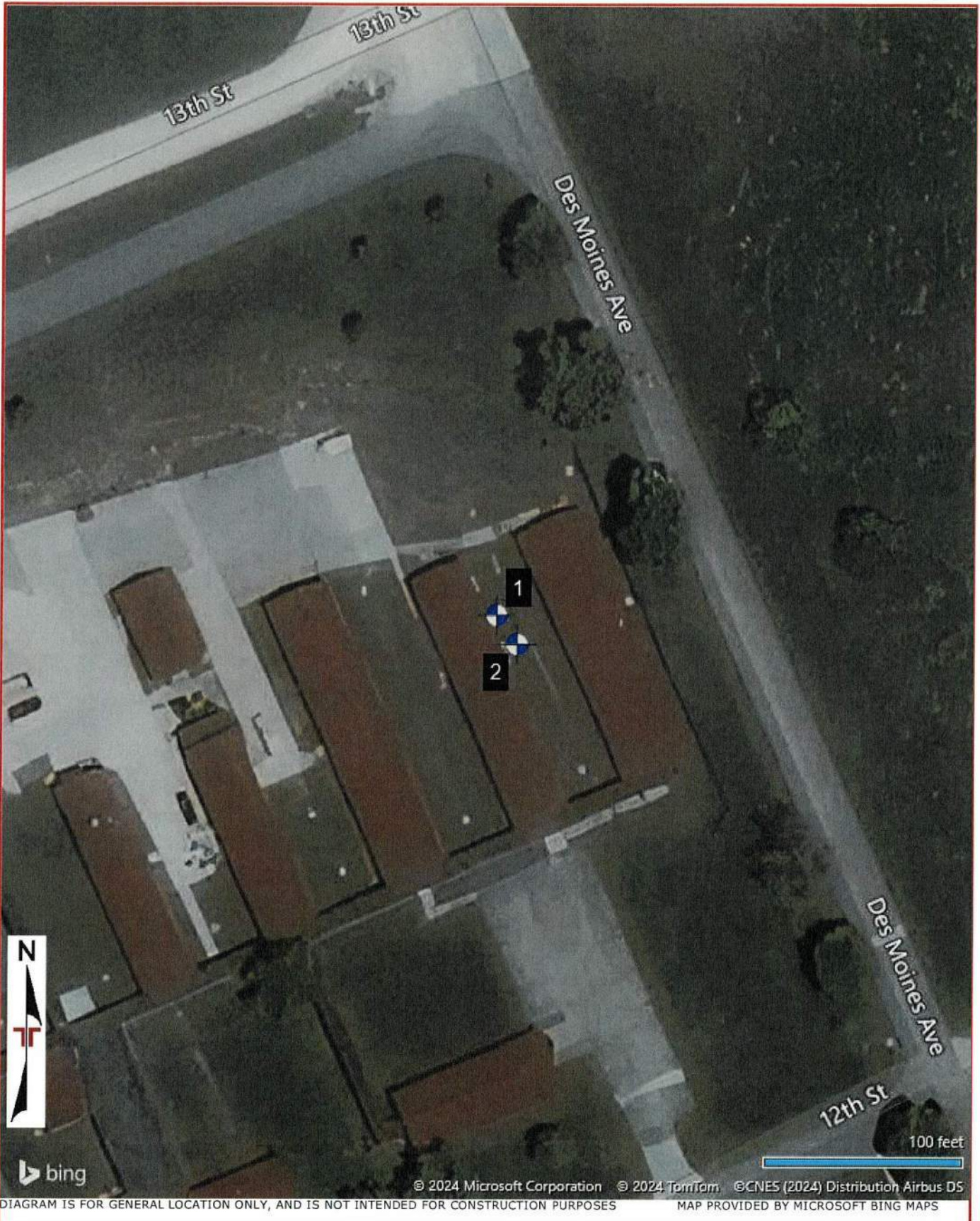
Exploration Plan

Note: All attachments are one page unless noted above.

Site Location



Exploration Plan



Exploration and Laboratory Results

Contents:

Boring Logs (1 and 2)
Grain Size Distribution

Note: All attachments are one page unless noted above.

Boring Log No. 1

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 41.7075° Longitude: -93.7158°	Depth (Ft.)	Elevation.: 98.5 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Unconfined Compressive Strength (psf)	Water Content (%)	Dry Unit Weight (pcf)
1		0.2 Approximately 2 inches of Root Zone	0.2	98.3							
2		1.0 FILL - LEAN CLAY , trace sand, dark brown	1.0	97.5							
		SAND with fines (SP-SM) , fine to medium grained, brown, loose									
3					5			1-1-2 N=3		11.5	
								2-3-4 N=7		18.2	
								4-3-3 N=6		16.2	
		9.5		89	10			2-2-4 N=6		20.9	
4		SANDY LEAN CLAY (CL) , trace gravel, brown, medium stiff									
		becomes gray at 14 feet									
		15.5		83	15			3-4-4 N=8		16.4	
		Boring Terminated at 15.5 Feet									

See **Exploration and Testing Procedures** for a description of field and laboratory procedures used and additional data (If any).
See **Supporting Information** for explanation of symbols and abbreviations.
Elevation Reference: Elevations were measured in the field using an engineer's level and grade rod.

Notes

Water Level Observations
None Observed During Drilling and at Completion

Drill Rig
837
Hammer Type
Automatic
Driller
KS

Advancement Method
Power Auger

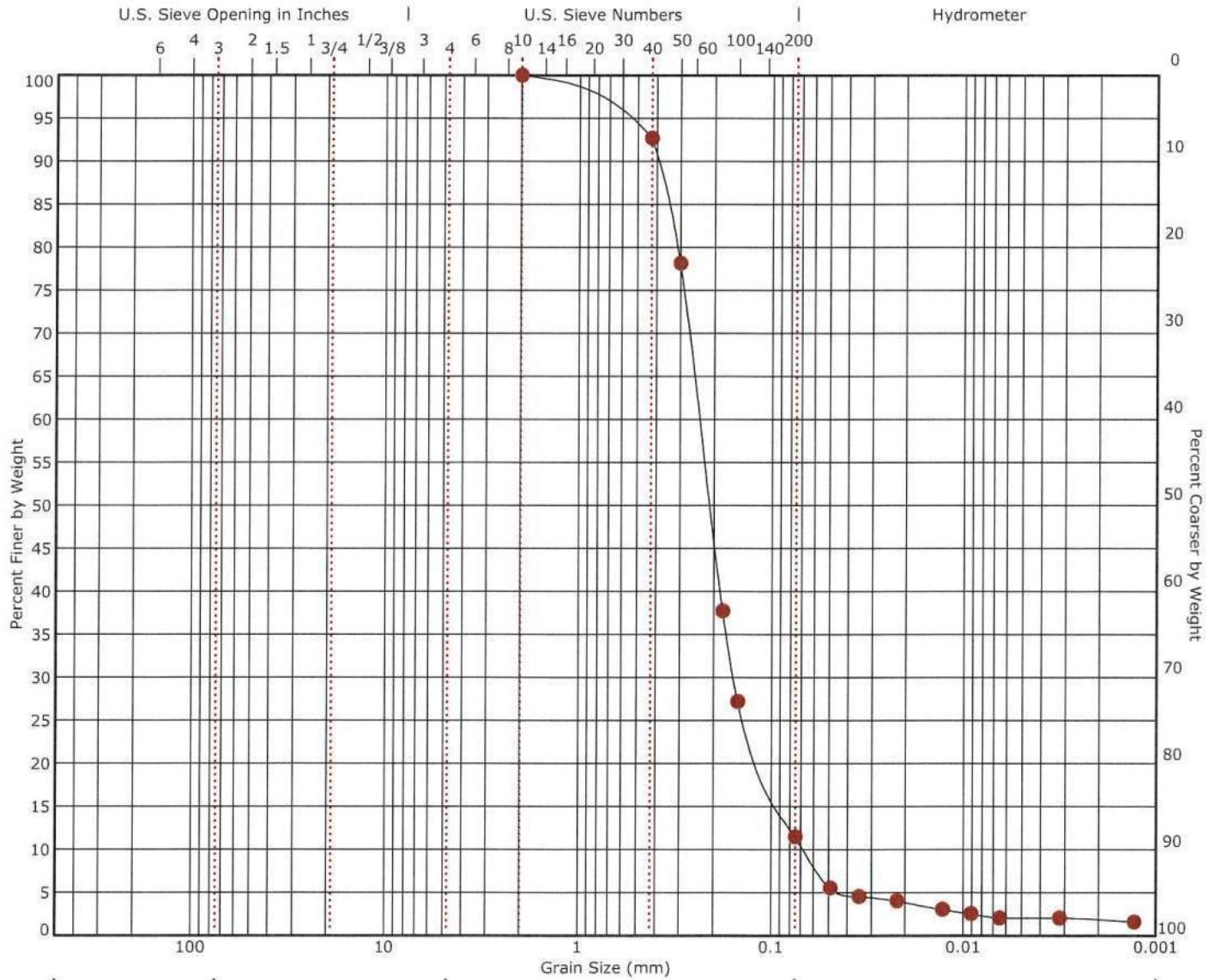
Logged by
JG
Boring Started
03-20-2024
Boring Completed
03-20-2024

Abandonment Method
Boring backfilled with auger cuttings upon completion.

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 41.7074° Longitude: -93.7157°	Depth (Ft.)	Elevation (Ft.)	Water Level Observations	Sample Type	Field Test Results	Unconfined Compressive Strength (psf)	Water Content (%)	Dry Unit Weight (pcf)
1		Approximately 2 inches of Root Zone	0.2	97.8						
2		FILL - LEAN CLAY, trace sand, dark brown	1.0	97						
3		SAND with fines (SP-SM), fine to medium grained, brown, loose	9.5	88.5			2-3-4 N=7		11.7	
							2-3-3 N=6		12.5	
							3-3-3 N=6		15.7	
		LEAN CLAY (CL), trace sand, gray, medium stiff	14.0	84			3-3-3 N=6 2000 (HP)		27.0	
4		SANDY LEAN CLAY (CL), trace gravel, gray, medium stiff to very stiff	20.5	77.5				1630	17.8	111
		Boring Terminated at 20.5 Feet					5-8-9 N=17 7000 (HP)		18.4	

Grain Size Distribution

ASTM D422 / ASTM C136 / AASHTO T27



Boring ID	Depth	Gravel		Sand			Silt or Clay		USCS
		coarse	fine	coarse	medium	fine	% Silt	% Clay	
1	1 - 2.5	0.0	0.0	88.6			9.4	2.0	

Description	Sieve		Sieve		Sieve		Grain Size	
		% Finer		% Finer		% Finer		
	#10	100.0					D ₆₀	0.239
	#40	92.67						
	#50	78.12						
	#80	37.7						
	#100	27.17					D ₁₀	0.068
	#200	11.44						
Remarks							Coefficients	
							C _c	1.54
							C _u	3.53

Supporting Information

Contents:

General Notes

Unified Soil Classification System

Note: All attachments are one page unless noted above.

General Notes

Sampling	Water Level	Field Tests
 Shelby Tube  Standard Penetration Test	 Water Initially Encountered  Water Level After a Specified Period of Time  Water Level After a Specified Period of Time  Cave In Encountered Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.	N Standard Penetration Test Resistance (Blows/Ft.) (HP) Hand Penetrometer (T) Torvane (DCP) Dynamic Cone Penetrometer UC Unconfined Compressive Strength (PID) Photo-Ionization Detector (OVA) Organic Vapor Analyzer

Descriptive Soil Classification

Soil classification as noted on the soil boring logs is based Unified Soil Classification System. Where sufficient laboratory data exist to classify the soils consistent with ASTM D2487 "Classification of Soils for Engineering Purposes" this procedure is used. ASTM D2488 "Description and Identification of Soils (Visual-Manual Procedure)" is also used to classify the soils, particularly where insufficient laboratory data exist to classify the soils in accordance with ASTM D2487. In addition to USCS classification, coarse grained soils are classified on the basis of their in-place relative density, and fine-grained soils are classified on the basis of their consistency. See "Strength Terms" table below for details. The ASTM standards noted above are for reference to methodology in general. In some cases, variations to methods are applied as a result of local practice or professional judgment.

Location And Elevation Notes

Exploration point locations as shown on the Exploration Plan and as noted on the soil boring logs in the form of Latitude and Longitude are approximate. See Exploration and Testing Procedures in the report for the methods used to locate the exploration points for this project. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

Strength Terms

Relative Density of Coarse-Grained Soils (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance		Consistency of Fine-Grained Soils (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance		
Relative Density	Standard Penetration or N-Value (Blows/Ft.)	Consistency	Unconfined Compressive Strength Qu (psf)	Standard Penetration or N-Value (Blows/Ft.)
Very Loose	0 - 3	Very Soft	less than 500	0 - 1
Loose	4 - 9	Soft	500 to 1,000	2 - 4
Medium Dense	10 - 29	Medium Stiff	1,000 to 2,000	4 - 8
Dense	30 - 50	Stiff	2,000 to 4,000	8 - 15
Very Dense	> 50	Very Stiff	4,000 to 8,000	15 - 30
		Hard	> 8,000	> 30

Relevance of Exploration and Laboratory Test Results

Exploration/field results and/or laboratory test data contained within this document are intended for application to the project as described in this document. Use of such exploration/field results and/or laboratory test data should not be used independently of this document.

Unified Soil Classification System

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests ^A				Soil Classification	
				Group Symbol	Group Name ^B
Coarse-Grained Soils: More than 50% retained on No. 200 sieve	Gravels: More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels: Less than 5% fines ^C	$Cu \geq 4$ and $1 \leq Cc \leq 3$ ^E	GW	Well-graded gravel ^F
			$Cu < 4$ and/or $[Cc < 1 \text{ or } Cc > 3.0]$ ^E	GP	Poorly graded gravel ^F
		Gravels with Fines: More than 12% fines ^C	Fines classify as ML or MH	GM	Silty gravel ^{F, G, H}
			Fines classify as CL or CH	GC	Clayey gravel ^{F, G, H}
Fine-Grained Soils: 50% or more passes the No. 200 sieve	Sands: 50% or more of coarse fraction passes No. 4 sieve	Clean Sands: Less than 5% fines ^D	$Cu \geq 6$ and $1 \leq Cc \leq 3$ ^E	SW	Well-graded sand ^I
			$Cu < 6$ and/or $[Cc < 1 \text{ or } Cc > 3.0]$ ^E	SP	Poorly graded sand ^I
		Sands with Fines: More than 12% fines ^D	Fines classify as ML or MH	SM	Silty sand ^{G, H, I}
			Fines classify as CL or CH	SC	Clayey sand ^{G, H, I}
Silts and Clays: Liquid limit less than 50	Silts and Clays: Liquid limit 50 or more	Inorganic:	$PI > 7$ and plots above "A" line ^J	CL	Lean clay ^{K, L, M}
			$PI < 4$ or plots below "A" line ^J	ML	Silt ^{K, L, M}
		Organic:	$\frac{LL \text{ oven dried}}{LL \text{ not dried}} < 0.75$	OL	Organic clay ^{K, L, M, N}
					Organic silt ^{K, L, M, O}
Highly organic soils: Primarily organic matter, dark in color, and organic odor		Inorganic:	PI plots on or above "A" line	CH	Fat clay ^{K, L, M}
			PI plots below "A" line	MH	Elastic silt ^{K, L, M}
		Organic:	$\frac{LL \text{ oven dried}}{LL \text{ not dried}} < 0.75$	OH	Organic clay ^{K, L, M, P}
					Organic silt ^{K, L, M, Q}
				PT	Peat

^A Based on the material passing the 3-inch (75-mm) sieve.

^B If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

^C Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

^D Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay.

^E $Cu = D_{60}/D_{10}$ $Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

^F If soil contains $\geq 15\%$ sand, add "with sand" to group name.

^G If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

^H If fines are organic, add "with organic fines" to group name.

^I If soil contains $\geq 15\%$ gravel, add "with gravel" to group name.

^J If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

^K If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

^L If soil contains $\geq 30\%$ plus No. 200 predominantly sand, add "sandy" to group name.

^M If soil contains $\geq 30\%$ plus No. 200, predominantly gravel, add "gravelly" to group name.

^N $PI \geq 4$ and plots on or above "A" line.

^O $PI < 4$ or plots below "A" line.

^P PI plots on or above "A" line.

^Q PI plots below "A" line.

^A Based on the material passing the 3-inch (75-mm) sieve.

^B If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

^C Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

^D Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay.

$$E \quad Cu = D_{60}/D_{10} \quad Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$$

^F If soil contains $\geq 15\%$ sand, add "with sand" to group name.

^G If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

^H If fines are organic, add "with organic fines" to group name.

^I If soil contains $\geq 15\%$ gravel, add "with gravel" to group name.

^J If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

^K If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

^L If soil contains $\geq 30\%$ plus No. 200 predominantly sand, add "sandy" to group name.

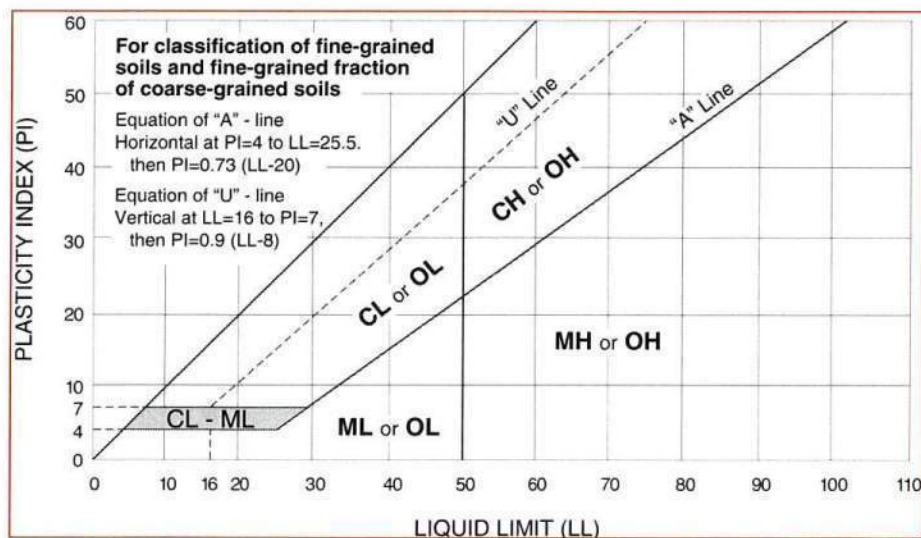
^M If soil contains $\geq 30\%$ plus No. 200, predominantly gravel, add "gravelly" to group name.

^N $PI \geq 4$ and plots on or above "A" line.

^O $PI < 4$ or plots below "A" line.

^P PI plots on or above "A" line.

^Q PI plots below "A" line.



FORM OF BID
for
CONSTRUCTION CONTRACT

I. PROJECT TITLE: BUILDING M-04 RENOVATION & ADDITION	BID DATE: SEPTEMBER 24, 2026 AT: 2:00 p.m. Local time
PROJECT LOCATION: CAMP DODGE, JOHNSTON, IOWA	PROJECT NO.: 19082943 CONTRACT NO.: C442N4260

TO: Iowa Army National Guard
State Comptroller Office
Attn: Procurement Officer
(Reference Section 00 21 00 for Submittal of Bids)

II. ACKNOWLEDGEMENT

- A. The undersigned Bidder, in response to your Advertisement for Bids for construction of the above project, having examined the Drawings, Specifications, and other Bidding Documents and the site of the proposed work, and being familiar with all of the conditions surrounding the construction of the proposed project including the availability of materials and labor, hereby proposes to furnish all labor, materials, and supplies, and to construct the project in accordance with the proposed Contract Documents within the time set forth therein and at the prices stated below. These prices are to cover all expenses incurred in performing the work required under the proposed Contract Documents of which this bid is a part.
- B. Accompanying this proposal are the following required documents:
1) Supplement D: Targeted Small Business Form(use provided form).
- C. Bidder acknowledges receipt of the following Addenda which are a part of the Bidding Documents:
Numbers _____, _____, _____, _____, _____, _____.

III. LUMP SUM PROPOSAL

- A. **BASE BID:** Bidder agrees to perform all of the work described in the proposed Contract Documents and shown on the Drawings for the Sum of:

_____ Dollars (\$ _____)

- B. **UNIT PRICES:** If the required quantities of the items listed below are increased or decreased by Change Order, the adjustment unit prices set forth below shall apply to such increased or decreased quantities:

Unit Price No. 1: Masonry Repointing – Additional Work:

_____ Dollars / SF) (\$ _____ / SF)

- C. **Amounts will be shown in both words and figures. In case of discrepancy, the amount in words will govern.**

IV. SCHEDULE

- A. It is estimated that work can commence by..... (mm/dd/yyyy).
and be completed by..... (mm/dd/yyyy).

(Note: Not a bid award determining factor.)

V. SUBMISSION CONDITIONS

- A. In submitting this bid, it is understood that the Owner reserves the right to accept Alternates in any order or combination and to determine the low Bidder on the basis of the sum of the Base Bid and Alternate(s) accepted.
- B. Bidder hereby certifies: (a) that his bid is genuine and is not made in the interest of or on behalf of any undisclosed person, firm, or corporation; (b) that Bidder has not directly or indirectly induced or solicited any other bidder to put in a false or sham bid; (c) that Bidder has not solicited or induced any person, firm, or corporation to refrain from bidding; (d) that Bidder has not sought by collusion to obtain any advantage over any other bidder or over Owner.

VI. CONTRACTOR SIGNATURE

- A. Respectfully Submitted:

Firm Name: _____ Telephone No.: _____

Official Address: _____ Email: _____

Mailing Address: _____
(if different from above)

Signed By: _____

Printed Name: _____

(Title)

Date: _____

Federal ID No.: _____

Iowa Contractor Registration No.: _____

END OF DOCUMENT 00 41 00

SUPPLEMENT D: TARGETED SMALL BUSINESS FORM

(To be submitted with Form of Bid)

I. PROJECT TITLE:

BUILDING M-04 RENOVATION & ADDITION

PROJECT NO.: 19082943**CONTRACT NO.:** C442N4260**PROJECT LOCATION:**

CAMP DODGE, JOHNSTON, IOWA

Bidder's Company Name_____
Area Code/Telephone_____
Address_____
City_____
State_____
Zip Code

Bidder is _____ is not _____ a certified Iowa Targeted Small Business.

INSTRUCTIONS: Bidder shall provide the information requested below showing any Targeted Small Business Enterprise contacts made prior to bid submission for the project listed. Bidder shall use the construction-related Iowa Targeted Small Business Directory as certified by the Department of Economic Development, State of Iowa. Bidders shall comply with all affirmative action/equal opportunity provisions of State and Federal laws. The Owner seeks to provide opportunities for Targeted Small Businesses in accordance with the provisions of Chapter 73 of the Code of Iowa. Information is subject to verification and confirmation.

TSB Company Name and Phone #	Date Contacted	Quote Rec'd (Y/N)	\$ Amount Proposed (if quote used in bid)

(Use second sheet if needed)

Date_____
Signature of Bidder (same person signing the Form of Bid)

END OF DOCUMENT 00 43 16

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SUPPLEMENT F:
SUBSTITUTION REQUEST FORM (BIDDING PHASE)

TO: **FORWARD ALL SUBSTITUTION REQUESTS TO:**

Matthew Cole, BBS Architects | Engineers
219 8th Street, Suite 100, Des Moines, IA 50309
Phone (515) 244-7167 Email: mcole@bbsae.com

PROJECT: BUILDING M-04 RENOVATION & ADDITION, CAMP DODGE, JOHNSTON, IOWA

Specification: Title, Section, Page, Paragraph / Article

Proposed Substitution: Description, Manufacturer, Model, Phone No., Trade Name

Product Data: Drawings, Specifications, Performance Data, Test Data – Attached

The Undersigned Certifies: (Check each)

- _____ Substitution is equal or superior in all respects to specified item.
- _____ Will provide same warranty as specified item.
- _____ Same maintenance service and source of replacement parts, as applicable, are available.
- _____ Substitution will have no adverse effect on other trades and will not affect or delay progress schedule.
- _____ Substitution does not affect dimensions or functional clearances.
- _____ Will coordinate installation and adjust other work which may be required, at no additional cost to the Owner.
- _____ Waives claims for additional costs or time extensions which may subsequently become apparent.
- _____ Will reimburse Owner for review or design services for re-approval by authorities, for changes in building design, detailing, and construction costs caused by the substitutions.

Requested By: _____

Signature: _____

Company: _____

Telephone: _____

Address: _____

Fax: _____

END OF DOCUMENT 00 43 25

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SUPPLEMENT G:
PROPOSED SUBCONTRACTOR FORM

(To be submitted within 48 hours of notification of selection for the award of a contract)

A. Work proposed to be performed by the Bidder with his/her own forces:

1. _____
2. _____
3. _____
4. _____
5. _____

(attach additional pages as required)

B. A list of names of the subcontractors or other persons or entities (including those who are to furnish materials or equipment fabricated to a special design) proposed for the principal portions of the Work including but not limited to the following (as applicable):

1. Mechanical: _____
2. Electrical: _____
3. Masonry: _____
4. Geothermal: _____
5. Telecommunication: _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____

(attach additional pages as required)

END OF DOCUMENT 00 43 36

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SUPPLEMENT J:
889 REPRESENTATION FORM

MICRO-PURCHASE NATIONAL DEFENSE AUTHORIZATION ACT (NDAA) SECTION 889 REPRESENTATION			
<i>For additional information see: https://www.acquisition.gov/FAR-Case-2019-009/889_Part_B</i>			
1. ☐ Merchant has an active registration in SAM (www.sam.gov) and FAR 52.204-26 is dated Oct 2020 (or later) ☐ Merchant is not registered in SAM (www.sam.gov) or is registered, but FAR 52.204-26 is dated earlier than Oct 2020			
2. Company Name / Merchant (Offeror)		3. Date	
4. Company Street Address	5. City	6. State	7. Zip Code
8. Owner or Designated Representative Name	9. E-mail		10. Telephone Number
11. DUNS Number (if applicable)	12. Cage Code Number (if applicable)	13. SAM Registration Expiration Date (if applicable)	
14. Complete the following FAR 52.204-26 Representation: COVERED TELECOMMUNICATIONS EQUIPMENT OR SERVICES-REPRESENTATION (OCT 2020) (a) <i>Definitions.</i> As used in this provision, "covered telecommunications equipment or services" and "reasonable inquiry" have the meaning provided in the clause 52.204-25, Prohibition on Contracting for Certain Telecommunications and Video Surveillance Services or Equipment. (b) <i>Procedures.</i> The Offeror shall review the list of excluded parties in the System for Award Management (SAM) (http://www.sam.gov) for entities excluded from receiving federal awards for "covered telecommunications equipment or services". (c)(1) <i>Representation.</i> The Offeror represents that it ☐ does, ☐ does not provide covered telecommunications equipment or services as a part of its offered products or to the Government in the performance of any contract, subcontract, or other contractual instrument. (2) After conducting a reasonable inquiry for purposes of this representation, the offeror represents that it ☐ does, ☐ does not use covered telecommunications equipment or services, or any equipment, system, or service that uses covered telecommunications equipment or services Signature of Owner or Designated Representative identified in Block 8 above. <i>This representation expires on the date in block 13 or one year from the date in block 3, whichever is soonest. Forward any representation modifications/changes to the sender within 30 days.</i>			
Additional Disclosure Instructions to Merchant/Offeror (if applicable)			
(a) If the Offeror represents in (c)(1) above that, "it <i>does</i> provide covered telecommunications equipment [...]", then the Offeror should go to FAR 52.204-24 -- Representation Regarding Certain Telecommunications and Video Surveillance Services or Equipment, paragraph (e)(1) <i>Disclosures</i> (https://www.acquisition.gov/far/part-52#FAR_52_204_24) to identify the additional documentation that should accompany this representation when sending it back to the sender. (b) If the Offeror represents in (c)(2) above that, "it <i>does</i> use covered telecommunications equipment [...]", then the Offeror should go to FAR 52.204-24 -- Representation Regarding Certain Telecommunications and Video Surveillance Services or Equipment, paragraph (e)(2) <i>Disclosures</i> (https://www.acquisition.gov/far/part-52#FAR_52_204_24) to identify the additional documentation that should accompany this representation when sending it back to the sender.			

GPC-Merchant 889 Representation v.4

END OF DOCUMENT 00 43 46

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DOCUMENT 00 52 00

FORM OF AGREEMENT BETWEEN OWNER AND CONTRACTOR

**IOWA DEPARTMENT OF PUBLIC DEFENSE
(MILITARY DIVISION)**

**ARMORY BOARD
IOWA ARMY NATIONAL GUARD**

STANDARD CONTRACT FOR CONSTRUCTION

STATE PROJECT: PROJECT NO.: 19082943
CONTRACT NO.: C442N4260

AGREEMENT

made as of the _____ day of _____ in the year of Two Thousand Twenty-Six (2026).

BETWEEN the Owner: Iowa Department of Public Defense (Military Division)
Armory Board, Iowa Army National Guard, Adjutant General Chairman
Camp Dodge, 7105 NW 70th Avenue, Johnston, Iowa 50131-1824

and the Contractor:

The Project: BUILDING M-04 RENOVATION & ADDITION
CAMP DODGE, JOHNSTON, IOWA

The Architect: BBS Architects | Engineers
219 8th Street, Suite 100
Des Moines, IA 50309

Amount: \$ _____

Payment to be made by: Iowa Department of Public Defense
State Comptroller Office
Building W-41, Camp Dodge
7105 NW 70th Avenue
Johnston, Iowa 50131-1824

The Owner and the Contractor agree as follows:

ARTICLE 1 - THE CONTRACT DOCUMENTS

1.1 The Contract Documents consists of this Agreement, the Conditions of the Contract (General, Supplementary, and other Conditions), the Drawings, the Specifications, all Addenda issued prior to execution of this Agreement, all other documents listed in this Agreement, and all Modifications issued after execution of this Agreement; these form the Contract, and all are as fully a part of the Contract as if attached to this Agreement or repeated herein. The Contract represents the entire and integrated agreement between the parties hereto and supersedes prior negotiations, representations or agreements, either written or oral. An enumeration of the Contract Documents, other than modifications, appears in Article 9.

ARTICLE 2 - THE WORK OF THIS CONTRACT

2.1 The Contractor shall fully execute the Work described in the Contract Documents, except to the extent specifically indicated in the Contract Documents to be the responsibility of others.

ARTICLE 3 - DATE OF COMMENCEMENT AND SUBSTANTIAL COMPLETION

3.1 DATE OF COMMENCEMENT: The Contractor will be required to commence Work under this Contract by _____, after receipt by the Contractor of Notice to Proceed. The Contract Time shall be measured from the date of commencement.

3.2 SUBSTANTIAL COMPLETION: The Contractor shall achieve Substantial Completion of the entire Work not later than _____, subject to adjustments of this Contract Time as provided in the Contract Documents.

ARTICLE 4 - CONTRACT SUM

4.1 The Owner shall pay the Contractor in current funds for the performance of the Work, subject to additions and deductions by Change Order as provided in the Contract Documents, the Contract Sum of

\$ _____

4.2 The Contract Sum is determined as follows:

BASE BID: \$ _____

4.3 Unit prices are as follows:

UNIT PRICE NO. 1: \$ _____ / S.F.

ARTICLE 5 - PROGRESS PAYMENTS

5.1 Based upon Applications for Payment submitted to the Architect by the Contractor and Certificates for Payment issued by the Architect, the Owner shall make progress payments on account of the Contract Sum to the Contractor for the period ending on the last day of the month as provided in the Contract Documents and as follows:

5.1.1 Not later than 30 days following the date the Application for Payment is received by the Owner's Representative, ninety-seven (97%) of the portion of the Contract Sum properly allocable to labor, materials, and equipment incorporated in the Work and ninety-seven (97%) of the portion of the Contract Sum properly allocable to materials and equipment suitably stored at the Site or at some other location agreed upon in writing, for the period covered by the Application for Payment, less the aggregate of previous payments made by the Owner, and upon Substantial Completion of the entire Work, a sum sufficient to increase the total payments to ninety-seven (97%) of the Contract Sum, less such amounts as the Architect shall determine for all incomplete Work, retainage applicable to such work and unsettled claims as provided in the Contract Documents.

5.2 Application for Payment: One (1) copy shall be submitted to the Architect via email in pdf format on AIA Document G702 - 1992, Application and Certificate for Payment, supported by AIA Document G703 - 1992, Continuation Sheet.

5.3 Payments due and unpaid under the Contract Documents shall bear interest from the date payment is due in accordance with Section 573.12, Code of Iowa.

ARTICLE 6 - FINAL PAYMENT

6.1 Final payment, constituting the entire unpaid balance of the Contract Sum, shall be made by the Owner to the Contractor when:

6.1.1 The Contractor has fully performed the Contract except for the Contractor's responsibility to correct Work as provided in Subparagraph 12.2.2 of the General Conditions and to satisfy other requirements, if any, which extend beyond final payment;

6.1.2 all closeout documents required to be submitted with the final Application have been received by the Architect; and

6.1.3 a final Certificate for Payment has been issued by the Architect.

6.2 The Owner's final payment to the Contractor shall be made thirty days after the issuance of the Owner's Letter of Final Acceptance.

ARTICLE 7 - MISCELLANEOUS PROVISIONS

7.1 Terms in this Agreement which are defined in the Conditions of the Contract shall have the meanings designated in those Conditions.

7.2 Where reference is made in this Agreement to a provision of the General Conditions or another Contract Document, the reference refers to that provision as amended or supplemented by other provisions of the Contract Documents.

ARTICLE 8 - FUNDING

8.1 Award of this contract is dependent on receiving requested Federal and/or State funding. If such funding is not received within the sixty (60) day bid guarantee after the date of receiving bids, all rights and obligations under this agreement are considered null and void.

ARTICLE 9 - ENUMERATION OF THE CONTRACT DOCUMENTS

9.1 The Contract Documents, except for Modifications issued after execution of this Agreement, are enumerated as follows:

1. This executed Agreement
2. Any issued Addendums
3. Performance and Payment Bond
4. Application and Certificate for Payment
5. General Conditions of the Contract for Construction
6. Supplementary and other Conditions
7. Certificate(s) of Insurance
8. Certificate of Substantial Completion
9. General Requirements (Division 1)
10. Technical Specifications (All other Divisions)
11. Drawings

STATE OF IOWA:

Department of Public Defense (Military Division)
Armory Board, Iowa Army National Guard

By _____

(Name Typed)

(Title)

Iowa National Guard
(Address)

Camp Dodge, 7105 NW 70th Avenue

Johnston, Iowa 50131-1824

CONTRACTOR:

By _____
(Contractor)

(Name Typed)

(Title)

(Address)

Phone No.: _____

Email: _____

Federal ID No.: _____

IA Registration No.: _____

NOTE: If the Contractor is a corporation, the following witness signatures are not required, but the annexed Certificate of Corporate Authority must be completed. Type or print names under all witness signatures.

IN WITNESS WHEREOF, the parties hereto have executed this Contract as of the _____ day of _____, 2026.

(Date to be completed by Owner upon receipt of all signatures.)

State of Iowa - Witness Signature

Printed Name

Contractor – Witness Signature

Printed Name

CERTIFICATE OF CORPORATE AUTHORITY

I, _____ certify that I am the
(typed name of corporate officer other than person signing Contract)
_____ of the corporation named as Contractor
(typed corporate office of person signing above)
herein; that _____, who signed this Contract on behalf of
(typed name of person who signed Contract)
the Contractor, was then _____ of said corporation;
(typed position of person signing Contract)
that said Contract was duly signed for and in behalf of said corporation by authority of its governing body,
and is within the scope of its corporate powers.

AFFIX YOUR CORPORATE SEAL TO THE BOTTOM OF THIS FORM IF ONE EXISTS

END OF DOCUMENT 00 52 00

DOCUMENT 00 61 00

PERFORMANCE AND PAYMENT BOND

AIA Document A312 – Performance and Payment Bond, 2010 Edition shall be utilized for this project and is hereby a part of the Specifications and Contract Documents as if it were bound herein.

Copies and samples for preview of the document can be obtained online from:
<https://www.aiacontracts.org/purchase>.

END OF DOCUMENT 00 61 00

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DOCUMENT 00 62 10

APPLICATION AND CERTIFICATE FOR PAYMENT

AIA Document G702 (1992) – Application and Certificate for Payment Form, supported by AIA Document G703 (1992) Continuation Sheet shall be utilized for this project and is hereby a part of the Specifications and Contract Documents as if it were bound herein.

Copies and samples for preview of the document can be obtained online from:
<https://www.aiacontracts.org/purchase>.

Note: Electronically submit Applications for Payment to the Architect or Engineer per the Supplementary Conditions.

END OF DOCUMENT 00 62 10

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DOCUMENT 00 72 00

GENERAL CONDITIONS

AIA Document A201-2007 – General Conditions of the Contract for Construction, hereafter referred to as General Conditions, forms the General Conditions for this Construction Contract and is hereby a part of the Specifications and Contract Documents as if it were bound herein.

Copies and samples for preview of the document can be obtained online from:
<https://www.aiacontracts.org/purchase>.

END OF DOCUMENT 00 72 00

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SUPPLEMENTARY CONDITIONS

The following supplements modify the General Conditions of the Contract for Construction, AIA Document A201-2007. Where a portion of the General Conditions is modified or deleted by these Supplementary Conditions, the unaltered portions of the General Conditions shall remain in effect.

Unless noted otherwise, all references are to Articles and Sections of AIA Document A201-2007, General Conditions of the Contract for Construction.

See also related topics in Division 1 – General Requirements for additional requirements.

REFERENCE ARTICLE 1 - GENERAL PROVISIONS

1. Reference Section 1.1.1:

A written order for a minor change in the Work may also be issued by the Owner's Construction Manager as provided in Section 2.1.1.5 of these Supplementary Conditions.

2. Reference Section 1.1.2; Add Sections:

1.1.2.1 All contracts awarded by the State are subject to access by the State, National Guard Bureau, The Comptroller General of the United States, or any of their duly authorized representatives. This includes books, documents, papers, etc., and records of the Contractor which are directly pertinent to that specific contract for the purpose of making audits, examinations, excerpts, and transcriptions.

1.1.2.2 Regulations for proper operation and administration of construction contracts: Code of Federal Regulations (CFR), provide solicitation provisions and contract clauses that pertain to this Project. A copy of these regulations are not bound herein, but are included by reference. Copies may be reviewed in the State Comptroller Office, Building 3465 (W-41), Camp Dodge, 7105 NW 70th Avenue, Johnston, Iowa 50131-1824.

3. Reference Section 1.2.1; Add Section:

1.2.1.1 In the event of conflicts or discrepancies among the Contract Documents, interpretations will be based on the following priorities:

- .1 Modifications
- .2 The Agreement.
- .3 Addenda, with those of later date having precedence over those of earlier date.
- .4 The Supplementary Conditions.
- .5 The General Conditions of the Contract for Construction.
- .6 Division 1 of the Specifications.
- .7 Drawings and Divisions 2-49 of the Specifications.
- .8 Other documents specifically enumerated in the Agreement as part of the Contract Documents.

In the case of conflicts or discrepancies between Drawings and Division 2-49 of the Specifications or within or among the Contract Documents and not clarified by Addendum, the Architect will determine which takes precedence in accordance with Sections 4.2.11, 4.2.12, and 4.2.13. In instances where conflict or discrepancy involves quality or quantities, the better quality or greater quantity of work will take precedence.

4. Reference Section 1.5; Delete Section 1.5.1 and substitute the following:

1.5.1 All Drawings, Specifications, and other Instruments of Service, and copies thereof, including those in electronic form, are and shall remain the Owner's property with the exception of one contract set for each party to the Contract.

5. Reference Section 1.5; Delete Section 1.5.2 and substitute the following:

1.5.2 The Drawings, Specifications and other Instruments of Service prepared by the Owner or Architect and Architect's consultants, and copies thereof furnished to, or made by, the Contractor, are for use solely with respect to this Project. They are not to be reproduced or used by the Contractor or any Subcontractor, Sub-subcontractor or material or equipment supplier on other projects or for additions to this Project outside the scope of Work without the specific written consent of the Owner.

REFERENCE ARTICLE 2 - OWNER

6. Reference Section 2.1.1; Add Sections:

2.1.1.1 Unless otherwise indicated, the term Owner where referred to in the Contract Documents shall mean The Armory Board for the Iowa Army National Guard – Adjutant General Chairman.

2.1.1.2 The Owner's Representative shall be the State Contracting Officer for the Iowa Army National Guard – State Comptroller Office, executing the Contract on behalf of the State and any other officer or civilian employee properly designated Contracting Officer.

The Owner's Representative hereby authorizes the following persons to represent the Owner in the fulfillment of their respective duties as hereinafter described:

1. The Architect
2. The Owner's Construction Manager

2.1.1.3 Duties of the Owner's Representative

1. The Owner's Representative is authorized to act on behalf of the Owner and shall fulfill the duties, rights and obligations of the Owner under the Contract Documents.
2. The Owner's Representative will prepare and initiate Contract Change Orders in accordance with Section 7.2.
3. The Owner's Representative will have authority to reject Work that does not conform to the Contract Documents in accordance with Section 4.2.6 after review with the Architect.

2.1.1.4 Duties of the Architect

1. The Architect is as defined in Section 4.1.1 and shall provide administration of the Contract as described in the Contract Documents.

2.1.1.5 Duties of the Construction Manager

1. The Owner's Construction Manager shall act on behalf of the Owner in all daily actions and communication in accordance with Section 4.2.4.
2. The Owner's Construction Manager shall be responsible for communication and coordination of concerns of the Project to and from all persons within the Owner's organization.
3. The Owner's Construction Manager shall observe the progress of the Work and report any observed deviations from the Contract Documents to the Architect for a determination. The Owner's Construction Manager is not authorized to permit deviations from the Contract Documents.

4. The Owner's Construction Manager shall assist in coordinating the Contractor's operations with those of the Owner. The Owner's Construction Manager, however, shall not perform any duties for the Contractor.
 5. The Owner's Construction Manager shall have the authority to, and may issue an order for a minor change in the Work in accordance with Section 7.4 after review with the Architect.
7. Reference Section 2.2; Delete Section 2.2.5 and substitute the following:

2.2.5 No copies of the Contract Documents will be furnished by the Owner to the Contractor with the exception of any complete sets of Bidding Documents returned to the issuing entity designated in the Advertisement for Bids. Additional reproductions may be made by the Contractor pursuant to Section 1.5.2.
8. Reference Section 2.2; Add Section:

2.2.6 The Owner will procure and bear costs of Special Inspections if required by applicable building codes for the project. See Section 13.5.1.1 of these Supplementary Conditions for additional requirements.
- REFERENCE ARTICLE 3 - CONTRACTOR**
9. Reference Section 3.1.1; Add Section:

3.1.1.1 Under Chapter 91C of the Iowa Code (1989), any construction contractor performing work in Iowa (including out-of-state contractors) is required to register with the Iowa Division of Labor. (See Article 11 of the Instructions to Bidders).
10. Reference Section 3.2.1; Add Section:

3.2.1.1 The Contract is executed as set forth in the Instructions to Bidders.
11. Reference Section 3.2; Add Sections:

3.2.5 Figured dimensions on the Drawings shall be used in preference to scaling the Drawings. If Contractor scales Drawings, dimensions so obtained shall be the sole responsibility of the Contractor.

3.2.6 Where the Work of the Contractor is affected by finish dimensions of manufacturer's equipment, the finish dimension shall be determined by the Contractor, who shall assume the responsibility for proper coordination.

3.2.7 If in the opinion of the Contractor it is not reasonably possible to provide first-class Work by following the procedures and requirements detailed or specified in the Contract Documents, the Contractor shall make a written request for interpretation to the Architect outlining the conditions and concerns. The Contractor shall not proceed with the portion of the Work in question until a response has been received from the Architect. The Architect shall respond with reasonable promptness.
12. Reference Section 3.3; Add Sections:

3.3.4 The Contractor shall not be relieved of obligations to perform the Work in accordance with the Contract Documents either by activities or duties performed by the Owner or Architect in the Administration of the Contract, or by tests, inspections or approvals required or performed by persons other than the Contractor.

3.3.5 The Contractor shall perform the Work so as to cause a minimum of inconvenience to and interruption of the Owner's operations. Any and all interruptions of the operations of the Owner necessary for the performance of the Work shall be noted in the progress schedule and the Contractor shall additionally give the Owner sufficient advance notice of such interruptions as to allow the Owner time to adjust its operations accordingly. Contractor's failure to give the Owner timely notice of such intentions shall place the responsibility for any resulting delays, additional costs, or other liabilities solely with the Contractor.

3.3.6 Prior to commencing the Work under the Contract, the Contractor shall contact all affected entities supplying utilities and arrange for the moving of such utility installations as is necessary for the performance of the Work. It shall be the responsibility of the Contractor to coordinate the Work with that of the affected entities in such a manner as to cause the least possible interference.

13. Reference Section 3.4.1; Add Section:

3.4.1.1 By virtue of statutory authority, give preference to Iowa domestic labor and materials in the execution of the Work, in accordance with provisions of Chapter 73, Code of Iowa, 1962, and amendments including Senate File 2160, dated April 11, 1984. Machinery, equipment, materials and articles installed or used without such approval are at risk of subsequent rejection.

14. Reference Section 3.4.2; Add Section:

3.4.2.1 After the Contract has been executed, the Owner and Architect will consider a formal request for the substitution of products in place of those specified only under the conditions set forth in the General Requirements (Division 1 of the Specifications).

15. Reference Section 3.5; Add Sections:

3.5.1 This warranty shall be for the period specified in the Contract Performance and Payment Bond unless a longer period is required elsewhere in the Contract Documents for certain portions of Work, in which case the longer period shall govern.

3.5.2 The general warranty provided herein is in addition to and not in limitation of the Contractor's obligations under Section 12.2 and any other warranty or remedy provided by law or by the Contract Documents.

3.5.3 The Contractor will furnish maintenance and 24-hour call-back service for the equipment provided and/or installed by the Contractor for a period of 3 months after the date of Substantial Completion. This maintenance and service will include repair and regular examinations of the equipment and installation by competent and trained employees of the Contractor, and all necessary adjustments, greasing, oiling, cleaning, supplies and parts required to keep the equipment in proper operations, except such parts made necessary due to misuse, accidents, or negligence not caused by the Contractor, Subcontractors, or Sub-subcontractors.

16. Reference Section 3.6; Delete Section and substitute the following:

3.6 TAXES

3.6.1 This project is TAX EXEMPT.

.1 The Iowa Department of Public Defense (DPD) is a registered Designated Exempt Entity (DEE) with the Iowa Department of Revenue (IAC chapter 701 - 19.12.) As a DEE, all contractors that are awarded a contract with the Department are issued a tax-exempt certificate for each project that allows the purchase of building materials or withdraw of inventory without incurring a state sales tax. This special exemption certificate would also allow a manufacturer of building materials to consume materials in the performance of a construction contract with a designated exempt entity, without owing tax on the fabricated cost of those materials.

.2 All Contractors responding to a DPD request for proposal should take this in to consideration when figuring out the cost of materials in the project proposal. Refunds for

state sales tax on building materials will not need to be considered in the proposal and are discouraged. For more information please refer to:

<https://tax.iowa.gov/construction-contracts-designated-exempt-entities>

.3 If the contract includes machinery or equipment, the contractor must purchase it for resale and give the supplier a regular exemption certificate (issued from DPD). The contractor should not charge sales tax on machinery and equipment sold to DPD.

17. Reference Section 3.7.2; Add Section:

3.7.2.1 Compliance with the above shall not preclude the establishment of and compliance with non-conflicting higher standards as may be specified or indicated elsewhere in the Contract Documents.

18. Reference Section 3.7.4; Add Sections:

3.7.4.1 The conditions described in the first sentence include any conditions which the Contractor will consider as the basis for a claim for extra compensation and include but are not limited to materials containing asbestos, polychlorinated biphenyl (PCB), or other hazardous materials.

3.7.4.2 By failing to give notice within the time allotted above, the Contractor waives all rights for extra compensation of any kind arising out of the concealed or unknown conditions.

19. Reference Section 3.7.5; Modify Section by adding the underlined words, so that the section now reads as follows:

3.7.5 If, in the course of the Work, the Contractor knowingly encounters and recognizes human remains, burial markers, archeological sites or previously undelineated wetlands not indicated in the Contract Documents, the Contractor shall immediately suspend any operations that would affect them and shall notify the Owner and Architect. Upon receipt of such notice, the Owner shall promptly take any action necessary to obtain governmental authorization required to resume the operations. The Contractor shall continue to suspend such operations until otherwise instructed by the Owner but shall continue with all other operations that do not affect those remains or features. Requests for adjustments in the Contract Sum and Contract Time arising from the existence or good faith belief of such existence of such remains or features may be made as provided in Article 15.

20. Reference Section 3.7; Add Sections:

3.7.6 See Section 10.7 of these Supplementary Conditions for Stormwater Pollution Prevention Plan and Permit requirements.

3.7.7 The Contractor must recognize mandatory standards and policies relating to energy efficiency contained in the State Energy Conservation Plan issued in compliance with the Energy Policy and Conservation Act (PL 94-163).

21. Reference Section 3.9.1; Modify the first sentence by adding the underlined words, so that the first sentence now reads as follows:

3.9.1 The Contractor shall employ a competent superintendent and necessary assistants who shall be in attendance at the Project site during performance of the Work (including work performed by subcontractors).

22. Reference Section 3.9; Add Section:

3.9.4 The superintendent shall organize and coordinate scheduling of the Work and shall review and coordinate Work between the trades/Subcontractors.

23. Reference Section 3.10.2; Delete the last sentence.

24. Reference Section 3.13; Add Sections:

3.13.1 The Contractor shall provide any additional facilities or areas beyond those areas permitted at the site as required for construction operations or storage of materials at no additional cost to the Owner.

3.13.2 The Contractor shall take all necessary precautions to prevent damage to pipes, conduits, and other underground structures. The Contractor shall protect from disturbance or damage all monuments and property marks until an authorized agent of the Owner has witnessed or otherwise referenced their location and the Contractor shall not remove such marks or monuments until directed.

25. Reference Section 3.15; Delete Sections 3.15.1 and 3.15.2 and substitute the following:

3.15.1 The Contractor shall at all times keep the site of the Work and adjacent premises as free from materials, debris, rubbish and trash as practical and shall remove same from any portion of the site and adjacent premises if, in the opinion of the Owner, such materials, debris, rubbish or trash constitute a nuisance or are in any way objectionable to the public. The Contractor shall be responsible for the timely removal of dirt accumulations or any other debris on access roads and public streets and highways resulting from the Contractor's operations.

3.15.2 At the completion of the Work, the Contractor shall remove all materials, implements, staging, piling falsework, debris and rubbish connected with or caused by operations for such Work immediately upon completion of that Work and shall leave the premises in perfect condition insofar as affected by the Work under the Contract. Fires for disposal of rubbish on the site are prohibited.

3.15.3 If the Contractor should fail to clean up the premises as provided in the Contract Documents, the Owner, after giving the Contractor forty-eight hours notice, may do so and Owner shall be entitled to reimbursement from the Contractor.

26. Reference Section 3.16; Add Section:

3.16.2 The Contractor shall furnish the Owner and Architect all necessary assistance to facilitate inspections throughout the process of manufacture or construction, or for the examination of any materials entering into the Work, or for any other purpose required in the discharge of the Owner or Architect's duties.

27. Reference Section 3.18; Add Sections:

3.18.3 The obligations of the Contractor under Section 3.18 shall not extend to the liability of the Owner and its consultants, its agents or employees arising out of: (1) the preparation or approval of maps, Drawings, opinions, reports, surveys, Contract Change Orders, designs or specifications, or (2) the giving of or failure to give directions or instructions by the Owner, its agents or employees providing such giving or failure to give directions or instructions is the primary cause of the injury or damage.

3.18.4 The Contract Documents define claims, damage, losses, and expenses as, but do not limit them to: (1) injury or damage consequent upon the failure of or use or misuse by the Contractor, its Subcontractors, agents, servants, or employees, of any hoist, rigging, blocking, scaffolding, or any and all other kinds of items of equipment furnished or loaned by the Owner; (2) all attorneys' fees and costs incurred in defense of the claim or in bringing an action to enforce the provision of this indemnity or any other indemnity contained in the Contract Documents; and (3) all costs, expenses, lost time, opportunity costs, etc., incurred by the party being indemnified or its employees, agents, or consultants.

3.18.5 The indemnification obligations of the Contractor under this Contract does not extend to the liability of the Owner, any Owner's consultants, or their agents, consultants, or employees arising out of their own negligence.

3.18.6 If trade unions perform the Work or any portion of the Work, the Contractor shall make all necessary arrangements to reconcile without delay, damage or cost to the Owner and its consultants, any conflict between the Contract Documents and any agreements or regulations of any kind at any time in force among members or councils which regulate or distinguish what activities are not included in the work of any particular trade. If this affects the progress of the Work in finishing or installing any items or materials or equipment required under the Contract Documents because of the conflict involving any such agreement or regulation, the Owner or its consultants may require that the Contractor provide other material or equipment of equal kind and quality at no additional cost to the Owner.

REFERENCE ARTICLE 4 - ADMINISTRATION OF THE CONTRACT

28. Reference Section 4.2.2; Add Section:

4.2.2.1 The presence or absence of an Owner's Representative or the Architect on the site for the purpose of inspection shall not relieve the Contractor from any obligations to perform the Work in accordance with the requirements of the Contract Documents.

29. Reference Section 4.2.6:

The Owner will also have the authority to reject Work as provided in Section 2.1.1.3 of these Supplementary Conditions.

REFERENCE ARTICLE 5 - SUBCONTRACTORS

30. Reference Section 5.3; Add Sections:

5.3.1 Such agreements between the Contractor and each Subcontractor (and where appropriate between Subcontractors and Sub-subcontractors) shall also contain provisions that:

.1 require submission to the Contractor of applications for payment under each subcontract to which the Contractor is a party, in reasonable time to enable the Contractor to apply for payment in accordance with Article 9;

.2 require that all Claims for additional costs, extensions of time, damages for delays or other claims with respect to subcontracted portions of the Work shall be submitted to the Contractor (via any Subcontractor or Sub-subcontractor where appropriate) in sufficient time so that the Contractor may comply in the manner provided in the Contract Documents for like Claims by the Contractor against the Owner;

.3 waive all rights the contracting parties may have against one another for damages caused by fire or other perils covered by property insurance described in Article 11, except such rights as they may have to the proceeds of such insurance held by the Owner as trustee;

.4 inform Subcontractors of their rights under Chapter 573, Code of Iowa; and

.5 obligate each Subcontractor to consent specifically to the provisions of Section 5.2.

5.3.2 In accordance with Section 573.12 of the Code of Iowa, the Contractor will make prompt payments to Subcontractors for satisfactory performance of the Work.

REFERENCE ARTICLE 6 - CONSTRUCTION BY OWNER OR BY SEPARATE CONTRACTORS

31. Reference Section 6.1.3; Add Section:

6.1.3.1 The Contractor shall be responsible for furnishing accurate information for and participating in the development of a realistic Project schedule.

32. Reference Section 6.2.4; Add Section:

6.2.4.1 Should the Contractor cause damage to the Work or property of any separate contractor or be the cause of delay or failure to perform, the Contractor shall upon due notice promptly attempt to settle with such other contractor by agreement, or otherwise to resolve the dispute. If such separate contractor sues or initiates an arbitration proceeding against the Owner on account of any damage alleged to have been caused by the Contractor, the Owner shall notify the Contractor who shall defend such proceedings, and if any judgment or award against the Owner arises therefrom the contractor shall pay or satisfy it and shall reimburse the Owner for all attorneys' fees and court or arbitration costs which the Owner has incurred.

33. Reference Section 6.2; Add Sections:

6.2.6 Claims and other disputes and matters in question between the Contractor and separate contractors are subject to the provisions of Section 15.3 and 15.4 provided the separate contractor has reciprocal obligations.

6.2.7 The Contractor shall execute all Work in such manner and in such order, or procedure, as will permit the commencement and carrying on of the Work of the Owner and of separate contractors with the least interference possible using a reasonable procedure whenever it is necessary or desirable to execute such work either simultaneously with the Work under Contract, or otherwise. To this end the Contractor shall cooperate and assist the Owner and separate contractors in every reasonable way, and shall interfere as little as possible with their Work. The Contractor shall move, free of charge, the Contractor's plant equipment and materials or any part of same whenever the Owner considers it reasonable and necessary for the work of the Owner or separate contractors.

REFERENCE ARTICLE 7 - CHANGES IN THE WORK

34. Reference Section 7.1.2; Add Section:

7.1.2.1 The Owner's Construction Manager shall also have authority to act alone in issuing an order for a minor change in the Work as provided in Section 2.1.1.5 of these Supplementary Conditions.

35. Reference Section 7.1; Add Sections:

7.1.4 The pricing of changes in the Work which result in an adjustment to the Contract Sum (excepting Alternate Bids, see Section 7.1.5) shall be limited to the Contractor's direct expenses as defined in Sections 7.3.7.1 through 7.3.7.5, plus the applicable percentage of overhead and profit subject to the following limits:

- .1** Fifteen percent (15%) maximum mark-up for Work directly performed by employees of the Contractor, Subcontractor, or Sub-subcontractor.
- .2** Five percent (5%) maximum Contractor's mark-up for Work performed or passed through by a Subcontractor and passed through to the Owner by the Contractor.
- .3** Five percent (5%) maximum Subcontractor's mark-up for Work performed by a Sub-subcontractor and passed through to the Owner by the Subcontractor and Contractor.
- .4** The maximum allowable mark-up is twenty-five percent (25%) passed through to the Owner by the Contractor under any circumstances.

7.1.5 The pricing of changes in the Work that add work already bid as an Alternate which have expired, shall adhere to the following guidelines:

- .1** Direct material and labor costs associated with the alternate shall be enumerated in the Request for Change and highlight the original cost, the current cost, the difference, and the reason for the difference.

.2 The Contractor may add up to 15% mark-up for the difference between the original direct material and labor costs and the current material and labor costs only.

.3 The contractor may add to the total a 2% mark-up for increased bonds and insurance costs.

7.1.6 Prices shall include all subcontracts and shall be itemized as follows:

.1 Labor costs shall indicate trade, hourly rate, man hours, and total costs.

.2 Materials, supplies and equipment costs shall indicate unit cost, quantity, and total cost for each item.

.3 Machinery and equipment costs shall indicate machinery or equipment type, number of each, hourly rate, and total cost for each item.

7.1.7 The Contractor shall be allowed no additional compensation for any costs, fees or expenses incurred in performing services already required by the Contract for Construction, and shall not be entitled to additional reimbursement for its home office, other non-job site or indirect overhead expenses, or tools necessary for construction.

7.1.8 Any request for time extension as a result of the Change in Work must be justified and presented in adequate detail showing that the proposed change will delay the final Contract completion date.

7.1.9 Contractor shall not apply sales, consumer, use and similar tax charges incurred for material purchases in charges toward the overhead and profit percentage.

7.1.10 The following definitions shall be used in establishing process for Changes in Work:

.1 Direct expense is the Contractor's actual cost of any item that is easily defined as a required item for the completion of his Contract obligation.

.2 Overhead is a business expense created by the Project but not necessarily a direct part of that portion of the Work involved.

.3 Profit is the compensation accruing to the Contractor for the assumption of risk in a business enterprise.

36. Reference Section 7.2.1; Delete Section and substitute the following:

7.2.1 A Change Order is a written instrument prepared by the Owner and signed by the Owner and Contractor stating their agreement upon all of the following:

37. Reference Section 7.4; Add Section:

7.4.1 The Owner's Construction Manager shall also have authority to issue an order for a minor change in the Work as provided in Section 2.1.1.5 of these Supplementary Conditions.

REFERENCE ARTICLE 8 - TIME

38. Reference Section 8.2; Add Section:

8.2.4 In the event the Contractor fails to maintain the schedule, including accepted revisions, the Contractor shall promptly, at no additional cost to the Owner, increase work forces, increase hours, and/or initiate revisions to means and methods of construction as required to make up lost time and complete the Work in accordance with the construction schedule.

REFERENCE ARTICLE 9 - PAYMENTS AND COMPLETION

39. Reference Section 9.3.1; Add the following sentence to Section 9.3.1:

The Form of Application for Payment shall be a current authorized edition of AIA Document G702 – 1992, Application and Certificate for Payment, supported by a current authorized edition of AIA Document G703 – 1992, Continuation Sheet. One copy of each Application for Payment shall be submitted electronically in .pdf format via email to the Architect or, if applicable, uploaded to the project website for each progress payment.

40. Reference Section 9.3.1; Add Sections:

9.3.1.3 Applications for Payment shall be submitted once a month.

9.3.1.4 The Owner will withhold until final payment, retainage in an amount consistent with the provisions of Section 573.12, 573.13, and 573.14 of the Code of Iowa.

41. Reference Section 9.5.1; Add Section:

9.5.1.8 third party claims filed pursuant to Chapter 573 of the Iowa Code.

42. Reference Section 9.5.3; Delete section in its entirety.

43. Reference Section 9.6.4; Delete the first two sentences.

44. Reference Section 9.8.5; Delete the second sentence and substitute the following:

Upon such acceptance and consent of surety, if any, the Owner shall make payment sufficient to increase the total payments to ninety-seven percent (97%) of the Contract Sum, less such amounts as the Architect shall determine for incomplete Work and unsettled claims.

45. Reference Section 9.10.1; Add Section:

9.10.1.1 Issuance of a letter of Final Acceptance by the Owner shall establish the commencement of the thirty-day period during which the Owner retains final payment of the balance due under the Contract under Iowa law and per provisions of this Agreement. If at the end of such thirty-day period, claims are on file with the Owner, the Owner will withhold a sum equal to double the total amount of claims on file or three percent (3%) of the Contract price, whichever is less, until such claims are released or otherwise adjudicated. The Owner will issue a letter of Final Acceptance to the Contractor upon receipt of the Final Certificate for Payment from the Architect.

46. Reference Section 9.10.2; Add Sections:

9.10.2.1 The Owner will not make final payment until the Contractor has performed final cleanup in accordance with Section 3.15

9.10.2.2 See Division 1 – General Requirements for items to be submitted with the final Application for Payment. The Architect will not issue a final Certificate of Payment until all items indicated are submitted:

REFERENCE ARTICLE 10 - PROTECTION OF PERSONS AND PROPERTY

47. Reference Section 10.1; Add Sections:

10.1.1 Accident Prevention: The safety provisions of all applicable laws, building and construction codes shall be observed. Machinery, equipment and all hazards shall be guarded or eliminated in accordance with the safety provisions of the latest edition of the Manual of Accident Prevention in Construction, published by the Associated General Contractors of America, to the extent that such provisions are not in contravention of applicable laws.

10.1.2 The Work shall be governed by applicable provisions of the general law, including the latest amendments of the following:

1. William-Steiger Occupational Safety & Health Act of 1970, Public Law 91-596.
2. Part 1910 – Occupational Safety & Health Standards, Chapter XVII of Title 29, Code of Federal Regulations.
3. Part 1518 –Safety and Health Regulations for Construction, Chapter XIII of Title 29, Code of Federal Regulations.

10.1.3 The Contractor is responsible for conducting a safety program and/or precautions on the project site that assures work on the site is conducted in accordance with all guidelines and requirements of OSHA and other applicable laws, building and construction codes, and sound construction practice. The Contractor shall prepare, implement and enforce a project safety plan for the purpose of maintaining a site where work is conducted in a safe manner. A copy of the safety plan shall be maintained on the site at all times.

48. Reference Section 10.2; Add Sections:

10.2.9 The Contractor must comply with provisions of Section 88.6(1) of the Code of Iowa pertaining to Occupational Safety and Health Administration (OSHA) entrance and inspections which states that the State Labor Commissioner or State Labor Commissioner's representative upon presenting appropriate credentials to the Owner, operator, or agent in charge, is authorized:

- .1 To enter without delay and at reasonable times a factory, plant, establishment, construction site, or other area, work place, or environment where work is performed by an employee of an employer; and
- .2 To inspect and investigate during regular working hours and other reasonable times, and within reasonable limits, and within a reasonable manner, any such place of employment and all pertinent conditions, structures, machines, apparatus, devices, equipment, and materials therein, and to question privately any such owner, operator, agent, or employer.

49. Reference Section 10.3.1; Add Section:

10.3.1.1 The Contractor is not required pursuant to Article 7 to perform without consent any work relating to asbestos or polychlorinated biphenyl (PCB).

50. Reference Section 10.3; Add Sections:

10.3.7 Lamps, bulbs and ballasts indicated to be removed by the Contractor, and not indicated to be reused on the project, can be salvaged by the Owner or the Contractor. If not salvaged, the Contractor shall pay any required fees and ensure proper disposal as universal waste (ballasts labeled as "PCB Free" can be disposed as solid waste).

10.3.8 All self-luminous or photo-luminescent (radioactive tritium) exit signs shown to be removed by the Contractor shall be removed without damage and turned over to the Owner for disposal.

10.3.9 The Contractor shall not use asbestos-containing products or materials. Requests for exceptions shall be forwarded by the Contractor to the Owner for approval by the Environmental Branch of the Directorate of Installation Management.

10.3.10 The Contractor shall not knowingly remove, damage or disturb asbestos-containing materials unless required by the project's plans and specifications. Any asbestos abatement identified in the Contract Documents as the responsibility of the Contractor must be performed by properly trained and certified personnel in accordance with all environmental and worker safety regulations.

51. Reference Section 10.3.1; Add Section:

10.3.1.1 The Contractor is not required pursuant to Article 7 to perform without consent any work relating to asbestos or polychlorinated biphenyl (PCB).

52. Reference Article 10; Add Sections:

10.5 IOWA HAZARDOUS CHEMICAL RISKS RIGHT TO KNOW LAW:

10.5.1 Owner's Responsibility. Upon request, the Owner will provide to the Contractor a list of known hazardous chemicals within the Project Site to which their employees may be exposed and suggestions for appropriate protective measures.

10.5.2 Contractor's Responsibility. Contractor must inform his/her employees of the Iowa Hazardous Chemical Risks Right to Know Law.

10.5.3 The Contractor must provide to the Owner a list of known hazardous chemicals that they anticipate using on site as well as other pertinent information relating to employee protection. Contractor's Material Safety Data Sheets (MSDS) must be available to the Owner upon request.

10.7 POLLUTION PREVENTION PROCEDURES

10.7.1 The following pollution prevention procedures shall apply to all Contractors working on Iowa Army National Guard projects:

.1 Spill Prevention and Response: The Contractor shall take adequate precautions to prevent spills of hazardous chemicals, oils, and fuels. The Contractor shall have procedures in place to immediately clean up all spills that could occur on the job site or during transportation to and from the job site. Expenses incurred in the spill cleanup shall belong to the Contractor. Specifically:

- .a When liquid hazardous chemicals, oils, or fuels are stored on the job site, the contractor shall provide secondary containment, for containers with 55 gallon capacity or greater, equal to or greater than 110% of the volume of the single largest container.
- .b The Contractor shall notify the Iowa Army National Guard Environmental Branch in the event of a spill of chemicals, oils or fuels. The Contractor must have sufficient resources on the work site to clean up a spill. All workers at the site shall know whom the Contractor point of contact is and what they are to do in the event of a spill.
- .c The point of contact for the Environmental Branch is:

Shannan Garretson, Environmental Program Manager
Building B-61, Camp Dodge
7105 NW 70th Avenue
Johnston, Iowa 50131-1824
Phone: (515) 252-4557
Non-duty Hours Cell Phone (515) 249-5847

.d The Contractor must notify the Iowa Department of Natural Resources and the local sheriff's office of a hazardous substance spill that meets the definition of a "hazardous condition" as defined in the Iowa Administrative Code. Iowa law requires reporting as soon as possible but not later than six hours. Spills meeting the criteria of a "reportable spill" will also require notification of the National Response Center.

10.7.4 Storm Water Pollution Prevention Plans and Permits:

.1 A Storm Water Pollution Prevention Plan and a discharge permit will be required for construction activities resulting in one acre or more soil disturbance.

.2 The Iowa Army National Guard's Director of Installation Management Environmental Branch shall obtain the permit.

.3 The General Contractor, and each subcontractor that has a responsibility described in the plan, will be a co-permittee with the Owner. The General Contractor shall be responsible for compliance with and fulfilling all requirements of the NPDES General Permit Number 2, including the Storm Water Pollution Prevention Plan.

.4 The initial Storm Water Pollution Prevention Plan and Notice of Intent will be provided by the Owner. These and the General Contractor's project inspection diary must be kept on-site and presented to federal, state and local environmental regulatory personnel, and the Owner, when requested.

.5 The General Contractor will provide an individual experienced with storm water pollution prevention plans and techniques to conduct weekly and rainfall inspections of the construction site and review the project's Storm Water Pollution Prevention Plan at the time of each inspection. The General Contractor is responsible for maintaining a copy of each inspection report. The General Contractor will review the weekly and rainfall storm water inspection reports and address any deficiencies within seven days. Deficiencies may also be identified by the Owner at any time. Corrective actions may include installation of additional erosion controls and/or maintenance of existing controls.

.6 If the Contractor should fail to conduct inspections, create reports, maintain the project inspection diary, and address deficiencies, the Owner, after giving the Contractor forty-eight hours notice, may do so and the Owner shall be entitled to reimbursement from the Contractor.

The General Contractor shall be responsible for continuing compliance with all SWPPP requirements until final stabilization is achieved regardless of whether Substantial Completion has been granted or the Owner has occupied any portion of the site or facility. Such practices shall include, but not be limited to, inspections and reports and maintenance of erosion control measures as described above.

.7 The Owner will file a Notice of Discontinuation upon final stabilization of the disturbed area. The General Contractor will provide the original project inspection diary and the marked-up copy of the Storm Water Pollution Prevention Plan to the Owner at the completion of the project.

10.7.5 Removal of Regulated Wastes:

.1 At the completion of the construction project, the Contractor will be required to remove all waste and unused hazardous chemicals including, but not limited to: solvents, adhesives, paints, and fuels. Said materials shall be properly identified, containerized and, if no longer usable, disposed at the Contractor's expense.

REFERENCE ARTICLE 11- INSURANCE AND BONDS

53. Reference Section 11.1; Add Sections:

11.1.5 Insurance: No prime Contractor shall commence work under this contract until he/she has obtained all insurance required under this Section and until such insurance has been approved by the Owner, nor his/her sub-contractor until all similar insurance required of the subcontractor has been obtained and approved. No policy of insurance which is cancelable on less than 30 days written notice to the insured is satisfactory to the Owner's Representative.

11.1.6 Compensation and Employer's Liability Insurance: The Contractor shall take out and maintain during the life of this Contract the Statutory Workmen's Compensation and Employer's Liability Insurance for all of his/her employees to be engaged in work on the project under this Contract, and in case any work is sublet, the Contractor shall require the subcontractor similarly to provide Workmen's Compensation and Employer's Liability Insurance for all of the latter's employees to be engaged in such work.

11.1.7 Bodily Injury Liability and Property Damage Liability Insurance: Each prime Contractor shall take out and maintain during the life of the Contract such Bodily Injury Liability and Property

Damage Liability Insurance as shall protect him/her and any subcontractor performing work covered by the Contract from claims for damage for personal injury, including accidental death, as well as from claims for property damage, which may arise from operations under this Contract, whether such operations be by him/herself or by any subcontractor or by anyone directly or indirectly employed by either of them and the amount of such insurance shall be no less than:

.1 Public Liability Insurance, in an amount no less than Five Hundred Thousand Dollars (\$500,000.00), for injuries including wrongful death to any one person, and subject to the same limit for each person in any amount not less than One Million Dollars (\$1,000,000.00) on account of one accident.

.2 Property Damage Insurance, in a minimum amount of One Million Dollars (\$1,000,000.00) for damages on account of all accidents other than automobile property damage accidents.

.3 Motor Vehicle Bodily Injury Liability in a minimum amount of Five Hundred Thousand Dollars (\$500,000.00), per occupant and One Million Dollars (\$1,000,000.00) per accident on account of any one automobile accident."

11.1.8 Insurance Certificates: Each prime Contractor shall furnish certificates of insurance listed above to the Owner and they shall also be subject to the Owner's approval for adequacy of protection."

11.1.9 Owner's Protective Liability Insurance: Each prime Contractor shall take out and furnish to the Owner and maintain during the life of this Contract, complete Owner's Protective Liability Insurance in amounts as specified in Section 11.1.7 above, for Bodily Injury Liability Insurance and for Property Damage Liability Insurance."

11.1.10 All insurance coverage must be provided by insurance companies having policy holder ratings no lower than "A" and financial ratings not lower than "XII" in the Best's Insurance Guide, latest edition in effect as of the date of the Contract.

11.1.11 The required limits of liability may be met by using a split-limit or a combined single limit basis. However, the total limit of liability cannot be less than that stated in the requirements.

54. Reference Section 11.4; Delete Section 11.4.1 and substitute the following:

11.4.1 The Contractor shall furnish bonds on the date of execution of the Contract covering faithful performance of the Contract and payment of obligations arising thereunder as stipulated in the Bidding Requirements or specifically required in the Contract Documents. The bond shall be on the form prescribed in the Bidding Requirements and the cost thereof shall be included in the Contract Sum. The amount of each bond shall be equal to one hundred percent (100%) of the Contract Sum.

.1 The Contractor shall deliver the required bonds to the Owner simultaneously with the delivery of the executed Contract.

.2 The Contractor shall require the attorney-in-fact who executes the required bonds on behalf of the surety to affix thereto a certified and current copy of the power of attorney.

55. Reference Section 11.4; Add Section:

11.4.3 If any surety upon any bond furnished in connection with this Contract becomes unacceptable to the State, or if any such surety fails to furnish reports as to their financial condition from time to time as additional security as may be required from time to time to protect the interests of the State or of persons supplying labor or materials in the prosecution of the Work contemplated by the Contract, the State may terminate the Contract.

REFERENCE ARTICLE 12- UNCOVERING AND CORRECTION OF WORK

56. Reference Section 12.1.2; Add Section:

12.1.2.1 If the condition noted in Section 12.1.2 above was caused by a separate contractor, the Contractor shall first attempt to reach settlement with the separate contractor as provided in Article 6.

57. Reference Section 12.2.2; Add the following sentence to Section 12.2.2.1:

The obligations of the Contractor under this Section shall survive termination of the Contract.

58. Reference Section 12.2.2; Add Sections:

12.2.2.4 Upon request by the Owner and prior to the expiration of one year from the date of Substantial Completion, the Architect will conduct and the Contractor shall attend a meeting with the Owner to review the facility operations and performance.

12.2.2.5 If it becomes necessary for the Contractor to replace an item after Substantial Completion under the terms of the Contract Documents, the warranty period of time for the replacement shall begin with the date of the completion of the replacement.

12.2.2.6 If the Contractor does not proceed with correction of such nonconforming Work within a reasonable time fixed by written notice, the Owner may remove it and store the salvageable materials or equipment at the Contractor's expense. If the Contractor does not pay costs of such removal and storage within ten (10) days after written notice, the Owner may, upon ten (10) additional days written notice, sell such materials and equipment and account for the proceeds thereof, after deducting costs and damages that should have been borne by the Contractor, including compensation of the Owner's services and expenses made necessary by this action. If such proceeds of sale do not cover costs which the Contractor should have borne, the Contract Sum will be reduced by the deficiency. If payments then or thereafter due the Contractor are not sufficient to cover such amount, the Contractor must pay the difference to the Owner.

REFERENCE ARTICLE 13 - MISCELLANEOUS PROVISIONS

59. Reference Section 13.1; Delete the words following "...where the Project is located".

60. Reference Section 13.1; Add Section:

13.1.1 This agreement is for services related to a project that is subject to the Build America, Buy America Act (BABAA) requirements under Title IX of the Infrastructure Investment and Jobs Act ("IIJA"), Pub. L. 177-58. Absent an approved waiver, all iron, steel, manufactured products, and construction materials used in this project must be produced in the United States, as further outlined by the Office of Management and Budget's Memorandum M-22-11, Initial Implementation Guidance on Application of Buy America Preference in Federal Financial Assistance Programs for Infrastructure, April 18, 2022.

61. Reference Section 13.5.1; Add Section:

13.5.1.1 Special Inspections, if required for this Project by the Contract Documents, will be procured and paid for by the Owner. The duties and responsibilities of the Contractor in regard to Special Inspections shall be as defined in the General Requirements of the Contract Documents. Special Inspections, if required, are separate and distinct from other Tests and Inspections required by the Contract Documents which shall be procured and paid for by the Contractor under the provisions of Section 13.5.

62. Reference Section 13.6; Delete Section 13.6 and substitute the following:

13.6 INTEREST: Payments due and unpaid under the Contract Documents shall bear interest in accordance with Section 573.12 and 573.14 of the Code of Iowa.

63. Reference Section 13.7; Delete Section in its entirety and substitute the following:

13.7 COMMENCEMENT OF STATUTORY LIMITATION PERIOD

13.7.1 As between the Owner and Contractor:

.1 Before Substantial Completion. As to acts or failures to act occurring prior to the relevant date of Substantial Completion, any applicable statute of limitations shall commence to run and any alleged cause of action shall be deemed to have accrued in any and all events not later than such date of Substantial Completion;

.2 Between Substantial Completion and Final Certificate for Payment. As to acts or failures to act occurring subsequent to the relevant date of Substantial Completion and prior to issuance of the final Certificate for Payment, any applicable statute of limitations shall commence to run and any alleged cause of action shall be deemed to have accrued in any and all events not later than the date of issuance of the final Certificate for Payment; and

.3 After Final Certificate for Payment. As to acts or failures to act occurring after the relevant date of issuance of the final Certificate for Payment, any applicable statute of limitations shall commence to run and any alleged cause of action shall be deemed to have accrued in any and all events not later than the date of any act or failure to act by the Contractor pursuant to any Warranty provided under Section 3.5, the date of any correction of the Work or failure to correct the Work by the Contractor under Section 12.2, or the date of actual commission of any other act or failure to perform any duty or obligation by the Contractor or Owner, whichever occurs last.

64. Reference Article 13; Add Sections:

13.8 MANUFACTURER'S DIRECTIONS

13.8.1 Manufactured articles, materials, and equipment shall be applied, installed, connected, erected, used, cleaned, and conditioned as directed by the manufacturer unless herein specified to the contrary.

13.8.2 Any additional costs incurred as a result of this requirement shall be borne by the Contractor.

13.9 CODE OF FAIR PRACTICES

13.9.1 During the performance of this Contract, the Contractor agrees as follows:

.1 The Contractor will not discriminate against any employee or applicant for employment because of race, creed, color, religion, national origin, sex, age, or physical or mental disability, or status as a Vietnam-era disabled veteran. The Contractor will take affirmative action to ensure that applicants are employed and that employees are treated during employment without regard to their race, creed, color, religion, national origin, sex, age, physical or mental disability, or status as a Vietnam-era disabled veteran except where it relates to a bona fide occupational qualification. Such action includes but is not limited to the following: employment, upgrading, demotion or transfer, recruitment or recruitment advertising, layoff or terminations, rates of pay or other forms of compensation, and selection for training, including apprenticeship. The Contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices provided by the Owner setting forth provisions of the nondiscrimination clause.

.2 The Contractor will in all solicitations or advertisements for employees placed by or on behalf of the Contractor, state that all qualified applicants will receive consideration for employment without regard to race, creed, color, religion, national origin, sex, age, physical or mental disability, or status as a Vietnam-era disabled veteran except where it relates to a bona fide occupational qualification.

.3 The Contractor will send to each labor union or representative of workers with which it has a collective bargaining agreement or other contract or understanding a notice advising

the labor union or workers' representative of the Contractor's commitments under this nondiscrimination clause and post copies of the notice in conspicuous places available to employees and applicants for employment.

.4 The Contractor will comply with all relevant provisions of the Iowa Civil Rights Act of 1965, as amended by Iowa Executive order #15 of 1973, as amended by Iowa Executive Order #34 of 1988; Federal Executive Order 11246 of 1965, as amended by Federal Executive Order 11375 of 1967; the Equal Employment Opportunity Act of 1972; and all provisions relevant to fair application of the rules and regulations of the Owner. The Contractor will furnish all information and reports requested by the Owner or required by or pursuant to the rules and regulations thereof and will also permit access to its payroll and employment records by the Owner or representatives for purposes of investigation to ascertain compliance with such rules, regulations, or requests, or with this nondiscrimination clause.

.5 In the event of the Contractor's noncompliance with the nondiscrimination clauses of this Contract or with any of the aforesaid rules, regulations, or requests, this Contract may be canceled, terminated, or suspended in whole or in part and the Contractor may be declared ineligible for further contracts with the Owner. In addition, the Owner may take such further action, and such other sanctions may be imposed and remedies invoked, as provided by the Iowa Civil Rights Act of 1965 as amended, Chapter 601A, Code of Iowa, as heretofore and hereafter amended, or by the rules and regulations of the Owner or as otherwise provided by law.

.6 The Contractor will include the provisions of this section of Article 13 hereof in every subcontract and purchase order unless specifically exempt by approval of the Owner, in accordance with the rules and regulations, so that such provisions will be binding on each Subcontractor and vendor. The Contractor will take such action with respect to any Subcontractor or purchase order as the Owner or the authorized representative thereof may direct as a means of enforcing such provisions including sanctions for noncompliance; provided however, that in the event the Contractor becomes involved in, or is threatened with, litigation by a Subcontractor or vendor as a result of such direction by the Owner, the Contractor may request the State of Iowa to enter into such litigation to protect the interests of the State of Iowa.

REFERENCE ARTICLE 14 - TERMINATION OR SUSPENSION OF THE CONTRACT

65. Reference Section 14.3; Add Section:

14.3.3 Adjustments made for increases in the cost may have a mutually agreed fixed or percentage fee.

66. Reference Section 14.4; Delete Section 14.4.3 and substitute the following:

14.4.3 In case of such termination for the Owner's convenience, the Contractor shall be entitled to receive from the Owner, payment for Work executed and for proven loss with respect to material, equipment, tools, and construction equipment and machinery, including reasonable overhead and profit. The Contractor shall transfer title to Owner and deliver in the time, place and manner as directed by the Owner, all fabricated and unfabricated parts, Work-in-process, completed Work, supplies and other materials produced as part of, or acquired in connection with the discontinued Work, and other property which would have been required to be furnished to Owner if the Contract had been completed.

67. Reference Article 14; Add Section:

14.5 MISCELLANEOUS TERMINATION

14.5.1 Funding: If the Bidding Requirements indicate Federal funding for this project is received from the Federal Government prior to award of the Contract and such Federal

funding is not received within the sixty (60) day bid guarantee after the date of receiving bids, all rights and obligations to enter into a Contract are considered null and void.

14.5.2 Provisions of law as contained in Chapter 573A of the Code of Iowa, current edition (which pertains to termination of contracts for construction of public improvements when Work thereon is stopped because of a national emergency), applies to and is a part of this Contract and binding upon all parties hereto, including Subcontractors and sureties.

REFERENCE ARTICLE 15 – CLAIMS AND DISPUTES

68. Reference Section 15.1.5.1; Add Section:

15.1.5.1.a The Contractor shall not be entitled to an increase in the Contract Sum as a result of any delays in the progress of the Work. The Contractor's sole remedy for delay is an extension of time, extended by Change Order for such reasonable time as proposed by the Contractor and approved by the Owner.

END OF DOCUMENT 00 73 00

SECTION 01 10 00

SUMMARY

PART 1 - GENERAL

1.1 PROJECT

- A. Project Name: Building M-04 Renovation & Addition
- B. Owner's Name: Iowa Army National Guard (IA ARNG).
- C. Architect's Name: BBS Architects | Engineers (BBS, Architect, Engineer, Design Professional).
- D. Summary of Work:
 - 1. The general scope of Work includes Renovation of an existing 3,530 SF, masonry and wood framed structure and a 737 SF addition to include a new entry vestibule, Janitor closet and latrines. Work includes but is not limited to selective demolition, painted gypsum wall board, ceramic tile, painted gypsum ceilings, acoustic ceiling tile, sealed concrete floors, carpet, windows and doors, connection to new electrical service, new concrete sidewalk, masonry repair, electrical, mechanical and plumbing. Work associated with the addition includes but is not limited to new masonry walls, concrete foundations, asphalt shingle roof, painted gypsum wall board, painted gypsum ceilings and associated MEP work. Work also includes new connections to existing water utilities, geothermal wellfields, and geothermal mechanical systems.

1.2 CONTRACT DESCRIPTION

- A. Contract Type: A single prime contract based on a Stipulated Price as described in Document 00 52 00 - Form of Agreement.

1.3 HAZARDOUS MATERIAL EXCLUSION

- A. Removal or encapsulation of hazardous materials is specifically excluded from the Work under this Contract. All hazardous materials will be removed by Owner prior to commencement of Contractor's demolition procedures within each phase of construction. If, during execution of the Work, the need for removal or encapsulation of hazardous materials is encountered or suspected, the Contractor shall immediately cease work in the area of such materials and notify Owner and Architect, in writing. The Owner is responsible for removal procedures concerning all such hazardous materials discovered during the Work of this Contract.

1.4 OWNER-FURNISHED/CONTRACTOR-INSTALLED (OFCI) PRODUCTS

- A. Owner's Responsibilities: Owner will furnish products indicated and perform the following, as applicable:
 - 1. Provide to Contractor Owner-reviewed Product Data, Shop Drawings, and Samples.
 - 2. Provide for delivery of Owner-furnished products to Project site.
 - 3. Upon delivery, inspect, with Contractor present, delivered items.

- a. If Owner-furnished products are damaged, defective, or missing, arrange for replacement.
- 4. Inform Contractor of earliest available delivery date for Owner-furnished products.
- B. Contractor's Responsibilities: The Work includes the following, as applicable:
 - 1. Designate delivery dates of Owner-furnished products in Contractor's construction schedule, utilizing Owner-furnished earliest available delivery dates.
 - 2. Review Owner-reviewed Product Data, Shop Drawings, and Samples, noting discrepancies and other issues in providing for Owner-furnished products in the Work.
 - 3. Receive, unload, handle, store, protect, and install Owner-furnished products.
 - 4. Make building services connections for Owner-furnished products.
 - 5. Protect Owner-furnished products from damage during storage, handling, and installation and prior to Substantial Completion.
 - 6. Repair or replace Owner-furnished products damaged following receipt.
- C. Owner-Furnished/Contractor-Installed (OFCI) Products:
 - 1. N/A

1.5 SUPERINTENDENT REQUIREMENTS

- A. Provide a superintendent at the job site at all times during the performance of all work (including work done by subcontractors).
- B. Superintendent shall have minimum five years' experience with comparable type construction.
- C. Contractor shall submit to the Owner for approval the qualifications of the superintendent.

1.6 OWNER OCCUPANCY AND CONTRACTOR USE OF SITE AND PREMISES

- A. Construction Operations: Coordinate use of the site with the Owner.
- B. Provide access to and from site as required by law and by Owner.
- C. Do not obstruct roadways, sidewalks, or other public ways without permit.
- D. Obtain written permission from the Owner for any activity outside the limits indicated on the drawings, including the path to be used by large construction equipment and trucks and dumpsters to and from the site.
- E. Utility Outages and Shutdowns:
 - 1. Do not disrupt or shut down life safety systems, including but not limited to fire sprinklers and fire alarm system, without 7 days notice to Owner and authorities having jurisdiction. Obtain all permits and comply with all requirements.
 - 2. Limit shutdown of utility services to an absolute minimum of time, arranged at least 7 days in advance with Owner.
 - 3. Prevent accidental disruption of utility services to other facilities or other portions of the same facility.

1.7 SAFETY REQUIREMENTS

- A. Safety and Health

1. The work shall be governed by applicable provisions of the general law, including the latest amendments of the following:
 - a. William-Steiger Occupational Safety & Health Act of 1970, Public Law 91-596.
 - b. Part 1910 – Occupational Safety & Health Standards, Chapter XVII of Title 29, Code of Federal Regulations.
 - c. Part 1518 – Safety and Health Regulations for Construction, Chapter XIII of Title 29, Code of Federal Regulations.

B. Accident Prevention

1. The safety provisions of applicable laws, building and construction codes shall be observed. Machinery, equipment and all hazards shall be guarded or eliminated in accordance with the safety provisions of the latest edition of the Manual of Accident Prevention in Construction, published by the Associated General Contractors of America, to the extent that such provisions are not in contravention of applicable laws.

C. Fire Protection

1. During the construction period, provide fire protection. Provide U.L. listed multipurpose dry chemical ABC type fire extinguishers in the quantity, designation and location necessary to conform to the requirements of NFPA 10.
2. Preparation of flammable compounds inside the building is prohibited.
3. Gasoline and other flammable and volatile fluids having low flash points and ignition temperatures shall not be handled in the building except in U.L. listed safety cans. Do not store flammables inside buildings unless they are locked in a flammable storage cabinet. Larger quantities of flammables may not be stored on the Owner's property (interior or exterior) without specific written permission from the Owner to do so.

END OF SECTION

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SECTION 01 14 00

GENERAL REQUIREMENTS

SCHEDULE 0 - GENERAL

1.1 SECTION INCLUDES

- 1.2 Schedule Of Values
- 1.3 Applications For Payment
- 1.4 Change Procedures
- 1.5 Coordination
- 1.6 Unanticipated Utility Lines
- 1.7 Demolition, Cutting And Patching And Alterations
- 1.8 Conferences
- 1.9 Progress Meetings
- 1.10 Submittal Procedures
- 1.11 Submittals For Review
- 1.12 Construction Schedules
- 1.13 Quality Assurance/Control
- 1.14 References
- 1.15 Inspections, Sampling, And Tests
- 1.16 Manufacturers' Field Services And Reports
- 1.17 Security
- 1.18 Temporary Facilities and Controls
- 1.19 Parking
- 1.20 Progress Cleaning
- 1.21 Products
- 1.22 Transportation, Handling, Storage And Protection
- 1.23 Product Options
- 1.24 Substitutions
- 1.25 Anchoring to New and Existing Construction
- 1.26 Demonstration And Instructions
- 1.27 Adjusting Operating Products
- 1.28 Project Record Documents
- 1.29 Final Cleaning
- 1.30 Operation And Maintenance Data
- 1.31 Extended Warranties
- 1.32 Maintenance Materials
- 1.33 Contract Closeout Procedures

1.2 SCHEDULE OF VALUES

- A. Submit schedule on AIA Form G703 or in a computer-generated printout which follows the format used in the AIA Form G703. Form must be typed.
- B. Submit two copies of the Schedule of Values for review within 15 days after date of Owner-Contractor Agreement established in Notice to Proceed but in no case later than one week before the first request for payment.
- C. Schedule of Values must be approved before first request for payment can be reviewed.

- D. Update Schedule of Values at each submission of request for payment by indicating modifications in individual items and additions or subtractions made through Change Orders (COs) or Construction Change Directives (CCDs). Place COs and CCDs at the end of the Schedule of Values.

1.3 APPLICATIONS FOR PAYMENT

- A. Submit three copies of each application on AIA Form G702, according to the requirements found in Document 00 73 00 - Supplementary Conditions.
- B. Content and Format:
 - 1. Utilize Schedule of Values to organize items listed in Application for Payment.
 - 2. If approved by the Owner, CCDs may be included in the request for payment once they have been signed by all parties.
 - 3. COs may be included in the request for payment once they have been signed by all parties. When a CO is added which contains previously authorized CCDs, the CCDs included in the CO must be removed from the Schedule of Values or listed as a sub-item to the CO.
- C. Payment Period: See Document 00 73 00 - Supplementary Conditions.

1.4 CHANGE PROCEDURES

- A. The Architect/Engineer may initiate Instructions to Contractor (ITC) describing clarifications or modifications to the Contract Documents. If the Contractor believes a modification requires additional fee or time, Contractor shall prepare and submit a price quotation. Proposals by the Contractor shall include all related items including modifications to other Work resulting from the proposed change. If Contractor does not indicate that a change in cost or time is required within 14 calendars after receiving an ITC, it shall indicate that the Contractor accepts that change as no cost / no time change.
- B. The Contractor may propose a change by submitting a request for change to the Architect/Engineer, describing the proposed change and its full effect on the Work, with a statement of the reason for the change, and the effect on the Contract Sum Price and Contract Time with full documentation, and a statement of the effect on the rest of the Work.
- C. Contractor's proposals (in response to a request for proposal or when initiated by him/her) shall be accompanied by a draft AIA Form G701 with all information filled out by the Contractor.
- D. Construction Change Directive (CCD) may be issued by the Architect/Engineer, based on agreement of all parties, when it is important that work proceed on an item of work before a Change Order can be fully processed.
- E. Final Change Order package will be prepared by the Owner as indicated in Document 00 73 00 - Supplementary Conditions.

1.5 COORDINATION

- A. Coordinate scheduling, submittals, and Work of the various Sections of the Project Manual and as described on the Drawings to ensure efficient and orderly sequence of installation of interdependent construction elements.
- B. Coordinate work of all subcontractors and sub-subcontractors.

- C. Coordinate delivery scheduling, equipment requirements, installation details and rough-in requirements with Equipment Vendor selected by Owner by separate bid.
- D. Coordinate space requirements and installation of mechanical and electrical work that are indicated diagrammatically on Drawings. Follow routing shown for pipes, ducts, and conduit, as closely as practicable.
- E. In finished areas, conceal pipes, ducts, and wiring within the construction.

1.6 UNANTICIPATED UTILITY LINES

- A. Should utility lines be encountered that are not indicated, advise Owner immediately.
- B. Rectify damage to or repair accidentally damaged or broken utility lines immediately under direction of Owner.

1.7 DEMOLITION, CUTTING AND PATCHING AND ALTERATIONS

- A. See Sections 01 73 29 - Cutting and Patching and 02 41 00 - Selective Demolition.

1.8 CONFERENCES

- A. Owner will schedule a preconstruction site mobilization conference after Notice of Award for all affected parties.
- B. If required to verify or resolve issues arising during the construction, convene a conference at project site of all parties involved. Record minutes and distribute to all parties including the Owner and A/E.

1.9 PROGRESS MEETINGS

- A. Schedule and administer meetings throughout progress of the Work at maximum two-week intervals.
- B. Preside at meetings, record minutes, and distribute copies within two days to those affected by decisions made.

1.10 SUBMITTAL PROCEDURES

- A. All submittals are to electronically via the Project Website as described Section 01 33 05.
- B. Transmit each submittal with a transmittal indicating, Project Name, IAARNG Project Number, BBSAE Project Number, Product Name, Submittal Number (as noted below).
 - 1. Provide separate transmittal for each product or group of related products that are to be reviewed as a group.
- C. Number the submittal forms with CSI MasterFormat 04 Section Number followed by a Submittals Number (e.g. 08 71 00.1, 08 71 00.2, 08 21 00.1.) For resubmittals, use the original number with an additional Revision number (e.g. 08 71 00.1-Rev 1, 08 71 00.1-Rev 2.) If it is not clear what number should be used for given item, request direction from the Architect.
- D. Identify Project, Contractor, subcontractor or supplier. Identify pertinent Drawing sheet and detail number(s), and Specification Section number, as appropriate.

- E. Schedule submittals to expedite the Project. Coordinate submission of related items.
- F. Clearly mark which parts of the submitted documents are to be reviewed. If submitted product data contains multiple products and there is no indication of which are to be used on the Project, the Architect reserves the right to return the submittal without review.
- G. Identify variations from Contract Documents and product or system limitations that may impact the completed Work.
- H. Schedule of Submittals including all proposed products shall be prepared by the Contractor and submitted in duplicate within 15 days after date of Owner-Contractor Agreement Notice to Proceed. Submit complete list of major Products proposed for use, with name of manufacturer, trade name, and model number of each Product and include date when submittal will be made to the Architect/Engineer and date when response is needed on each item. Allow minimum 2 weeks for responses.
- I. Maintain Schedule of Submittals showing status of each item. Make available at each Progress Meeting.
- J. Submittals for Information:
 - 1. Architect/Engineer reserves right to not respond to informational submittals.
 - 2. Architect/Engineer will forward informational submittals, unstamped and unmarked, to Owner, without comment, unless the fail to meet requirements of Contract Documents.

1.11 SUBMITTALS FOR REVIEW

- A. Architect/Engineer review is for general conformance with design concept and Contract Documents. Markings or comments shall not be construed as releasing Contractor from compliance with Contract Documents. Contractor is responsible for details and accuracy, for confirming and correlating quantities and dimensions, for selection of fabrication processes, for technique of assembly, and for performing work in a safe manner.
- B. Procedure:
 - 1. After Architect/Engineer review of submittal, at least one returned copy will have required corrections marked and/or will be accompanied by a comment sheet.
 - 2. Distribute copies of reviewed submittals to concerned parties. Instruct parties to promptly report any inability to comply with comments and indications.
 - 3. Revise and resubmit as required, identifying changes made since previous submittal. Clearly identify any unrequested changes on all submittals and resubmittals.
 - 4. The Architect will use the following marking system for indicating disposition of reviews. See review stamp on the sample Submittal Review/ Comment Form at the end of this section.
 - a. Submittals marked "APPROVED" or "FURNISH AS CORRECTED" shall be considered reviewed and approved by the Owner as noted in accordance with the requirements of Contract Documents. Resubmittal is not necessary.
 - b. Submittals marked with "REVISE AND RESUBMIT" have been reviewed and are considered not approved and subject to notes and markings indicating required revisions. The extent of information to be resubmitted will be specified in the attached notes. The Contractor shall process returned reviewed submittals marked "REVISE AND RESUBMIT" and shall resubmit with requested information or corrections until an approval rating is achieved as indicated in Subparagraph "a" above.
 - c. Submittals marked with "REJECTED" are not considered to meet Project Requirements.

- d. Submittals marked with "NOT REVIEWED" are considered for information only. The Architect neither approves nor disapproves the submittal.

1.12 CONSTRUCTION SCHEDULES

- A. Submit an initial Draft Construction Schedule at least 3 days before the Pre-Construction Conference. Submit copies to the Owner and to the Architect/Engineer.
- B. At the Pre-Construction Conference the Owner and Contractor will discuss scheduling differences and develop a revised Initial Construction Schedule.
- C. Within 5 days after the Pre-Construction Conference, the Contractor shall submit a revised Initial Construction Schedule. All major subcontractors shall sign the revised Construction Schedule indicating agreement therewith. Submit copies to the Owner and to the Architect/Engineer.
- D. Construction Schedule shall be in the form of a bar graph (Gantt Chart) and shall be computer generated. Each task shall include start date, end date and number of days. Required relationships to other tasks shall be shown. Tasks greater than 2 weeks shall be subdivided into smaller tasks.
- E. Maintain construction schedule and provide revised schedules at Progress Meetings as needed to maintained Owner and Architect informed as to progress.

1.13 QUALITY ASSURANCE/CONTROL

- A. Monitor material suppliers', fabricators', and subcontractors' quality control and workmanship to ensure work of specified quality.
- B. Comply fully with manufacturer's instructions and Contract Documents. Should instructions conflict with Contract Documents or deviate from good construction practice, request clarification from Architect/Engineer before proceeding.
- C. Comply with specified standards as a minimum quality for the Work. When more than one specified requirement applies or when additional code requirements apply, the Contractor shall comply with higher standard of those that are applicable.
- D. Secure products in place with positive anchorage devices designed and sized to withstand foreseeable stresses and vibration without physical distortion or disfigurement.
- E. Special Quality Control Form: Contractor shall prepare and submit the following to the Owner: (See Appendix)
 - 1. Backflow Device Test Report.
 - 2. Iowa Army National Guard Disinfection of Water Distribution/Service (Flushing and Disinfection).
 - 3. Iowa Army National Guard Water Distribution/Service Form (Pressure and Leak Test).
 - 4. High Potential Test Report

1.14 REFERENCED STANDARDS

- A. Conform to referenced standard by date of issue current as of date of Contract Documents, except when a specific date is specified or established by applicable code or stated in these Contract Documents.

- B. Should specified referenced standard conflict with Contract Documents, request clarification from Architect/Engineer before proceeding.
- C. The Contractual relationship of the parties to the Contract shall not be altered from the Contract Documents by mention or inference otherwise in any reference document.

1.15 INSPECTIONS, SAMPLING, AND TESTS

- A. The Owner reserves the right to employ a testing agency to test any part of the construction.
- B. Coordinate with the Owner's testing agency for inspections, sampling, and tests as indicated in Contract Documents.
- C. Provide all data required by the testing agency (including mixes to be used) in a timely manner.
- D. Notify Architect/Engineer, Owner and the Owner's testing agency at least 24 hours before the need for testing.
- E. Cooperate with Owner's testing agency as necessary for performance of their work including providing access and manpower for obtaining of samples and inspection of the Work.

1.16 MANUFACTURERS' FIELD SERVICES AND REPORTS

- A. When specified in individual Specification Sections or on the Drawings, require material or product suppliers or manufacturers to provide qualified staff personnel to observe site conditions and to initiate instructions when necessary.
- B. Report observations and site decisions or instructions that are supplementary or contrary to manufacturers' published recommendations.

1.17 SECURITY

- A. Take measures to protect Work and existing facilities, and Owner's operations from unauthorized entry, vandalism, or theft.
- B. Conform to Owner's safety and security requirements.

1.18 TEMPORARY FACILITIES AND CONTROLS

- A. Contractor may use existing electrical service to each building.
- B. Coordinate with the Owner to provide water from the nearest existing source. Contractor provide backflow protection.
- C. Provide additional temporary ventilation, lighting and heating if required to execute Work.
- D. Provide and maintain required toilet facilities and enclosures for employees. Existing facilities shall not be used.
- E. Provide for storage and security of tools and materials delivered to the site but not yet installed.
 - 1. Coordinate with the Owner for use of portions of the site outside those areas directly affected by the Work.
 - 2. Coordinate all usage of the site with the Owner's representative, including scheduling all deliveries.

F. Barriers

1. Provide barriers to prevent unauthorized entry to construction areas and to protect existing facilities and adjacent properties from damage from construction operations and demolition.
2. Provide protection barriers as required to protect building occupants and users from construction operations.
3. Provide barricades and covered walkways if required by governing authorities for public rights-of-way.
4. Provide protection for plants designated to remain. Replace damaged plants.
5. Protect non-owned vehicular traffic, stored materials, site, and structures from damage.
6. Coordinate location, installation and removal of barriers with Owner.

1.19 PARKING

- A. Coordinate parking areas with Owner to accommodate construction personnel.
- B. Coordinate with the Owner for use of the site.

1.20 PROGRESS CLEANING

- A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in a clean and orderly condition.
- B. Locate collection container in area designated by Owner.
- C. Entire work areas shall be cleaned daily.
- D. Areas outside primary construction area, which become dirtied by construction operations, shall be cleaned immediately.

1.21 PRODUCTS

- A. Products: Means new material, machinery, components, equipment, fixtures, and systems forming the Work, but does not include machinery and equipment used for preparation, fabrication, conveying, and erection of the Work. Products may also include existing materials or components authorized for reuse.
- B. Do not use materials and equipment removed from existing premises, except as specifically identified or allowed by the Contract Documents.
- C. Use interchangeable components of the same manufacturer for similar components.
- D. Definition of Terms
 1. Furnish: To supply and deliver, unload, inspect for damage (same as supply).
 2. Install: To unpack, assemble, erect, apply, place, connect, finish, cure, protect, clean, and ready for use.
 3. Provide: To furnish or supply, plus install.
 4. Supply: To supply and deliver, unload, inspect for damage (same as furnish).

1.22 TRANSPORTATION, HANDLING, STORAGE AND PROTECTION

- A. Transport, handle, store and protect products in accordance with manufacturer's instructions and generally accepted construction practice.

- B. Contractor is responsible for protection of stored and installed materials from moisture and mold resulting from failure to control moisture, including humidity levels.
- C. Materials or products which arrive at the site wet or with a moisture content above that designated in the Specification and which have no indication of mold shall be dried out or dried to recommended moisture content level by quickest possible means which will not damage the product or material.
- D. Materials or product which arrive at the site with mold present shall be removed from the site immediately.

1.23 PRODUCT OPTIONS

- A. Products Specified by Referenced Standards or by Description Only: Any Product meeting those standards or description.
- B. Products Specified by Naming One or More Manufacturers: Products of manufacturers named and meeting specifications, no options allowed. No substitutions allowed after Bid period, except under conditions specified herein.
- C. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions: Submit a pre-bid request for substitution within time limits established in Instructions to Bidders for any manufacturer not named. Lists of manufacturers beginning with "Acceptable manufacturers include:" shall be considered to permit substitutions.
- D. "Similar To" or "Equal To" indicate an example product that meets specifications. "Basis of Design" indicates applicable characteristics of named product were used to design systems. In either case Contractor may propose any product that has the same or similar characteristics. A formal substitution is not required, but submittals must include sufficient data to show that the product has the same or similar characteristics to the products so indicated. The Architect/Engineer may reject any product, which, in his/her opinion, is not sufficiently similar to the indicated product.

1.24 SUBSTITUTIONS

- A. Instructions to Bidders specify time for submitting requests for Substitutions during the bidding period.
- B. Subsequent to acceptance of bid, substitutions will be considered only as an included part of a Construction Change Directive or Change Order when a product becomes unavailable or not practical due to no fault of Contractor or when the substitution is substantially to Owner's advantage (equal product for less cost or higher quality product at no change in Contract Sum).
- C. For each request for substitution, prepare a copy of Document 00 43 25 Supplement F: Substitution Request Form.
- D. Document each request with complete data substantiating compliance of proposed substitution with Contract Documents.
- E. Substitutions made on submittals (without previous approval) will not be considered.
- F. Requests for substitutions during the bid period shall comply with Article 14 – Substitutions of the Instructions to Bidders and with this specification section.

- G. Subsequent requests for substitutions will be considered in the case of product unavailability or other conditions beyond the control of the Contractor or as follows:
1. Timing: Architect will consider requests for substitution if received within 60 days after commencement of the Work or the Notice to Proceed. Requests received after that time may be considered or rejected at the discretion of the Architect.
 2. Condition: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:
 - a. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Architect for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
 - b. Requested substitution does not require extensive revisions to the Contract Documents.
 - c. Requested substitution is consistent with the Contract Documents and will produce indicated results.
 - d. Substitution request is fully documented and properly submitted.
 - e. Requested substitution will not adversely affect Contractor's Construction Schedule.
 - f. Requested substitution has received necessary approvals of authorities having jurisdiction.
 - g. Requested substitution is compatible with other portions of the Work.
 - h. Requested substitution has been coordinated with other portions of the Work.
 - i. Requested substitution provides specified warranty.

1.25 ANCHORING TO NEW AND EXISTING CONSTRUCTION:

- A. Do not anchor items to new, or existing construction in a way that will place an excessive load on the construction.
- B. Plaster and Gypsum Board: Do not anchor anything directly to gypsum board or plaster, always anchor to the framing system or to wood blocking or to substrate to which the gypsum board or plaster is anchored
- C. Hollow Masonry
1. Do not anchor anything weighing more than 1 pound or capable of resulting in pressure being applied of more than 3 pounds in any direction to the face of hollow masonry.
 2. Where loads heavier than those listed above must be anchored to hollow concrete block, provide one of the following:
 - a. Set anchor into core that has been grouted solid at the core where the anchor is set, at least one core above and two cores below.
 - b. Provide a system that engages both walls of the concrete block and provides a rigid spacer/brace in the core between the walls similar to Hilti HIT SC for Masonry Construction.
 3. Under no circumstances use impact driven fasteners on hollow masonry unless the cores are grouted solid.

1.26 DEMONSTRATION AND INSTRUCTIONS

- A. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment at agreed-upon times, at equipment location. Owner shall be allowed to videotape all training.

1.27 ADJUSTING OPERATING PRODUCTS

- A. Adjust systems and equipment to ensure smooth and unhindered operation.

1.28 PROJECT RECORD DOCUMENTS

- A. Maintain in the Field Office one reference set of the following documents:
 - 1. Drawings.
 - 2. Specifications.
 - 3. Addenda.
 - 4. Architectural Supplemental Instructions (ASI's) and Instructions to Contractor (ITC's).
 - 5. Requests for Information and Responses (RFI's).
 - 6. Requests for Changes (RFC's)
 - 7. Change Orders and other modifications to the Contract.
 - 8. Reviewed Shop Drawings, Product Data, and Samples.
 - 9. Manufacturer's instruction for assembly, installation, and adjusting.
- B. Record Documents: Legibly mark and record actual revisions to the Work on one "Record" set of the Drawings and Specifications, including the following:
 - 1. Changes made by Addenda.
 - 2. Product substitutions or alternates utilized and approved.
 - 3. Manufacturer's name and product model of actual products installed.
 - 4. Changes made by the following:
 - a. Change Orders.
 - b. Architectural Supplemental Instructions (ASI's) and Instructions to Contractor (ITC's).
 - c. Responses to Requests for Information (RFI's).
 - d. Requests for Changes (RFC's)
 - e. Changes documented by Meeting Notes or Field Reports discussed and agreed to during Progress Meetings or Site Observations.
 - f. Measured location of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
 - g. Measured depths of foundations in relation to finish first main floor datum.
 - h. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
 - i. Field changes of dimensions and details.
 - j. Details not on the original Contract Drawings.
- C. All recorded changes shall be "clouded" and identified; Make reference to the document that originated the change.
- D. Ensure entries are complete and accurate, enabling future reference by Owner.
- E. Store record documents separate from documents used for construction.
- F. Record information concurrent with construction progress, not less than weekly. Provide status update as agenda item at regular progress meetings. Provide record documents for review during progress meeting when requested.
- G. Submit Record Documents to Architect/Engineer with request for final inspection.

1.29 FINAL CLEANING

- A. Execute final cleaning prior to Substantial Completion inspection for each phase.

- B. Dismantle and remove from the site all temporary barriers, closures and other temporary structures or materials.
- C. Remove waste and surplus materials, rubbish, and construction facilities from the site.
- D. Final cleaning must follow all procedure requirements indicated for Progress Cleaning.

1.30 OPERATION AND MAINTENANCE DATA

- A. Bind in a three-ring binder with durable covers.
- B. Prepare binder cover with printed title "OPERATION AND MAINTENANCE INSTRUCTIONS", and title of project.
- C. Internally subdivide the binder contents with permanent, tabbed page dividers, logically organized, with title clearly printed on or under reinforced laminated plastic tabs. Organize product data according to MasterFormat 04 numbering.
- D. Contents:
 - 1. Directory, listing names, addresses, and telephone numbers of Architect/Engineer, Contractor, Subcontractors, and major equipment suppliers.
 - 2. Product and system descriptions data.
 - 3. Operation and maintenance instructions, arranged by system.
 - 4. Project documents and certificates.
- E. O&M binders shall include all final, approved submittals that have been uploaded to the Closeout Tab of the Project Website. Do not submit O&M binders until all electronic copies of the required O&M and Warranty submittals have been uploaded to the Project Website and have achieved final approval.
- F. Submit the number of copies of O&M binders requested by the A/E for review (up to three copies maximum). A/E shall review the O&M binders to verify completion. Contractor shall make any corrections to the O&M binders noted and upon final approval submit the number of final copies requested by the Owner (up to two copies maximum).

1.31 EXTENDED WARRANTIES

- A. Effective dates of warranties shall be the Date of Substantial Completion (not the date of installation) and must be identified on the warranty or by signed letter modifying the warranty.
- B. Provide two copies of all extended warranties.
- C. Execute and assemble documents from Subcontractors, suppliers, and manufacturers.
- D. Submit with request for final inspection.
- E. Include warranties under a separate page divider at the end of the Operation and Maintenance Manual or in a separate binder, labeled as described for the Operations and Maintenance Manual.

1.32 MAINTENANCE MATERIALS

- A. Provide Products, spare parts, specialized tools, maintenance and extra materials in quantities specified in individual Specification Sections or on the Drawings.

- B. Deliver to Project site and place in location as directed by Owner; deliver prior to final payment; obtain a written receipt.

1.33 CONTRACT CLOSEOUT PROCEDURES

- A. After all utilities have been installed but prior to substantial completion, Contractor shall demonstrate, in the presence of the Owner, continuity of all tracer wires from end to end at all underground utilities. Tracer wires which fail a continuity test shall be repaired or replaced and re-tested until a successful continuity test is achieved. Provide Owner 48-hour notice of this activity.
- B. Substantial Completion
 - 1. Submit with request for Substantial Completion inspection:
 - a. List of incomplete work, value of incomplete work, and reasons for being incomplete.
 - b. One copy of Operation and Maintenance Manuals completed volumes in final form. This copy will be returned after Substantial Completion inspection, with Architect/Engineer comments. Revise content of documents as required prior to final submittal.
 - 2. If Work is found to be acceptable, the Architect/Engineer will provide a certification of Substantial Completion accompanied by a Punchlist showing items not yet completed or not yet completed satisfactorily. Omission of an item from the Punchlist does not relieve Contractor from the requirement to completely conform to the Contract Documents.
- C. Final Inspection
 - 1. Do not request a Final Inspection until all construction requirements of the Project have been met in conformance with the Contract Documents.
 - 2. Prior to requesting final inspection and final payment, as required by General Conditions, complete the following:
 - a. Submit copy of final punchlist of work to be completed or corrected, stating that each item has been completed or otherwise resolved for acceptance.
 - b. Submit Project Record Documents.
 - c. Submit two "hard copies" and one electronic copy of Operation and Maintenance Manuals, final volumes, revised.
 - d. Two copies of all written warranties, workmanship/maintenance bonds, agreements, final certifications and similar documents.
 - 1) For items of Work delayed materially beyond Date of Substantial Completion, provide updated submittal within ten days after acceptance, listing date of completion as start of warranty period.
 - e. Submit electronic copy of all submittals.
 - f. Submit Energy Rebate Forms.
 - g. Submit proof, satisfactory to Owner, that fees and similar obligations of Contractor have been paid.
 - h. Submit all Keys, Keying Schedule, and Biting List in accordance Section 08 71 00.
 - i. Submit proof to the Owner that all keys borrowed during the course of the project have been returned.
 - j. Submit Government Required Test Reports as described under Quality Assurance/Control Article in this Section.
 - k. Deliver tools, spare parts, extra stocks of materials (if any), and similar physical items to Owner.
 - 3. Submit the following to the Architect/Engineer with request for final inspection:
 - a. Written certification that Contract Documents have been reviewed, Work has been inspected, and that Work is complete in accordance with Contract Documents and ready for Architect/Engineer's and Owner's Representative's inspection.

- b. Written certification from product manufacturers stating that no asbestos containing materials have been installed in the Project. Statements are required from each manufacturer supplying materials installed on this job including those installed by all subcontractors and sub-subcontractors.
- 4. Coordinate schedule of final inspection so that all parties required to view and approve the Work are present.
- D. Complete items of work determined by Architect/Engineer's final inspection to be incomplete or unacceptable and request additional inspections as necessary.
- E. Reinspection Costs: Should the Owner or the Architect/Engineer be required to perform additional Final Inspections because of failure of work to comply with Contract Documents, Contractor shall compensate Owner and/or Architect/Engineer for additional services. Owner may deduct the cost of the inspections from final payment to Contractor.
- F. Final Acceptance and Payment
 - 1. See Appendix for "Project Closeout Submittal Checklist". This checklist shall be completed in its entirety and uploaded to the Project Website prior to requesting and receiving final payment.

SCHEDULE 1 - PRODUCTS (NOT USED)

SCHEDULE 2 - EXECUTION (NOT USED)

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ARCHITECTS
ENGINEERS

SUBMITTAL COMMENT FORM

PROJECT: IAARNG Building M-04 Renovation & Addition

PROJECT NUMBER: 23067

BUILDING:

SUBMITTAL NUMBER:

DESCRIPTION:

☐ No Exceptions Taken ☐ Rejected

☐ Make Corrections Noted

☐ Revise and Resubmit

Date: _____ By: _____

This review is only for general conformance with the design concept and the information given in the Construction Documents. Corrections or comments made on the shop drawings during this review do not relieve the contractor from compliance with the requirements of the plans and specifications and applicable laws, codes and regulations. Approval of a specific item shall not include approval of an assembly of which the item is a component. The contractor is responsible for: dimensions to be confirmed and correlated at the jobsite; information that pertains solely to the fabrication processes or to the means, methods, techniques, sequences and procedures of construction; coordination of the Work with that of all other trades and performing all Work in a safe and satisfactory manner.

Comments:

219 Eighth Street
Suite 100
Des Moines, IA 50309
515.244.7167

www.bbsae.com



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SECTION 01 22 00

UNIT PRICES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes administrative and procedural requirements for unit prices.

1.02 DEFINITIONS

- A. Unit price is a price per unit of measurement for materials, equipment, or services, or a portion of the Work, added to or deducted from the Contract Sum by appropriate modification, if the scope of Work or estimated quantities of Work required by the Contract Documents are increased or decreased.

1.03 PROCEDURES

- A. Unit prices include all necessary material, plus cost for delivery, installation, insurance, applicable taxes, overhead, and profit.
- B. List of Unit Prices: A schedule of unit prices is included in Part 3 of this section. Specification Sections referenced in the schedule contain requirements for materials described under each unit price.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 SCHEDULE OF UNIT PRICES

- A. Unit Price No. 1 – Masonry Repointing – Additional Work
 - 1. Description: Bid Documents indicate a defined quantity of masonry repointing to include in the Bid Price. Unit price is a price basis for additional masonry repointing, if approved as described in Section 04 01 27.
 - 2. Unit of Measure: Square foot of additional masonry wall face requiring repointing.

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SECTION 01 31 19

PROJECT MEETINGS

PART 1 - GENERAL

1.1 REQUIREMENTS INCLUDED

- A. General Contractor shall schedule and administer periodic progress meetings and specially called meetings throughout progress of the work.
 - 1. Prepare agenda for meetings.
 - 2. Distribute written notice of each meeting seven (7) days in advance of meeting date.
 - 3. Make physical arrangements for meetings.
 - 4. Presiding at meetings.
 - 5. Record the minutes; including significant proceedings and decisions.
 - 6. Meeting minutes shall be posted on the project website within three (3) days after each meeting.
 - a. Refer to Section 01 33 05 for electronic submittal requirements.
- B. Representatives of Contractors, Subcontractors, and suppliers attending meetings shall be qualified and authorized to act on behalf of the entity each represents.
- C. Contracting Officer will attend meetings to ascertain that work is expedited consistent with Contract Documents and construction schedules.
- D. Architect/Engineer will attend meetings.

1.2 RELATED REQUIREMENTS

- A. Section 01 14 00 General Requirements.
- B. Section 01 32 16 Construction Progress Schedule.

1.3 PRE-CONSTRUCTION MEETING

- A. Notice to Proceed will be issued within ten (10) days after Pre-Construction Meeting.
- B. Location: A central site, convenient for all parties, designated by Contracting Officer.
- C. Attendance:
 - 1. Contracting Officer or his authorized representative.
 - 2. Architect/Engineer and his professional consultants.
 - 3. Contractor's superintendent.
 - 4. Major subcontractors.
 - 5. Major suppliers.
 - 6. Others, as appropriate.
- D. Suggested Agenda:
 - 1. Distribution and discussion of:
 - a. List of major subcontractors and suppliers.
 - b. Projected construction schedules.
 - 2. Critical work sequencing.
 - 3. Major equipment deliveries and priorities.
 - 4. Project coordination:
 - a. Designation of personnel responsible.
 - 5. Procedures and processing of:
 - a. Field decisions.

- b. Proposal requests.
 - c. Submittals.
 - d. Change orders.
 - e. Applications for payment.
- 6. Adequacy of distribution of Contract Documents.
- 7. Procedures for maintaining Record Documents.
- 8. Use of premises:
 - a. Office, work and storage areas.
 - b. Owner's requirements.
- 9. Construction facilities, controls, and construction aids.
- 10. Temporary utilities.
- 11. Safety and first-aid procedures.
- 12. Security procedures.
- 13. Housekeeping procedures.
- 14. Review of pertinent Contract conditions of Contracting Officer.

1.4 PROGRESS MEETINGS

- A. Schedule regular meetings, monthly or as determined at pre-construction meeting.
- B. Hold-called meetings as required by progress of the work.
- C. Location of the Meetings: Project field office of Contractor, or as directed by Contracting Officer.
- D. Attendance:
 - 1. Architect/Engineer and his professional consultants as needed.
 - 2. General Contractor's Superintendent.
 - 3. Subcontractors as appropriate to the agenda.
 - 4. Suppliers as appropriate to the agenda.
 - 5. Contracting Officer.
 - 6. Others.
- E. Agenda:
 - 1. Review, approval of minutes of previous meeting.
 - 2. Review of work progress since previous meeting.
 - 3. Field observations, problems, and conflicts.
 - 4. Problems which impede construction schedules.
 - 5. Review of off-site fabrication and delivery schedules.
 - 6. Corrective measures and procedures to regain projected schedule.
 - 7. Revisions to construction schedule.
 - 8. Plan progress and schedule during succeeding work period.
 - 9. Coordination of schedules.
 - 10. Provide and review submittal schedules; expedite as required.
 - 11. Maintenance of quality standards.
 - 12. Pending changes and substitutions.
 - 13. Review proposed changes for:
 - a. Effect on construction schedule and on completion date.
 - b. Effect on other contracts of the Project.
 - 14. Other business.

END OF SECTION

SECTION 01 32 16

CONSTRUCTION PROGRESS SCHEDULE

PART 1 - GENERAL

1.1 REQUIREMENTS INCLUDED

- A. Promptly after award of the Contracts, the Contractor, with the assistance of prime Subcontractors, are to prepare and submit to the Contracting Officer estimated construction progress schedules for the Work, with sub-schedules of related activities, which are essential to its progress.
 - 1. Schedule shall be submitted prior to start of work and shall be realistic and achievable.
- B. Submit revised progress schedules periodically.

1.2 RELATED REQUIREMENTS

- A. Document 00 52 00: Form of Agreement Between the Owner and Contractor.
- B. Section 01 11 00: Summary of Work.
- C. Section 01 31 19: Project Meetings.

1.3 FORM OF SCHEDULE

- A. Prepare schedules in the form of a horizontal bar chart.
 - 1. Provide separate horizontal bar for each trade or operation.
 - 2. Horizontal Time Scale: Identify the first workday of each week.
 - 3. Scale and Spacing: To allow space for notations and future revisions.
 - 4. Minimum Sheet Size: 11" X 17".
- B. Format of Listings: The chronological order of the start of each item of work.
- C. Identification of Listings: By major Specification section numbers.

1.4 CONTENT OF SCHEDULES

- A. Construction Progress Schedule:
 - 1. Show the complete sequence of construction by activity.
 - 2. Show the dates for the beginning and completion of, each major element of construction. Specifically, list:
 - a. Site excavation.
 - b. Site utilities.
 - c. Foundation work.
 - d. Masonry work.
 - e. Structural steel, steel joist, metal deck.
 - f. Roofing.
 - g. Concrete placement.
 - h. Doors and frames; windows.
 - i. Finishes.
 - j. Mechanical and Electrical items.
 - k. Additive Bid Items.
 - 3. Show projected percentage of completion for each item, as of the first day of each month.

- B. Provide sub-schedules to define critical portions of prime schedules.

1.5 PROGRESS REVISIONS

- A. Indicate progress of each activity to date of submission.
- B. Show changes occurring since previous submission of schedule:
 - 1. Major changes in scope.
 - 2. Activities modified since previous submission.
 - 3. Revised projections of progress and completion.
 - 4. Other identifiable changes.
- C. Provide a narrative report, as needed, to define:
 - 1. Problem areas, anticipated delays, and the impact on the schedule, including any changes in requirements for processing submittals.
 - 2. Corrective action recommended, and its effect.
 - 3. The effect of changes on schedules of pertinent Subcontractors.

1.6 SUBMISSIONS

- A. Submit initial schedules within ten (10) days after award of Contract.
 - 1. Contracting Officer will review schedules and return reviewed copy within ten (10) days after receiving receipt.
 - 2. If required, resubmit within seven (7) days after return of reviewed copy.
- B. Submit revised progress schedules with each Application for Payment.
 - 1. Both the Application for Payment and the revised Progress Schedule require approval in order to process payment.
- C. Submit the number of opaque reproductions, which the Contractor requires, plus two (2) copies, which will be retained by the Contracting Officer.
- D. In addition to paper copies required above, initial and revised schedules shall be posted to the project website. Refer to Section 01 33 05 for electronic submittal requirements.

1.7 DISTRIBUTION

- A. Distribute copies of the reviewed schedules to:
 - 1. Job site file.
 - 2. Subcontractors.
 - 3. Other parties concerned.
- B. Instruct recipients to report promptly to the Contractor in writing any problems anticipated by the projections shown in the schedules.

END OF SECTION

SECTION 01 33 05

ELECTRONIC SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The Owner and Contractor shall utilize Procore Technologies, Inc. Procore system for electronic submittal of all data and documents (unless specified otherwise by the Owner's Representative) throughout the duration of the Contract. Procore is a web-based electronic media site that is hosted by Procore Technologies, Inc., utilizing their Procore web solution. Procore will be made available **(via the Owner's Procore subscription)** to all contractors' project personnel, subcontractor personnel, suppliers, consultants and the Designer of Record. The joint use of this system is to facilitate electronic exchange of information, automation of key processes, and overall management of the contract. Procore shall be the primary means of project information submission and management. When required by the Owner's Representative, paper documents will also be provided. In the event of discrepancy between the electronic version and paper documents, the paper documents will govern. Procore is a registered trademark of Procore Technologies, Inc.
- B. Related Sections and Documents:
 - 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
 - 2. Division 00 – Bidding and Contract Requirements issued by the Contracting Officer, apply to this Section.
 - 3. Division 01 Section 01 14 00 "General Requirements" for general submittal requirements.

1.2 USER ACCESS LIMITATIONS

- A. The Owner's Representative will control the Contractor's access to Procore by allowing access and assigning user profiles to accepted Contractor personnel. User profiles will define levels of access into the system, determine assigned function-based authorizations (determines what can be seen) and user privileges (determines what they can do). Sub-contractors and suppliers will be given access to Procore through the Owner. Entry of information exchanged and transferred between the Contractor and its sub-contractors and suppliers on Procore shall be the responsibility of the Contractor.
 - 1. Joint Ownership of Data: Data entered in a collaborative mode (entered with the intent to share as determined by permissions and workflows within the Procore system) by the Owner's Representative and the Contractor will be jointly owned.

1.3 AUTOMATED SYSTEM NOTIFICATION AND AUDIT LOG TRACKING

- A. Review comments made (or lack thereof) by the Owner on Contractor submitted documentation shall not relieve the Contractor from compliance with the requirements of the Contract Documents. The Contractor is responsible for managing, tracking, and documenting the Work to comply with the requirements of the Contract Documents. Owner's acceptance via automated system notifications or audit logs extends only to the face value of the submitted documentation and does not constitute validation of the Contractor's submitted information.

1.4 SUBMITTALS

- A. See Section 01 33 00 SUBMITTAL PROCEDURES:

- B. Preconstruction Submittals
 - 1. List of Contractor's, Sub-contractor's, and Supplier's key Procore personnel. List shall be populated into Owner provided Excel spreadsheet. Include contact information and descriptions of key personnel's roles and responsibilities for this project. Contractor should also identify their organization's administrator on the list.

1.5 COMPUTER SYSTEM REQUIREMENTS

- A. The Contractor shall provide computer hardware, software, and network connections necessary to access and utilize Procore, both at their home office and on the jobsite. Hardware, software, and network connectivity shall meet or exceed the minimum requirements as recommended by Procore Technologies, Inc. for running the Procore system efficiently without interruption or lag. As recommendations are modified by Procore, the Contractor will upgrade their system(s) and software versions to meet the recommendations or better. Upgrading of the Contractor's computer systems will not be justification for a cost or time modification to the Contract. It is recommended a faster internet connection speed be used for projects with heavy data loads.
- B. The Contractor shall be responsible for the validity of their information placed in Procore and for the abilities of their personnel. Accepted users shall be knowledgeable in the use of computers, including Internet Browsers, email programs, cad drawing applications, and Adobe Portable Document Format (PDF) document distribution program. The Contractor shall utilize the existing forms in Procore to the maximum extent possible. If a form does not exist in Procore the Contractor must include a form of their own or provided by the Owner Representative as an attachment to a submittal. Adobe PDF documents will be created through electronic conversion rather than optically scanned whenever possible. The Contractor is responsible for the training of their personnel in the use of Procore (outside what is provided by the owner) and the other programs indicated above as needed.
- C. User Access Administration: Provide a list of Contractor's key Procore personnel for the Owner's Representative acceptance. Owner is responsible for adding and removing users from the system. The Owners Representative reserves the right to perform a security check on all potential users.

1.6 CONNECTIVITY PROBLEMS

- A. Procore is a web-based environment and therefore subject to the inherent speed and connectivity problems of the Internet. The Contractor is responsible for its own connectivity to the Internet. Procore response time is dependent on the Contractor's equipment, including processor speed, Internet access speed, etc. and current traffic on the Internet. The Owner will not be liable for any delays associated from the usage of Procore including, but not limited to, slow response time, down time periods, connectivity problems, or loss of information. Under no circumstances shall the usage of the Procore be grounds for a time extension or cost adjustment to the contract.

1.7 TRAINING

- A. The Contractor shall be responsible for coordinating with the website service provider in a timely manner for training of their employees, sub-contractors, and suppliers in the use of the website service.

PART 2 - PRODUCTS

2.1 DESCRIPTION

- A. Procore project management application provided by Procore Technologies, Inc. www.Procore.com (no substitutions). **All project management shall utilize the Owner's Procore subscription**

PART 3 - EXECUTION

3.1 PROCORE UTILIZATION

- A. Procore shall be utilized in connection with submittal preparation and information management required by Sections:
1. PROJECT MANAGEMENT AND COORDINATION
 2. CONSTRUCTION PROGRESS DOCUMENTATION
 3. SUBMITTAL PROCEDURES
 4. QUALITY REQUIREMENTS
 5. Other Division One sections.
 6. Requirements of this section are in addition to requirements of all other sections of the specifications.
- B. The following items, at a minimum, shall be uploaded, entered, and/or managed on the project web site:
1. Directory.
 2. Drawings
 3. Specifications
 4. Submittals.
 5. Closeout Submittals.
 6. Substantial Completion Documents
 7. Supplemental Instructions (SI's) or Instructions to Contractor (ITC's).
 8. Change Directives (CD's).
 9. Requests for Information (RFI's).
 10. Requests for Change (RFC's) and Requests for Proposal (RFP's).
 11. Meeting Minutes.
 12. Schedules.
 13. Photos.
 14. Reports.
 15. Tests and Inspections.
 16. Punch Lists
 17. Pay Applications
 18. Change Orders
- C. DESIGN DOCUMENT SUBMITTALS
1. All design drawings and specifications shall be submitted as PDF attachments to the Procore submittal workflow process and form.
- D. SHOP DRAWINGS
1. Shop drawing and design data documents shall be submitted as PDF attachments to the Procore submittal workflow process and form. Examples of shop drawings include, but are not limited to:
 - a. Standard manufacturer installation drawings.
 - b. Drawings prepared to illustrate portions of the work designed or developed by the Contractor.
 - c. Steel fabrication, piece, and erection drawings.
- E. PRODUCT DATA

1. Product catalog data and manufacturer's instructions shall be submitted as PDF attachments to the Procore submittal work flow process and form. Examples of product data include, but are not limited to:
 - a. Manufacturer's printed literature.
 - b. Preprinted product specification data and installation instructions.

F. SAMPLES

1. Sample submittals shall be physically submitted as specified in Section 01 3300 SUBMITTAL PROCEDURES. Contractor shall upload a photograph of submitted samples, along with a transmittal sheet into Procore.

G. ADMINISTRATIVE SUBMITTALS

1. All correspondence and pre-construction submittals shall be submitted using Procore. Examples of administrative submittals include, but are not limited to:
2. Digging permits and notices for excavation.
3. List of product substitutions
4. List of contact personnel.
5. Notices for roadway interruption, work outside regular hours, and utility cut overs.
6. Requests for Information (RFI).
7. Construction progress Schedules and associated reports and updates.
 - a. Each schedule submittal specified in CONSTRUCTION PROGRESS DOCUMENTATION shall be submitted as a native backed-up file (.PRX or .STX) of the scheduling program being used. The schedule will also be posted as a PDF file in the format.
8. Plans for safety, demolition, environmental protection, and similar activities.
9. Quality Control Plan(s), Testing Plan and Log, Quality Control Reports, Production Reports, Quality Control Specialist Reports, Preparatory Phase Checklist, Initial Phase Checklist, Field Test reports, Summary reports, Rework Items List, etc.
10. Meeting minutes for quality control meetings, progress meetings, pre-installation meetings, etc.
11. Any general correspondence submitted.

H. COMPLIANCE SUBMITTALS

1. Test reports, certificates, and manufacture field report submittals shall be submitted on Procore as PDF attachments. Examples of compliance submittals include, but are not limited to:
 - a. Field test reports.
 - b. Quality Control certifications.
 - c. Manufacturer's documentation and certifications for quality of products and materials provided.

I. RECORD CLOSEOUT SUBMITTALS

1. Operation and maintenance data and closeout submittals shall be submitted on Procore as PDF documents during the approval and review stage as specified, with actual set of documents submitted for final. Examples of record submittals include, but are not limited to:
 - a. Operation and Maintenance Manuals: Final documents shall be submitted as specified.
 - b. As-built Drawings: Final documents shall be submitted as specified.
 - c. Extra Materials, Spare Stock, etc.: Submittal forms shall indicate when actual materials are submitted.

J. FINANCIAL SUBMITTALS

1. Schedule of Value, Pay Applications and Change Request Proposals, and Waste Reduction Reports shall be submitted on Procore. Supporting material for Pay

Applications and Change Requests shall be submitted on Procore as PDF attachments.
Examples of compliance submittals include, but are not limited to:

- a. Contractors Schedule of Values
- b. Contractors Monthly Progress Payment Requests
- c. Waste Reduction Reports
- d. Contract Change proposals requested by the project owner

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SECTION 01 73 29

CUTTING AND PATCHING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Cutting
 - 2. Patching
 - 3. Minor modifications to ensure exposed surfaces retain a finished appearance.
- B. Related Requirements
 - 1. Section 02 41 00 – Selective Demolition

1.2 SUBMITTALS

- A. Product Data: Submit all materials to be used in patching that are not submitted under another Section of this Specification.
- B. Cutting and Patching Proposal:
 - 1. Where cutting or patching is found to be necessary to accomplish the Work as described in the Construction Document, provide a description of the cutting and/or patching to be done and the reason it is required. Include what materials and utilities will be affected.
 - 2. Where cutting or patching is discovered to involve structural elements of the building, which are not specifically called out on the drawings, immediately advise the Design Professional and request direction.
- C. Approval by the Owner of cutting and patching proposal does not waive the Owner's right to later require complete removal and replacement of a part of the Work found to be otherwise in nonconformity with the Contract requirements.

1.3 PAYMENT FOR COSTS

- A. Contractor shall be responsible for all costs of cutting and patching specifically stated in or reasonably implied by the Work described in the Construction Documents.
- B. Contractor shall be responsible for all costs of cutting and patching caused by ill-timed or defective work, or work not conforming to contract documents, including costs for additional services of the Design Professional or Owner.
- C. Work done on instructions of Design Professional or Owner (by change order), other than defective or non-conforming Work will be paid for by the Owner.

1.4 QUALITY ASSURANCE

- A. Employ skilled workmen to perform cutting and patching. Where work is of a specific trade (such as plaster) engage tradesmen skilled in that trade to execute the Work.

- B. Requirements for Structural Work: Do not cut or patch structural elements in a manner that would reduce their load-carrying capacity or load-deflection ratio.
1. Obtain approval of the cutting and patching proposal before cutting and patching structural elements including, but not limited to, the following:
 - a. Foundation construction.
 - b. Bearing and retaining walls.
 - c. Structural concrete.
 - d. Structural steel.
 - e. Preformed metal panels
 - f. Lintels
 - g. Timber and primary wood framing.
 - h. Structural decking.
 - i. Stair systems.
 - j. Miscellaneous structural metals.
 - k. Equipment supports.
 - l. Shoring, bracing, and sheeting.
- C. Operational and Safety Limitations: Do not cut or patch operating elements or safety related components in a manner that would result in reducing their capacity to perform as intended, or result in increased maintenance, or decreased operational life or safety.
1. Obtain approval of the cutting and patching proposal before cutting and patching operating elements or safety related systems including, but not limited to, the following:
 - a. Piping, conduits, ductwork, vessels and equipment.
 - b. Primary operational systems and equipment.
 - c. Air or smoke barriers.
 - d. Water, moisture, or vapor barriers.
 - e. Membrane and flashings.
 - f. Fire protection systems.
 - g. Electrical wiring systems.
 - h. Control systems.
 - i. Communication systems.
 - j. Conveying systems.
 - k. Noise and vibration control elements and systems.
 - l.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Use materials for patching that are identical to existing materials. If identical materials are not available or cannot be used where exposed surfaces are involved, use materials that match existing adjacent surfaces to the fullest extent possible with regard to visual effect. Use materials whose installed performance will equal or surpass that of existing materials.
1. All substitute materials must be approved by the Owner before they may be used on the project.
- B. Use materials whose thermal, chemical or similar properties will not adversely affect the existing materials to remain.
- C. Where new materials are described in this Specification provide patching materials that conform to those Specification Sections in regard to quality unless otherwise indicated.
- D. Where no specific description of materials is found in the Construction Documents, provide materials of Professional or Commercial quality, heavy duty and top quality, meeting the highest commonly used standards in the trade or specialty under which the Work in question would normally be performed.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Before cutting existing surfaces, examine surfaces to be cut and patched and conditions under which cutting and patching is to be performed. Take corrective action before proceeding, if unsafe or unsatisfactory conditions are encountered.
- B. Where the cutting involves elements normally handled by differing trades, before proceeding, coordinate with parties involved in cutting and patching, including mechanical and electrical trades. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

3.2 PREPARATION

- A. Temporary Support: Provide all temporary support of Work to be cut as required to maintain the structural integrity of the remaining construction and as necessary to provide for a safe environment.
- B. Protection: Protect existing construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of the project that might be exposed during cutting and patching operations.
- C. Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.
- D. Cutting of existing pipe, conduit or ductwork serving the building, which is indicated to be removed or relocated, must be scheduled only after adequate provisions have been made to bypass them. Services must be maintained at all times.

3.3 PERFORMANCE

- A. General
 - 1. Proceed with cutting and patching at the earliest feasible time and complete without delay.
 - 2. Provide all cutting of existing construction as necessary to provide for installation of other components or performance of other construction activities or the subsequent fitting and patching required to restore surfaces to their original condition.
 - 3. If utilities or structural elements of the construction are encountered which are not specifically noted on the Drawings, immediately inform the Design Professional and await a response before proceeding.
- B. Cutting: Cut existing construction using methods least likely to damage elements to be retained or adjoining construction.
 - 1. In general, where cutting is required use hand or small power tools designed for sawing or grinding, not hammering and chopping.
 - 2. Cut holes and slots neatly to size required with minimum disturbance of adjacent surfaces.
 - 3. Temporarily cover openings when not in use.
 - 4. To avoid marring existing finished surfaces, cut or drill from the exposed or finished side into concealed surfaces.
 - 5. Cut no utilities without specific, written authorization from the Owner.
- C. Patching: Patch with durable seams that are as invisible as possible. Comply with specified tolerances.
 - 1. Where feasible, inspect and test patched areas to demonstrate integrity of the installation.

2. Where removal of walls or partitions extends one finished area into another, patch and repair floor, wall and ceiling surfaces in the new space to provide an even surface of uniform color and appearance. Remove existing floor, wall and ceiling coverings and replace with new materials, if necessary to achieve uniform color and appearance.
 3. Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
 - a. Where a patch occurs, refinish the entire surface to a point where the surface changes such as at a corner, a joint, a change in plane or a change in material or color.
 - b. Where patching occurs in a smooth painted surface, extend final paint coat over entire unbroken area containing the patch, after the patched area has received primer and second coat.
- D. Anchoring to Existing:
1. Do not anchor new items or new construction to existing construction in a way that will place an excessive load on the existing construction.
 2. Plaster and Gypsum Board
 - a. Do not anchor anything directly to gypsum board or plaster, always anchor to the framing system or substrate to which the gypsum board or plaster is anchored. If necessary open the gypsum board or plaster wall, provide additional blocking and repair the surface.
 3. Hollow Masonry
 - a. Do not anchor anything weighing more than 1 pound or capable of resulting in pressure being applied of more than 3 pounds in any direction to the face of hollow masonry.
 - b. Where loads heavier than those listed above must be anchored to hollow concrete block, provide one of the following:
 - 1) Open the core and grout solid at the core into which the anchor is to be placed plus at least one core above and two cores below where the anchor is to be placed. Patch and finish the surface of the block to match surrounding block.
 - 2) Provide a system that engages both walls of the concrete block and provides a rigid spacer/brace in the core between the walls similar to Hilti HIT SC for Masonry Construction.
 - c. Under no circumstances use impact driven fasteners on hollow masonry unless the cores are grouted solid.

3.4 CLEANING

- A. Immediately thoroughly clean walls to remove "runs" or "drips" after saw-cutting or core-drilling penetrations through CMU or concrete
- B. Thoroughly clean areas and spaces where cutting and patching is performed or used as access including cleaning piping, metal framing, conduits, ducts and other similar features.
- C. Thoroughly clean and prepare all surfaces before painting or other finishing is applied.
- D. Remove completely paint, mortar, oils, putty and items of similar nature that are not a part of the intended finish.

END OF SECTION

SECTION 01 74 19

CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for the following:
 - 1. Salvaging non-hazardous demolition and construction waste.
 - 2. Recycling non-hazardous demolition and construction waste.
 - 3. Disposing of nonhazardous demolition and construction waste.
- B. Related Requirements:
 - 1. Section 02 41 00 "Selective Demolition" for disposition of waste resulting from partial demolition of buildings, structures, and site improvements.
 - 2. Section 04 20 00 "Unit Masonry" for disposal requirements for masonry waste.

1.2 DEFINITIONS

- A. Construction Waste: Building and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.
- B. Demolition Waste: Building and site improvement materials resulting from demolition or selective demolition operations.
- C. Disposal: Removal of demolition and construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.
- D. Divert: Redirection of demolition or construction waste from disposal in landfills to alternate destinations for recycle, salvage, or reuse.
- E. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.
- F. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.
- G. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.

1.3 PERFORMANCE REQUIREMENTS

- A. General: Achieve minimum end-of-Project rate for salvage/recycling of **60 percent** by weight of total non-hazardous solid waste generated by the Work. Practice efficient waste management in the use of materials in the course of the Work. Use all reasonable means to divert construction and demolition waste from landfills and incinerators. Facilitate recycling and salvage of materials, including, but not limited to, the following:

1. Demolition Waste:

1) Asphalt paving. 2) Concrete. 3) Concrete reinforcing steel. 4) Brick. 5) Concrete masonry units. 6) Wood studs. 7) Wood joists. 8) Plywood and oriented strand board. 9) Wood paneling. 10) Wood trim. 11) Structural and miscellaneous steel. 12) Rough hardware. 13) Roofing. 14) Insulation. 15) Doors and frames. 16) Door hardware. 17) Windows. 18) Glazing. 19) Metal studs. 20) Gypsum board. 21) Acoustical tile and panels.	22) Carpet. 23) Carpet pad. 24) Demountable partitions. 25) Equipment. 26) Cabinets. 27) Plumbing fixtures. 28) Piping. 29) Supports and hangers. 30) Valves. 31) Sprinklers. 32) Mechanical equipment. 33) Refrigerants. 34) Electrical conduit. 35) Copper wiring. 36) Lighting fixtures. 37) Lamps. 38) Ballasts. 39) Electrical devices. 40) Switchgear and panelboards. 41) Transformers. 42) Site-clearing waste.
2. Construction Waste:

1) Masonry and CMU. 2) Lumber. 3) Wood sheet materials. 4) Wood trim. 5) Metals. 6) Roofing. 7) Insulation. 8) Carpet and pad. 9) Gypsum board. 10) Piping. 11) Electrical conduit.	12) Packaging: Regardless of salvage/recycle goal indicated in "General" Paragraph above, salvage or recycle 100 percent of the following uncontaminated packaging materials: 13) Paper. 14) Cardboard. 15) Boxes. 16) Plastic sheet and film. 17) Polystyrene packaging. 18) Wood crates. 19) Plastic pails.

B. Methods of trash/waste disposal that are not acceptable are:

1. Burning on the project site.
2. Burying on the project site.
3. Dumping or burying on other property, public or private.
4. Other illegal dumping or burying.

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

1.4 ACTION SUBMITTALS

A. Waste Management Plan: Submit plan within 10 days of date established for the Notice to Proceed or prior to commencement of any work, whichever comes first.

1.5 INFORMATIONAL SUBMITTALS

- A. Waste Reduction Reports: Reports shall be created using Owner's "Waste Reduction Report Template". Print reports to pdf prior to submission. **Include scans of all related invoices/weight tickets with each report.**
1. Progress Reports: Submit an updated report monthly. Submit concurrently with Applications for Payment. Failure to submit report may delay payment. Upload reports to the Project website. Include the following information:
 - a. Total quantity of construction waste in tons.
 - b. Total quantity of diverted waste in tons (itemized by material type).
 - 1) If containers taken to a recycling facility contain co-mingled waste to be sorted by the recycler, use the current recovery rate for their facility for each drop-off drop-off date when calculating actual diverted waste quantities for reporting. For example, if the facility's recovery rate is 75.8%, and 20 tons of co-mingled waste is dropped off, even though it may be 100% recyclable, only 75.87% of it can be reported (15.16 tons). Verify the facility's current recovery rate for the month in which each drop-off was made.
 - c. Total percentage of construction waste diverted from landfill.
 - d. Landfill Disposal:
 - 1) Identification of material.
 - 2) Amount of waste material disposed of in landfills in tons. List weights for each individual haul and calculated total weight on each updated report.
 - 3) Identity of the landfill, hauler, date of haul, and ticket number.
 - e. Recycled and Salvaged Material:
 - 1) Identification of material, including material retrieved by installer for use on other projects or for return to manufacturer for recycling.
 - 2) Amount of waste material recycled or salvaged in tons. List weights for each individual haul and calculated total weight on each updated report.
 - 3) Identity of the receiving party, hauler, date of haul, and ticket number.
 - 4) Certification by receiving party that materials will not be disposed of in landfills or by incineration.
 - f. Material Reused on Project:
 - 1) Identification of material and how it was reused on the Project.
 - 2) Amount of waste material reused in tons. List weights for each material and calculated total weight on each updated report.
 - 3) Include weight tickets or calculations as evidence of quantities.
 - g. Other Disposal Methods: Include information similar to that described above, as appropriate to disposal method.
 2. Final Report: At completion of Project, upload a Final Report to the Project website.

1.6 WASTE MANAGEMENT PLAN

- A. Develop a waste management plan to include the following information:
1. Analysis of the trash and waste projected to be generated during the entire project cycle, including types and quantities.
 2. Landfill Options: The name, address, and telephone number of the landfill(s) where trash/waste will be disposed of.
 3. Landfill Alternatives: List all waste materials that will be diverted from landfills using reuse, salvage, or recycling. Include list of local receivers and processors and type of material each will accept. Include names, addresses, and telephone numbers.
 4. Meetings: Describe regular meetings to be held to address waste prevention, reduction, recycling, salvage, reuse, and disposal.
 5. Materials Handling and Procedures: Describe the means by which materials to be diverted from landfills will be protected from contamination and prepared for acceptance by

- designated facilities; include separation procedures for recyclables, storage, and packaging.
6. Transportation: Identify the destination and means of transportation of materials to be recycled; i.e. whether materials will be site-separated and self-hauled to designated centers, or whether mixed materials will be collected by a waste hauler.
- B. The following sources may be useful in developing the Waste Management Plan:
1. Phoenix C&D Recycling
 - a. www.phoenixrecycling.net
 - b. creynolds@phoenixrecycling.net
 - c. 4764 NE 22nd St, Des Moines, Iowa
 - d. (515) 323-5888
 - e. **ACCOUNT #: 1332** (NOTE- Account # must be referenced for each delivery)
 2. Waste Commission of Scott County
 - a. www.wastecom.com
 - b. Knorris@wastecom.com
 - c. 11555 110th Avenue, Davenport, Iowa
 - d. (563) 381-1300
 - e. **ACCOUNT #: 1832** (NOTE- Account # must be referenced for each delivery)
 3. Hallett Material
 - a. www.hallettmaterials.com
 - b. jsinclair@hallettmaterials.com
 - c. 4764 NE 22nd St, Des Moines, Iowa
 - d. (515) 266-9928
 - e. **ACCOUNT #: 13835** (NOTE- Account # must be referenced for each delivery)

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 PLAN IMPLEMENTATION

- A. Coordinator: Designate an on-site waste management coordinator responsible for instructing workers and overseeing and documenting results of the Waste Management Plan.
- B. Communication: Distribute copies of the Waste Management Plan to the job site foreman, each subcontractor, the Owner, and the Owner's Project Architect.
- C. Training: Train workers, subcontractors, and suppliers on proper waste management procedures as appropriate for the work:
 1. Distribute and review the Waste Management Plan with each entity when they first begin work on-site. Provide on-site instruction of appropriate separation, handling, and recycling, salvage, reuse and return methods to be used by all parties at the appropriate stages of the project.
 2. Provide follow-up training for each entity as needed to maintain compliance with the plan.
- D. Meetings:
 1. Review the Waste Management Plan at the Pre-Construction Meeting. Discuss responsibilities of each involved party and goals for the project. Revise and resubmit the plan as agreed to at the meeting.

2. Include waste management and recycling discussion in pre-installation meetings.
 3. Include waste management and recycling as an agenda item in all progress meetings with the Owner and job safety meetings with the subcontractors.
- E. Facilities: Provide specific facilities for separation and storage of materials for recycling, salvage, reuse, return, and trash disposal, for use by all contractors and installers.
1. As a minimum, provide:
 - a. Separate area for storage of materials to be reused on-site, such as wood cut-offs for blocking.
 - b. Separate dumpsters for each category of recyclable.
 - c. Recycling bins at worker lunch areas.
 2. Provide adequate space for pick-up and delivery and convenience to subcontractors.
 3. Keep recycling and trash/waste bin areas neat and clean and clearly marked in order to avoid contamination of materials.
- F. Hazardous Wastes: Separate, store, and dispose of hazardous wastes in accordance with applicable regulations.
- G. Transportation: Arrange for timely pickups from the site or deliveries to approved facilities of trash/waste material to keep construction site clear and prevent contamination of materials. Keep copies of delivery and pickup receipts for reporting.

3.2 SALVAGING DEMOLITION AND CONSTRUCTION WASTE

- A. Salvaged Items for Reuse in the Work: Salvage items for reuse and handle as follows:
1. Clean salvaged items.
 2. Pack or crate items after cleaning. Identify contents of containers with label indicating elements, date of removal, quantity, and location where removed.
 3. Store items in a secure area until installation.
 4. Protect items from damage during transport and storage.
 5. Install salvaged items to comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make items functional for use indicated.
- B. Salvaged Items for sale and donation not permitted on Project site.
- C. Salvaged Items for Owner's Use: Salvage items for Owner's use and handle as follows:
1. Clean salvaged items.
 2. Pack or crate items after cleaning. Identify contents of containers with label indicating elements, date of removal, quantity, and location where removed.
 3. Store and protect items from damage in a secure area until pick-up by Owner.
 4. Notify Owner when items are ready for pick-up.

3.3 RECYCLING DEMOLITION AND CONSTRUCTION WASTE, GENERAL

- A. General: Recycle paper and beverage containers used by on-site workers.
- B. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical according to approved construction waste management plan.

1. Provide appropriately marked containers or bins for controlling recyclable waste until removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.
 - a. Inspect containers and bins for contamination and remove contaminated materials if found.
2. Stockpile processed materials on-site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
3. Stockpile materials away from construction area. Do not store within drip line of remaining trees.
4. Store components off the ground and protect from the weather.
5. Remove recyclable waste from Owner's property and transport to recycling receiver or processor.

3.4 RECYCLING DEMOLITION WASTE

- A. Land Clearing Debris: Collect wood debris from land clearing separate from large amounts of dirt and other non-wood materials and transport to recycling facility.
- B. Asphalt Paving: Break up and transport paving to asphalt-recycling facility.
- C. Concrete and Masonry: Free of metals including reinforcing, wood, and other contaminants. Process by one of the following means:
 1. If allowed by specifications, during demolition, crush concrete and concrete masonry to aggregate size. Store crushed material on-site in a clean area to avoid contamination from other materials or building processes. Re-use on site crushed material for fill, for stabilizing soils, or as base and sub-base materials.
 2. If crushing on-site is impractical, store material during demolition processes on site in a clean, uncontaminated area and transport concrete and masonry materials to a certified concrete recycler.
- D. Wood Materials: Sort and stack members according to size, type, and length. Separate lumber, engineered wood products, panel products, and treated wood materials. Reuse on-site as appropriate or transport to recycling facility.
- E. Metals: Cut as required to fit into containers.
- F. Asphalt Shingle Roofing: Separate organic and glass-fiber asphalt shingles and felts. Remove and dispose of nails, staples, and accessories.
- G. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location. Remove edge trim and sort with other metals. Remove and dispose of fasteners.
- H. Acoustical Ceiling Panels and Tile: Stack large clean pieces on wood pallets and store in a dry location.
- I. Metal Suspension System: Separate metal members including trim, and other metals from acoustical panels and tile and sort with other metals.
- J. Carpet (and pad): Roll large pieces tightly after removing debris, trash, adhesive, and tack strips.
 1. Store clean, dry carpet (and pad) in a closed container or trailer provided by Carpet Reclamation Agency or carpet recycler.

- K. Carpet Tile: Remove debris, trash, and adhesive.
 - 1. Stack tile on pallet and store clean, dry carpet in a closed container or trailer provided by Carpet Reclamation Agency or carpet recycler.
- L. Piping: Reduce piping to straight lengths and store by type and size. Separate supports, hangers, valves, sprinklers, and other components by type and size.
- M. Conduit: Reduce conduit to straight lengths and store by type and size.
- N. Packaging:
 - 1. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.
 - 2. Polystyrene Packaging: Separate and bag materials.
 - 3. Pallets: As much as possible, require deliveries using pallets to remove pallets from Project site. For pallets that remain on-site, break down pallets into component wood pieces and comply with requirements for recycling wood.
 - 4. Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.

3.5 DISPOSAL OF WASTE

- A. General: Except for items or materials to be salvaged, recycled, or otherwise reused, remove waste materials from Project site and legally dispose of them in a landfill acceptable to authorities having jurisdiction.
 - 1. Except as otherwise specified, do not allow waste materials that are to be disposed of to accumulate on-site.
 - 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

END OF SECTION

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SECTION 01 77 20
CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
 - 1. Substantial Completion procedures.
 - 2. Final completion procedures.
 - 3. Final cleaning.
 - 4. Repair of the Work.
- B. Related Requirements:
 - 1. Section 01 73 00 "Execution" for progress cleaning of Project site.
 - 2. Section 01 78 00 "Closeout Submittals" for operation and maintenance manual and warranty submittal requirements.

1.2 ADMINISTRATIVE REQUIREMENTS

- A. Pre-Closeout Meetings: Contractor shall arrange a meeting with the Owner and Architect and such subcontractors as may be necessary to plan the closeout.
 - 1. Meeting shall be held not later than the date of request for a substantial completion inspection.
 - 2. Participants shall review the list of items listed in SUBSTANTIAL COMPLETION PROCEDURES – GENERAL REQUIREMENTS in this section.
 - 3. Meeting shall result in a written document, prepared by the Contractor and distributed to the other parties for review and approval, containing a detailed list of items to be delivered to the owner in order to complete the closeout and any other special requirements agreed to.

1.3 ACTION SUBMITTALS

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

1.4 CLOSEOUT SUBMITTALS

- A. Certificates of Release: From authorities having jurisdiction.
- B. Certificate of Insurance: For continuing coverage.
- C. See Section 01 78 00 for additional closeout submittals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Schedule of Maintenance Material Items: For maintenance material submittal items specified in other Sections.

1. Provide a list of all maintenance materials required in specific sections of this Project Manual as well as any other maintenance materials offered voluntarily.
2. Main a record of when and where maintenance materials are delivered and to whom.

1.6 SUBSTANTIAL COMPLETION PROCEDURES – GENERAL REQUIREMENTS

- A. Procedures Prior to Substantial Completion: Complete the following before requesting inspection for determining date of Substantial Completion.
 1. 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.
 2. Advise Owner of pending insurance changeover requirements.
 3. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
 4. Complete startup and testing of systems and equipment.
 5. Perform preventive maintenance on equipment used prior to Substantial Completion.
 6. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems.
 7. Advise Owner of changeover in heat and other utilities.
 8. Participate with Owner in conducting inspection and walkthrough with local emergency responders.
 9. Terminate and remove temporary facilities from Project work area or Project site, as appropriate, along with mockups, construction tools, and similar elements.
 10. Complete final cleaning requirements, including touchup painting.
 11. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.
 12. 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 or temporary occupancy permits, operating certificates, and similar releases.
 13. Operation and Maintenance Manual(s) completed volumes in final form for review.
 - a. See Section 01 78 00 for specific requirements
 - b. Architect/Engineer will review and return to Contractor with comments. Revise content of documents as required prior to final submittal.
- B. Substantial Completion Inspection Procedure:
 1. Submit a written request for inspection to determine Substantial Completion 5 days minimum prior to date the Work will be completed and ready for final inspection and tests.
 - a. Submit with the request the Contractor's List of Incomplete Items.
 2. Upon receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements.
 3. If accepted, the Architect will prepare a Certification of Substantial Completion accompanied by a Punchlist showing items not yet completed or not yet completed satisfactorily.
 - a. Omission of an item from the Punchlist does not relieve Contractor from the requirement to completely conform to the Contract Documents.
 4. After all utilities have been installed but prior to substantial completion, Contractor shall demonstrate, in the presence of the Owner, continuity of all tracer wires from end to end at all underground utilities. Tracer wires which fail a continuity test shall be repaired or replaced and re-tested until a successful continuity test is achieved. Provide Owner 48-hour notice of this activity.

1.7 FINAL PROJECT COMPLETION PROCEDURES

- A. Do not request a Final Inspection until all construction requirements of the Project have been met in conformance with the Contract Documents.
- B. Submittals Prior to Final Completion: Before requesting final inspection for determining final completion, complete the following:
 - 1. Submit copy of Owner's final Punchlist of work to be completed or corrected, indicating when each item was completed or how the item was otherwise resolved for acceptance.
 - 2. Submit one copy Project Record Documents as specified in Section 01 78 39 - Record Documents for review and comment by the Architect/Engineer.
 - 3. Submit corrected Operations and Maintenance Manuals and warranties and bonds in final form.
 - 4. Submit proof, satisfactory to Owner, that taxes, fees and similar obligations of Contractor have been paid.
 - 5. Submit proof to the Owner that all keys borrowed during the course of the project have been returned.
 - 6. Deliver tools, spare parts, maintenance materials, and similar physical items to Owner. See Division 2 through Division 33 for specific requirements.
 - 7. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.
- C. Submit the following to the Architect with request for Final Inspection:
 - 1. Written certification that Contract Documents have been reviewed, Work has been inspected, and that Work is complete in accordance with Contract Documents and ready for Architect/Engineer's and Owner's Representative's inspection.
 - 2. Written certification from product manufacturers stating that no asbestos containing materials have been installed in the Project. Statements are required from each manufacturer supplying materials installed on this job including those installed by all sub-contractor and sub-subcontractor.
- D. Final Inspection:
 - 1. Submit a written request for final inspection to determine acceptance a minimum of 5 days prior to date requested for final inspection.
 - a. Upon receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements.

1.8 FINAL ACCEPTANCE

- A. Submit after final inspection and written acceptance:
 - 1. Two copies of Project Record Documents with corrections based on review and comments by Architect/Engineer.
 - 2. Two copies of all inspections and certifications required by governing authorities.
 - 3. Final Application for Payment, identifying total adjusted Contract Sum, previous payments, and sum remaining due. See Section 01 20 00 for specific requirements. Submit with final release of liens.
 - 4. AIA Forms G706 - Contractor's Affidavit of Payment of Debts and Claims, G706A - Contractor's affidavit of Release of Liens, and G707 - Consent of Surety to Final Payment.
- B. Complete items of work determined by Architect's final inspection to be incomplete or unacceptable and request additional inspections as necessary.

- C. Reinspection Costs: Should the Owner or the Architect be required to perform additional Final Inspections because of failure of work to comply with Contract Documents, Contractor shall compensate Owner and/or Architect for additional services. Owner may deduct the cost of the inspections from final payment to Contractor.

PART 2 - PRODUCTS

2.1 MATERIALS

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

PART 3 - EXECUTION

3.1 FINAL CLEANING

- A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.
- B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
 - 1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:
 - a. Remove tools, construction equipment, machinery, and surplus material from Project site.
 - b. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
 - c. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
 - d. Sweep concrete floors broom clean in unoccupied spaces.
 - e. Remove labels that are not permanent. Remove any temporary protective coatings, membranes and similar items.
 - f. Wipe surfaces of mechanical and electrical equipment and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
 - g. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
 - h. Clean ducts, blowers, and coils if units were operated without filters during construction or that display contamination with particulate matter on inspection.
 - i. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency.
 - j. Leave Project clean and ready for occupancy.
- C. Remove waste, surplus materials, trash/rubbish, and construction facilities from the site; dispose of in legal manner; do not burn or bury.

3.2 REPAIR OF THE WORK

- A. Complete repair and restoration operations before requesting inspection for determination of Substantial Completion.
- B. 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.
 - 1. Touch up and otherwise repair and restore marred exposed finishes and surfaces. Replace finishes and surfaces that already show evidence of repair or restoration.
 - a. Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates. Remove paint applied to required labels and identification.
 - 2. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.
 - 3. Replace burned-out bulbs, bulbs noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.

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SECTION 01 78 00
CLOSEOUT SUBMITTALS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Operation and Maintenance Data.
 - 2. Warranties and bonds.
- B. Related Requirements:
 - 1. Section 01 77 20 - Closeout Procedures.
 - 2. Individual Product Sections: Specific requirements for operation and maintenance data.
 - 3. Individual Product Sections: Warranties required for specific products or Work.

1.2 SUBMITTALS

- A. Operation and Maintenance Data: Submit as described in this Section.
- B. Warranties and Bonds: Submit as described in this Section.
- C. Project Closeout Submittal Checklist. This checklist shall be completed in its entirety and uploaded to the Project Website prior to requesting and receiving final payment.
- D. Submit one hardcopy plus a complete electronic copy on CD or other computer transferable media acceptable to the Owner.
 - 1. See section 01 77 20 for submittal and review sequence.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PROJECT RECORD DOCUMENTS

- A. See Section 01 78 10 - Record Documents.

3.2 OPERATION AND MAINTENANCE DATA

- A. For Each Product or System: List names, addresses and telephone numbers of Subcontractors and suppliers, including local source of supplies and replacement parts.
- B. Product Data: Mark each sheet to clearly identify specific products and component parts, and data applicable to installation. Delete or clearly eliminate from consideration inapplicable information.

1. Approved submittals made during the Project are acceptable if they indicate exactly the product, system, installation, etc as installed in the Project. If not provide product description corrected to show actual product and installation.
- C. Drawings: Supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams. Do not use Project Record Documents as maintenance drawings.
- D. Typed Text: As required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions.
- E. Data provided shall include, but not be limited to, data for the following:
 1. Finishes: Full description of each system as would be required to acquire matching, replacement product. Include any special maintenance and installation requirements.
 2. Doors and Hardware: Complete, corrected door and hardware schedule and product data.
 3. Operating Equipment: Including full description, data on operation, replacement parts, maintenance, and description of circuitry.

3.3 OPERATION AND MAINTENANCE MANUALS

- A. Provide a Table of Contents.
- B. Include general project directory in front of each volume listing names, addresses, and telephone numbers of Design Professional, Contractor, Subcontractors, and major equipment suppliers.
- C. Arrange content by systems under section numbers and sequence of Table of Contents of this Project Manual.
- D. O&M binders shall include all final, approved submittals that have been uploaded to the Closeout Tab of the Project Website. Do not submit O&M binders until all electronic copies of the required O&M and Warranty submittals have been uploaded to the Project Website and have achieved final approval.
- E. Submit the number of copies of O&M binders requested by the A/E for review (up to three copies maximum). A/E shall review the O&M binders to verify completion. Contractor shall make any corrections to the O&M binders noted and upon final approval submit 1 (one) copy.
- F. For each individual product or system organize data as follows:
 1. Part 1: Identification: General description of the product or system and name of the subcontractor responsible for the product or system. Provide subcontractor contact information if it is not included in the general project directory at the beginning of the volume.
 2. Part 2: Operation and maintenance instructions for product or system. Identify the following
 - a. Significant design criteria.
 - b. List of equipment.
 - c. Operating instructions.
 - d. Maintenance instructions for equipment and systems.
 - e. Maintenance instructions for special finishes, including recommended cleaning methods and materials, and special precautions identifying detrimental agents.

3. Part 3: Maintenance service documentation for obtaining both parts, service, and additional product identifying name, address, and telephone number of service provider.
4. Part 4: Project documents and certificates, including:
 - a. Shop drawings and product data. Either include the shop drawing in the manual or indicate where it can be found.
 - b. List of field quality control reports submitted by Contractor and where they can be found (if not included in the manual).
 - c. Applicable balance reports (air, water, electrical phase, etc).
 - d. Certificates and permits.

3.4 WARRANTIES AND BONDS

- A. Obtain warranties and bonds, executed in duplicate by responsible Subcontractors, suppliers, and manufacturers, within 10 days after completion of the applicable item of work. Except for items put into use with Owner's permission, leave date of beginning of time of warranty until the Date of Substantial Completion is determined.
 1. For items completed or placed in service after Substantial Completion, date of warranty shall be the date on which the item is completed or placed in service.
- B. Provide written warranties for all items requiring a warranty or guaranty of greater duration than one year.
- C. Verify that documents are in proper form, contain full information, and are notarized.
- D. Co-execute submittals when required.
- E. Retain warranties and bonds until time specified for submittal.
- F. Include originals of each in Operation and Maintenance Manuals, indexed separately in the Table of Contents or provide a separate volume for Warranties, Guaranties, and Bonds.
- G. Arrange content by systems under section numbers and sequence of Table of Contents of this Project Manual.

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SECTION 02 41 00

SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Selective demolition of building elements for alterations purposes.
- B. Related Requirements:
 - 1. Section 01 10 00 "Summary": Limitations on Contractor's use of site and premises, and sequencing and staging.
 - 2. Section 01 14 00 "General Requirements"
 - 3. Section 01 73 29 "Cutting and Patching": Cutting and patching requirements.
 - 4. Section 01 74 19 "Construction Waste Management".
 - 5. Section 26 05 01 - Selective Electrical Demolition.

1.2 REFERENCES

- A. 29 CFR 1926 -U.S. Occupational Safety and Health Standards; current edition.
- B. NFPA 241 -Standard for Safeguarding Construction, Alteration, and Demolition Operations; 2004.

1.3 SUBMITTALS

- A. Site Plan: Showing:
 - 1. Vegetation to be protected.
 - 2. Areas for temporary construction and field offices.
 - 3. Plans for closing off exterior portions of the site and building including building access points. Include extent and timing of temporary closures of sidewalks, drives and other areas of the site. Submit materials and systems to be used.
 - 4. Areas for temporary and permanent placement of removed materials.
- B. Demolition Plan: Submit demolition plan to the Owner including the following:
 - 1. Schedule of utility shut offs, partial closure of access or pathways and other key items which may affect operations of the facility.
 - 2. Measures planned to reduce noise and vibration and control dust.
 - 3. Sequencing of major portions of the work.
 - 4. Plans for closing off interior portions of the building to remain including submit materials and systems to be used.
- C. Project Record Documents: Accurately record actual locations of capped and active utilities and subsurface construction.

1.4 PROJECT CONDITIONS

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

- B. All waste to be lowered to ground by methods that do not result in loose debris or dust. If chutes are used they must be fully enclosed chutes into covered dumpsters.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Temporary Closure materials
 - 1. Materials used for barriers, enclosures and other temporary structures may be new or used but must be in serviceable condition, safe and visually free of defect.
 - 2. Wood in contact with the public must not be an easy source of splinters.
 - 3. Barriers exposed to the public shall be painted a single color (e.g. not piece of old signs cut up with parts of many colors).
- B. Patching Materials: See Section 01 73 29 -Cutting and Patching for material requirements.

PART 3 - EXECUTION

3.1 SCOPE

- A. Remove minor portions of existing building as indicated on drawings or as required to execute the other Work as described in the drawings.
- B. Where indicated, remove items for salvage.
- C. Provide temporary closure at all locations where demolition results in temporary exposure of remaining interior spaces and surfaces to exterior conditions.

3.2 GENERAL PROCEDURES AND PROJECT CONDITIONS

- A. Comply with applicable codes and regulations for demolition operations and safety of adjacent structures and the public.
 - 1. Obtain required permits.
 - 2. Use of explosives is not permitted.
 - 3. Take precautions to prevent catastrophic or uncontrolled collapse of structures to be removed; do not allow worker or public access within range of potential collapse of unstable structures.
 - 4. Provide, erect, and maintain temporary barriers and security devices.
 - 5. Use physical barriers to prevent access to areas that could be hazardous to workers or the public.
 - 6. Conduct operations to minimize effects on and interference with adjacent structures and occupants.
 - 7. Do not close or obstruct roadways or sidewalks without permit (if public) or permission of the Owner.
 - 8. Conduct operations to minimize obstruction of public and private entrances and exits; do not obstruct required exits at any time; protect persons using entrances and exits from removal operations.
 - 9. Obtain written permission from the Owner for any activity outside the limits indicated on the drawings, including the path to be used by large construction equipment and trucks and dumpsters to and from the site.
 - 10. Obtain written permission from owners of adjacent properties when demolition equipment will traverse, infringe upon or limit access to their property.
- B. Do not begin removal until receipt of notification to proceed from Owner.

- C. Protect existing structures and other elements that are not to be removed.
 - 1. Provide bracing and shoring.
 - 2. Prevent movement or settlement of adjacent structures.
 - 3. Stop work immediately if adjacent structures appear to be in danger and report condition to the Owner and Architect.
- D. Minimize production of dust due to demolition operations; do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.
- E. If hazardous materials are discovered during removal operations, stop work and notify Architect and Owner; hazardous materials include regulated asbestos containing materials, PCB's, and mercury.

3.3 EXISTING UTILITIES

- A. Coordinate utility work with the Owner; notify before starting work and comply with Owner's requirements; obtain required permits.
- B. Protect existing utilities to remain from damage.
- C. Do not disrupt operating utilities without written permission from the Owner.
- D. Do not close, shut off, or disrupt existing life safety systems that are in use without at least 7 days prior written notification to Owner. Obtain required permits before modifying or disabling life safety system including exit pathways.
- E. Do not close, shut off, or disrupt existing utility branches or take-offs that are in use without at least 7 days prior written notification to Owner.
- F. Locate and mark utilities to remain; mark using highly visible tags or flags, protect from damage due to subsequent construction, using substantial barricades if necessary.
 - 1. At utilities or ductwork to be permanently capped and abandoned, provide a permanent type tag (metal or plastic) attached to the duct, pipe, conduit, etc. near the cap and containing the following information:
 - a. Utility carried (e.g. gas, hot water, return air, 240 V electrical, etc.)
 - b. Original source.
 - c. Original destination.
 - d. Note to which (if either) it is still connected.
 - e. Note whether the pipe, conduit or duct is active or contains anything.
 - f. Date capped.
 - 2. Utilities or ductwork to be temporarily capped may be tagged with less permanent tags (paper) but shall carry the same information.
- G. Remove abandoned piping, valves, meters, equipment, supports, and foundations of disconnected and abandoned utilities where possible to do so, including those above accessible ceilings. Remove back to source of supply where possible; otherwise cap stub and tag with identification.

3.4 SELECTIVE DEMOLITION FOR ALTERATIONS

- A. Drawings showing existing construction and utilities are based on casual field observation and existing record documents only.
 - 1. Verify that construction and utility arrangements are as shown.
 - 2. Report discrepancies to Architect before disturbing existing installation.

3. Beginning of demolition work constitutes acceptance of existing conditions.
- B. Maintain weatherproof exterior building enclosure except for interruptions required for replacement or modifications; take care to prevent water and humidity damage.
- C. Remove existing work as indicated and as required to accomplish new work.
- D. Services (Including but not limited to HVAC, Plumbing, Fire Protection, Electrical, and Telecommunications): Remove existing systems and equipment as indicated.
 1. Maintain existing active systems that are to remain in operation; maintain access to equipment and operational components.
 2. Where existing active systems serve occupied facilities but are to be replaced with new services, maintain existing systems in service until new systems are complete and ready for service.
 3. Verify that abandoned services serve only abandoned facilities before removal.
- E. Protect existing work to remain.
 1. Prevent movement of structure; provide shoring and bracing if necessary.
 2. Perform cutting to accomplish removals neatly and as specified for cutting new work.
 - a. See Section 01 73 29 "Cutting and Patching" for additional requirements.
 3. Repair and patch adjacent construction and finishes damaged during removal work as necessary:
 - a. Surfaces or elements which are scheduled to be removed or remodeled in a later phase of this project shall be patched as required to provide stable construction. Patches may be temporary but shall be of a nature which will serve until the finish construction scheduled for a later phase of this Project.
 - b. Surfaces or elements not scheduled to be removed or remodeled or refinished in later phases of this project, shall be patched and finished in a permanent manner to match existing finishes.
 - c. See Section 01 73 29 "Cutting and Patching" for additional requirements.

3.5 DEBRIS AND WASTE REMOVAL

- A. Remove debris, junk, and trash from site and dispose of legally.
- B. Leave site in clean condition, ready for subsequent work.
- C. Clean up spillage and wind-blown debris from public and private lands.

END OF SECTION

SECTION 03 01 35

CLEANING AND RESURFACING OF CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes cleaning and resurfacing concrete to be exposed and sealed.
- B. Related Requirements
 - 1. 03 30 00 "Cast-in-Place Concrete".

1.2 SUBMITTALS

- A. Floor Cleaning and Resurfacing Plan to include:
 - 1. Proposed floor cleaning procedure.
 - 2. Proposed procedure for removing ceramic tile and vinyl tile.
 - 3. Proposed procedure for grinding concrete surface including sequence of grits proposed.
 - 4. Product data on materials, products and equipment to be used.

PART 2 - PRODUCTS

2.1 CLEANING / DEGREASING AGENT

- A. Cleaner/Degreaser designed for cleaning sound concrete surfaces and compatible with applications of breathable sealers to cleaned surface.
- B. Sample product: Consolidex Cleaner/Degreaser by Prosoco: www.prosoco.com.

2.2 FLOOR PLANING MACHINE

- A. Designed to cut off ceramic tile and mortar and plane the surface of the concrete slab.
- B. Sample Product: ShaveMaster by AIRTEC International.

2.3 GRINDING AND POLISHING EQUIPMENT

- A. Grinding and Polishing Machine: 3 head or 4 head counter rotating variable speed floor grinding machine conforming to the following:
 - 1. Applies at least 600 pounds down pressure.
 - 2. Dust extraction system, pre-separator, and squeegee attachments with minimum flow rating of 322 cubic feet per minute.
- B. Grinding Pads:
 - 1. Final grind to be with resin bonded phenolic diamond pads, grit 200.
 - 2. Provide metal bonded diamond grit pads and resin bonded phenolic diamond pads of rougher grits in sequence as necessary to arrive at the 200 grit.
- C. Hand Grinder: Designed for grinding and polishing concrete with dust extraction equipment.

- D. Hand Grinder Pads:
 - 1. Final grind to be with resin bonded phenolic diamond pad, grit 200.
 - 2. Provide metal bonded diamond grit pads and resin bonded phenolic diamond grit pads of rougher grits in sequence as necessary to arrive at the 200 grit.

2.4 SEALER

- A. See Section 03 30 00 - Cast-In-Place Concrete.

PART 3 - EXECUTION

3.1 GENERAL

- A. Project includes:
 - 1. Cleaning existing exposed concrete surfaces to be remain.
 - 2. Removal of existing ceramic tile and vinyl tile.
 - 3. Grinding where tile is remove to remove residue and prepare surface for sealer.
- B. Submit Floor Cleaning and Resurfacing Plan and receive approval before proceeding.

3.2 EXISTING EXPOSED CONCRETE

- A. Clean existing exposed concrete to remain using cleaning / degreasing agent as recommended by manufacturer.

3.3 EXISTING CONCRETE WITH APPLIED TILE (CERAMIC OR RESILIENT)

- A. Removed existing applied tile, mortar, and adhesive using floor planing machine or as required.
- B. Grind concrete where tile has been remove to remove mortar and adhesive residue and prepare surface for specified sealer.
 - 1. Final product should approximate existing exposed concrete to remain and new exposed concrete with a steel trowel finish.

3.4 FINISH

- A. See Section 03 30 00 for application of penetrating, breathable sealer to all concrete - new, existing to remain and resurfaced.

END OF SECTION

SECTION 03 30 00

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

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

1.2 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, other pozzolans, and silica fume; materials are subject to compliance with requirements.
- B. W/C Ratio: The ratio by weight of water to cementitious materials.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate placement of joint devices and embedded work with erection of concrete formwork and placement of form accessories

1.4 ACTION SUBMITTALS

- A. Product Data: Submit manufacturers' data on manufactured products showing compliance with specified requirements. Include data on curing agents, sealer/hardeners, additives, and joint materials.
- B. Curing Proposal: Provide a proposal describing materials and methods and schedule to be used in curing concrete. Proposal must be approved by Architect before beginning concreting.

1.5 INFORMATIONAL SUBMITTALS

- A. Design Mixtures: Submit concrete mix design for each concrete strength. Clearly identify where each mix is intended to be used.
 - 1. In addition to any name assigned by the plant, label each mix to indicate where it will be used on this Project.
 - 2. Submit 10 ASTM C 39 strength tests from the last 12 months using this mix.
 - 3. Indicate all ingredients, including admixtures.
 - 4. Indicate amounts of mixing water to be withheld for later addition at Project site.
 - 5. Indicate measures to be taken if weather, Project conditions, test results or other circumstance warrant adjustments.

1.6 QUALITY ASSURANCE

- A. Perform work of this section in accordance with ACI 347, ACI 301 and ACI 318 and applicable portion of the State Building Code.
- B. Acquire cement from same source and aggregate from same source for entire project.

- C. Follow recommendations of ACI 305R when concreting during hot weather.
 - 1. Temperature of concrete at time of deposit must be below 90 degrees F (32 degrees C)
- D. Follow recommendations of ACI 306R when concreting during cold weather.
 - 1. From November 1 to May 1 or as environmental conditions dictate, maintain sufficient protective materials, readily available, on job site, to protect all concrete that has not cured for specified period.
 - 2. Contractor shall remove and replace concrete damaged by freezing.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

- A. Comply with ACI 301 (ACI 301M) and ACI 117 (ACI 117M).

2.2 FORM-FACING MATERIALS

- A. Conform to ACI 347.
- B. Form Materials: Contractor's choice of standard products with sufficient strength to withstand hydrostatic head without distortion in excess of permitted tolerances.
 - 1. Wood materials used as forms must be new in undamaged condition.
- C. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch (19 by 19 mm), minimum.
- D. Form-Release Agent: Commercially formulated form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.
 - 1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
- E. Formwork Accessories
 - 1. Framing, Studding and Bracing: Stud or No. 3 structural light framing grade or steel pipes or other steel shapes of sufficient size.
 - 2. Provide nails, spikes, lag bolts, through bolts, ties, anchorages, reinforcements, and similar items as required to cause formwork to function properly and sized as required and of sufficient strength and character to maintain formwork in place while placing concrete.
 - 3. Form Ties: Snap-off type, plastic, fixed length, cone type, 1 inch (25 mm) back break dimension, free of defects that could leave holes larger than 1 inch (25 mm) in concrete surface.

2.3 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.

- B. Plain-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, plain, fabricated from as-drawn steel wire into flat sheets.
- C. Steel Bar Mats: ASTM A 184/A 184M, fabricated from ASTM A 615/A 615M, Grade 60 (Grade 420), deformed bars, assembled with clips.
- D. Plain-Steel Wire: ASTM A 1064/A 1064M.
 - 1. Tie Wire: Annealed, minimum 16 gage (1.5 mm).
- E. Do not use Welded Wire Mat or Roll Reinforcement without specific written direction from the Architect or Engineer.

2.4 REINFORCEMENT ACCESSORIES

- A. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), plain-steel bars, cut true to length with ends square and free of burrs.
- B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
 - 1. Include load bearing pad on bottom to prevent vapor barrier puncture.
 - 2. For slabs on grade, pieces of concrete block may be used.
- C. Tension Transferring End Splice Connectors: Mechanical rebar end splice connectors for use as described in this Specification.
 - 1. Resulting connection must produce a tensile strength in the bar and connector assembly equal or greater than the tensile strength of the bar without a splice.
 - 2. The resulting connection must not extend more than 1/4 inch outside the perimeter of the bar without the splice.
 - 3. Acceptable manufacturers include
 - a. Erico (Lenton)
 - b. Dayton Richmond
 - c. Meadow Burke

2.5 CONCRETE MATERIALS

- A. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.
- B. Cementitious Materials:
 - 1. Portland Cement: ASTM C 150/C 150M, Type IL - Normal or Type III - High Early Strength, Portland type.
 - 2. Fly Ash: ASTM C 618, Class F or C.
 - 3. Slag Cement: ASTM C 989/C 989M, Grade 100 or 120.
 - 4. Silica Fume: ASTM C 1240, amorphous silica.
- C. Normal-Weight Aggregates: ASTM C 33/C 33M, grade size 5. Provide aggregates from a single source.
 - 1. Maximum Coarse-Aggregate Size: 1 inches (25 mm) nominal.
 - 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

- D. Air-Entraining Admixture: ASTM C 260/C 260M.
- E. Chemical Admixtures:
 - 1. Do not use calcium chloride or admixtures containing calcium chloride.
 - 2. Use no chemical admixtures unless indicated in Contract Drawings or authorized in writing by the design professional.
 - 3. If approved, use admixtures conforming to ASTM C494.
- F. Water: ASTM C 94/C 94M and potable.

2.6 FLOOR TREATMENTS

- A. Penetrating Sealer:
 - 1. Breathable: Shall not reduce the moisture vapor transfer rate at the surface on which it is applied.
 - 2. Must be low VOC: Less than 50 g/l.
 - 3. Must increase the hardness of concrete by at least 20 percent when tested according to ASTM C779.
 - 4. Slip Resistance: Wet Coefficient of Friction of 0.6 or greater when tested according to ASTM D 2047 for the specified concrete finish texture.
 - 5. Where sealer is used over curing compound, verify that the curing compound is compatible with the sealer.

2.7 CURING MATERIALS

- A. Provide one of the following:
 - 1. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
 - 2. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- B. Applied Curing Agents: Compatible with scheduled finishes. Where concrete will be exposed in final condition, agents must not stain, discolor, or interfere with scheduled coatings.

2.8 RELATED MATERIALS

- A. Joint Filler: Non-asphaltic expansion joint filler with removable top strip for sealant reservoir: closed-cell polyolefin, complying with ASTM D 7174, 1/2 inch (13 mm) thick and 4 inches (200 mm) deep. Use of fillers containing asphalt based products is not permitted.
 - 1. Joint Caps: Provide preformed, removable joint caps to ensure that the top of the joint filler is at the proper depth for installation of sealant.
- B. Bonding Agent: ASTM C 1059/C 1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene.
- C. Underslab Vapor Retarder: 15 mil thick, cross laminated multi-layer, fabric-, cord-, grid-, or aluminum-reinforced polyethylene or equivalent, complying with ASTM E 1745, Class A; stated by manufacturer as suitable for installation in contact with soil or granular fill under concrete slabs. Single ply polyethylene is prohibited.
 - 1. Acceptable products include:
 - a. Raven Industries Inc.; Product Vapor Block 15: www.ravenind.com.
 - b. Stego Industries, LLC; Product Strego Wrap 15: www.stegoindustries.com.

- c. W.R. Meadows, Inc; Product Perminator 15: www.wrmeadows.com.
- 2. Accessory Products: Vapor retarder manufacturer's recommended tape, adhesive, mastic, prefabricated boots, etc., for sealing seams and penetrations in vapor retarder.
- D. Non-Shrink Cementitious Grout: Premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents.
 - 1. Minimum Compressive Strength at 48 Hours: 2,400 psi (17 MPa).
 - 2. Minimum Compressive Strength at 28 Days: 7,000 psi (48 MPa).

2.9 CONCRETE MIXTURES, GENERAL

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301 (ACI 301M).
 - 1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.
- B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
 - 1. Fly Ash: 25 percent.
 - 2. Combined Fly Ash and Pozzolan: 25 percent.
 - 3. Slag Cement: 50 percent.
 - 4. Combined Fly Ash or Pozzolan and Slag Cement: 50 percent portland cement minimum, with fly ash or pozzolan not exceeding 25 percent.

2.10 CONCRETE MIXTURES FOR BUILDING ELEMENTS

- A. Normal Weight Concrete: Where not indicated otherwise on the drawing, provide the following:
 - 1. Compressive Strength, when tested in accordance with ASTM C 39/C 39M at 28 days: Where no other strength is indicated provide 4,000 psi (27.6 MPa).
 - a. For Footings and Foundations: 4,000 psi (20.7 MPa).
 - 2. Water-Cement Ratio: Do not exceed values in ACI 211.1, Table 6.3.4(a).
 - 3. Maximum Slump: 4 inches (100 mm) without plasticizers.
 - 4. Air Content: As determined in accordance with ASTM C 173
 - a. Where exposed to exterior temperatures: 7 percent (plus or minus 1 percent)
 - b. Interior concrete (not exposed to external temperatures): Maximum 3 percent for workability.

2.11 FABRICATING REINFORCEMENT

- A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."
- B. Bars may be prefabricated into steel bar mats in lieu of job placing individual bars.
- C. Welding of reinforcement is permitted only with the specific approval of Architect. Perform welding in accordance with AWS D1.4.
- D. Locate reinforcing splices not indicated on drawings at point of minimum stress.
 - 1. Review locations of splices with Architect.

2.12 CONCRETE MIXING

- A. Contractor may use either plant mixed or site mixed concrete.
- B. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.
 - 1. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.
- C. On Project Site: Obtain permission from the Owner before using any concrete mixed on site. If approved, mix in drum type batch mixer, complying with ASTM C685.
 - 1. For mixer capacity of 1 cu. yd. (0.76 cu. m) or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
 - 2. For mixer capacity larger than 1 cu. yd. (0.76 cu. m), increase mixing time by 15 seconds for each additional 1 cu. yd. (0.76 cu. m).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify lines, levels, and dimensions before proceeding with work of this section.
- B. Verify all items to be embedded in concrete are present and properly placed and secured.
- C. Verify that requirements for concrete cover of reinforcing will be met.

3.2 FORMWORK INSTALLATION

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301 (ACI 301M), to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.
- B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117 (ACI 117M).
- C. Construct forms tight enough to prevent loss of concrete mortar. Align joints and make watertight. Keep form joints to a minimum.
- D. Construct forms for easy removal without hammering or prying against concrete surfaces.
- E. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
- F. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
- G. Chamfer exterior corners and edges of equipment pads.

- H. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- I. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- J. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.
 - 1. Apply prior to placement of reinforcing steel, anchoring devices, and embedded items.
 - a. If release agent contacts reinforcing steel or other devices intended to bond with concrete remove all release agent from the steel or devise as necessary to facilitate full bonding with the concrete.
 - 2. Do not apply form release agent where concrete surfaces will receive special finishes or applied coverings that are affected by agent. Soak inside surfaces of untreated forms with clean water. Keep surfaces coated prior to placement of concrete.
 - 3. Do not use form release agents near air intakes serving occupied buildings. If such use is necessary, contact the Owner at least three (3) days in advance to arrange for protection of the building air system.

3.3 EMBEDDED ITEM INSTALLATION

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
- B. Install accessories in accordance with manufacturer's instructions, so they are straight, level, and plumb. Ensure items are not disturbed during concrete placement.

3.4 STEEL REINFORCEMENT INSTALLATION

- A. General: Comply with CRSI's "Manual of Standard Practice" and ACI 301 for fabricating, placing, and supporting reinforcement.
- B. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.
- C. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.
- D. Center reinforcing in full slab, unless noted otherwise.
 - 1. Positioning reinforcement by lifting with a hook from bottom of form, through concrete, is not permitted.
- E. Before concrete is placed, ensure reinforcement is free from dirt, loose, flaky rust and scale, oil, grease, ice, or other coating which could reduce or destroy bond. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.
- F. Maintain concrete cover around reinforcing as follows:
 - 1. Footings and Concrete Formed Against Earth: 3 inch (75 mm).
 - 2. Slabs on Fill: 2 inch (50 mm).

3. Slab not exposed to earth or weather: 1 inch (25 mm) or 1.5 times maximum size of coarse aggregate, whichever is greater.
 4. Where not otherwise noted: Not less than 1½ inch (38 mm) or 1.5 times maximum size of coarse aggregate, whichever is greater.
- G. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- H. Where overlap splicing would result in insufficient space to provide minimum cover required, provide end splice connectors conforming to PART 2 of this Section.

3.5 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete. Anchor to prevent movement during concrete placement.
- B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
- C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:
1. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (3.2-mm-) wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.
 2. Cut joints not more than 12 hours after concrete is initially finished.
 3. At interior and exterior slabs and walks, locate contraction joints at not more than 24 to 36 times the thickness of the slab on center and with a width to length ratio of not more than 2 to 1. If joints are not located on drawings, submit a joint layout drawing for approval by the Architect.
- D. Isolation Joints in Slabs-on-Grade: Provide at all location where slab meet vertical surface, at other locations where slab must be able to move freely and where indicated.
1. Terminate full-width joint-filler strips not less than 1/2 inch (13 mm) or more than 1 inch (25 mm) below finished concrete surface to receive joint sealants as specified in Section 07 92 00 "Joint Sealants". Use removable guide strip or similar means to maintain consistent depth.
 2. At exterior slabs, locate an isolation joint in all concrete walks and slabs where two walkways meet or where walkways meet larger slabs.
 3. Provide at approximately 30 feet on center where not indicated otherwise.

3.6 UNDER SLAB VAPOR BARRIER

- A. Install vapor retarder under interior slabs on grade in conformance with ASTM E 1643 and manufacturer's recommendations. Lap joints minimum 6 inches (150 mm) and seal watertight by taping edges and ends. Repair damaged vapor retarder before pouring concrete. Maintain a continuous barrier.

3.7 CONCRETE PLACEMENT

- A. Notify Architect and testing agency not less than 24 hours before commencement of placement operations.
- B. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections are completed.
 - 1. Verify that forms are clean and that release agents are applied.
 - 2. Verify that reinforcement is securely in place and uncontaminated by release agents, dirt or other contaminants that affect bonding.
 - 3. Verify that all embedded items and accessories are in place.
 - 4. Verify placement of reinforcement will permit minimum required cover.
 - 5. Verify formed cavity is free of debris.
- C. Where new concrete is to be bonded to previously placed concrete, prepare existing surface by cleaning with steel brush and applying bonding agent in accordance with manufacturer's instructions.
 - 1. Use latex bonding agent only for non-load-bearing or transferring applications.
- D. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301 (ACI 301M).
 - 1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- E. Place concrete in accordance with ACI 304R.
- F. Place concrete floor slabs in accordance with ACI 301.1R
- G. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
 - 1. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301 (ACI 301M).
 - 2. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches (150 mm) into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.
- H. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
 - 1. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
 - 2. Maintain reinforcement in position on chairs during concrete placement.
 - 3. Screed slab surfaces with a straightedge and strike off to correct elevations.
 - 4. Slope surfaces uniformly to drains where required.
 - 5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

3.8 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
 - 1. Apply to concrete surfaces not exposed to public view.
- B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
 - 1. Apply to concrete surfaces that will be exposed to public view or to be covered with a coating or covering material applied directly to concrete.

3.9 FINISHING FLOORS AND SLABS

- A. General: Comply with ACI 302.1R recommendations for screeding, restraighening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighen until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
 - 1. Apply a trowel finish to surfaces indicated to be exposed.
- C. Trowel and Fine-Broom Finish: Apply where ceramic tile is to be installed. First trowel the surface, then, while concrete is still plastic, slightly scarify surface with a fine broom.
- D. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and elsewhere as indicated.
 - 1. Immediately after float finishing, draw a soft-bristle broom across float-finished concrete surface, perpendicular to line of traffic, to provide a uniform, fine-line texture.

3.10 FLOOR FLATNESS AND LEVELNESS TOLERANCES

- A. Minimum F(F) Floor Flatness and F(L) Floor Levelness Values:
 - 1. Concrete Floor Slabs: F(F) of 25; F(L) of 20, on-grade only.
- B. Measure F(F) and F(L) in accordance with ASTM E1155, within 48 hours after slab installation; report both composite overall values and local values for each measured section.
- C. Correct the slab surface if composite overall value is less than specified and if local value is less than two-thirds of specified value or less than F(F) 13/F(L) 10.
- D. Where deficient concrete finish is identified, correct defects by grinding or by removal and replacement of the defective work. Re-measure corrected areas by the same process.
- E. Other Surfaces:
 - 1. At patches in existing surfaces, match existing surface with no more than 1/4 inch variation in 10 feet within the patch area.
 - 2. At equipment slabs, meet requirements indicated for the equipment.

3. At exterior walks: Follow site contours. Provide 1/8 inch per foot slope to one side of the walkway.
 4. Permit no ponding of water on any surface.
- F. In areas with floor drains, maintain floor elevation at walls; where not indicated otherwise, pitch surfaces uniformly to drains at 1:50 nominal. Permit no ponding.

3.11 MISCELLANEOUS CONCRETE ITEM INSTALLATION

- A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.
- B. Equipment Bases and Foundations:
1. Coordinate sizes and locations of concrete bases with actual equipment provided.
 2. Construct concrete bases 4 inches (100 mm) high unless otherwise indicated, and extend base not less than 6 inches (150 mm) in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated or unless required for seismic anchor support.
 3. Minimum Compressive Strength: 4000 psi (27.6 MPa) at 28 days, unless otherwise indicated.
 4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.

3.12 CONCRETE PROTECTING AND CURING

- A. Comply with requirements of ACI 308R. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
- B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.
1. Normal concrete: Not less than 7 days.
 2. High early strength concrete: Not less than 4 days.
- C. Cure all surface according to the approved Curing Proposal. (See under Submittals).
- D. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
1. Moisture Curing.
 2. Moisture-Retaining-Cover Curing.
 3. Curing Compound. Curing compound shall not interfere with application of finish material or scheduled sealer.
- E. Verify all curing methods are compatible with scheduled finishes.
- F. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for remainder of curing period.
- G. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.

H. Form Removal

1. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads. Leave forms in place for minimum number of days as specified in ACI 347.
 - a. Leave forms in place until concrete has reached at least 75% of its design strength but in no case remove forms supporting horizontal surfaces in less than 3 days.
 - b. Where horizontal surfaces are to be loaded before 28-day strength is reached, including for supporting forms for additional concrete work, re-shore slab as necessary to support applied weight.
2. Loosen forms carefully. Do not wedge pry bars, hammers, or tools against finish concrete surfaces scheduled for exposure to view.

3.13 CONCRETE SURFACE REPAIRS

- A. Defective Concrete: Concrete not conforming to required lines, details, dimensions, tolerances or specified requirements or concrete which fails to result in the specified appearance.
- B. Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.
- C. When replacement or repair is required, the Contractor shall replace or repair in a timely manner.
- D. Do not patch, fill, touch-up, repair, or replace exposed concrete except upon express direction of Architect for each individual area.

3.14 QUALITY CONTROL

- A. Special Inspections: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Inspections:
 1. Steel reinforcement placement.
 2. Steel reinforcement welding.
 3. Headed bolts and studs.
 4. Verification of use of required design mixture.
 5. Concrete placement, including conveying and depositing.
 6. Curing procedures and maintenance of curing temperature.
 7. Verification of concrete strength before removal of shores and forms from beams and slabs.
- C. Concrete Tests: Testing of samples of fresh concrete obtained according to ASTM C 172/C 172M shall be performed according to the following requirements:
 1. Testing Frequency: Obtain one sample for each day's pour of each concrete mixture exceeding 5 cu. yd. (4 cu. m), but less than 25 cu. yd. (19 cu. m), plus one set for each additional 50 cu. yd. (38 cu. m) or fraction thereof.
 2. Slump: ASTM C 143/C 143M; one test at point of placement for each sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
 3. Air Content: ASTM C 231/C 231M, pressure method, for normal-weight concrete; not less often than once in the morning and once at mid-day when air-entrained concrete is placed.

4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F (4.4 deg C) and below or 80 deg F (27 deg C) and above, and one test for each sample.
 5. Unit Weight: ASTM C 567/C 567M, fresh unit weight of structural lightweight concrete; one test for each sample, but not less than one test for each day's pour of each concrete mixture.
 6. Compression Test Specimens: ASTM C 31/C 31M.
 - a. Cast and laboratory cure three standard cylinder specimens for each sample.
 - b. Cast and field cure (1) one standard cylinder specimens for each sample.
 7. Compressive-Strength Tests: ASTM C 39/C 39M; test one laboratory-cured specimens at 7 days and two specimens at 28 days.
 - a. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same sample and tested at age indicated.
- D. If tests show that the installed concrete failed in any of the performance requirement as defined in these Contract Documents, the Design Professional, in consultation with the Owner and the Contractor, will direct removal and replacement of the failed concrete or compensation to the Owner to accept the concrete as installed or other remedy as appropriate.
1. The Contractor shall promptly execute the correction or adjustment as directed.

3.15 LIQUID FLOOR TREATMENT APPLICATION

- A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment according to manufacturer's written instructions.
1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
 2. Apply as recommended by treatment manufacturer, but not less than two coats. Apply at the earliest time after placing that is recommended by the manufacturer.
 3. Apply to all interior concrete left exposed in the final Project, unless noted otherwise.
 4. Apply minimum of two coats.

3.16 PROTECTION OF LIQUID FLOOR TREATMENTS

- A. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.

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SECTION 03 48 00

PRECAST CONCRETE SPLASH BLOCKS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Precast Concrete Splash Blocks – Grade Only.

1.2 RELATED SECTIONS

- A. Section 03 30 00 - Cast-in-Place Concrete.

1.3 REFERENCES

- A. ASTM C 136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
- B. ASTM C 293 - Standard Test Method for Flexural Strength of Concrete.

1.4 SUBMITTALS

- A. Submit under provisions of Section 01 33 23 – Shop Drawings, Product Data and Samples.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Preparation instructions and recommendations.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: All primary products specified in this section will be supplied by a single manufacturer with a minimum of three (3) years experience.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Transport, store and handle precast concrete splash blocks in accordance with manufacturers written instructions.
- B. Transport and store splash blocks so that edges and corners of treads are not damaged.

1.7 WARRANTY

- A. At project closeout, provide to Owner or Owners Representative an executed copy of the manufacturer's standard limited warranty against manufacturing defect, outlining its terms, conditions, and exclusions from coverage.
 - 1. Duration: One (1) year from date of substantial completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers:
 - 1. NuCast: Precast Steps & Concrete Products; Splash Blocks (wet-pour).

2.2 MATERIALS

- A. Concrete: Comply with requirements in Division 3 Section "Cast-in-Place Concrete" for normal-weight, ready-mixed concrete with a minimum 28-day compressive strength of 4000 psi and a total air content of not less than 4 percent or more than 6 percent.
- B. Flexural Strength: 2500 to 3000 psi in accordance with ASTM C 293.
- C. Water Absorption: 3 to 4 percent absorption in accordance with ASTM C 67.
- D. Aggregate: Report sieve analysis in accordance with ASTM C 136.
- E. Water: Potable.
- F. Color: Standard Gray
- G. Splash Block Dimensions:
 - 1. 11" x 30" x 3" inches

2.3 PRECAST CONCRETE SPLASH BLOCK FINISHES

- A. Surfacing: Smooth finish.
- B. Edges to form a 2 to 2 1/2 inch radius.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for, installation tolerances and other conditions affecting performance of work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean surfaces thoroughly prior to installation.

3.3 INSTALLATION, GENERAL

- A. Set units accurately in location, alignment, and elevation. Set units below each downspout and to drain water away from the building.

3.4 FIELD QUALITY CONTROL

- A. Appearance of Finished Work: Variations in appearance to adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable.

3.5 PROTECTION

- A. Protect installed products until completion of project.
- B. Protect finishes on exposed surfaces from damage during manufacture and installation.
- C. Repair or replace damaged products before Substantial Completion.

3.6 SCHEDULE

- A. Precast splash blocks at all downspout locations at grade.
- B. Provide (1) splash block per downspout.
 - 1. Verify quantity of locations with drawings and site conditions.

END OF SECTION

SECTION 04 01 27

MASONRY REPOINTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Repointing of existing masonry.
- B. Related Requirements
 - 1. Section 04 20 00 "Unit Masonry".

1.2 DEFINITIONS

- A. Rebuilding (Setting) Mortar: Mortar used to set and anchor masonry in a structure, distinct from pointing mortar installed after masonry is set in place.
- B. Pointing Mortar: Mortar used to point or partial fill joints in masonry that has been previously set.

1.3 SUBMITTALS

- A. Product Data: Mortar materials and mixes.
- B. Sample: Proposed replacement bricks, if required.
- C. Installers Qualifications: Submit qualifications as described under Quality Assurance.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Company shall have at least 5 years of experience doing similar type of masonry repointing.
 - 2. Individual supervising the installation shall have at least 5 years of experience making similar repairs, at least 2 years of which must be repair work.
 - 3. Provide at least 3 projects showing similar work performed by or under the direction of the individual who will direct this work.
- B. Comply with provisions of ACI 530/ASCE 5/TMS 402 and ACI 530.1/ASCE 6/TMS 602, except where exceeded by requirements of the Contract Documents.
- C. Conform to BIA 46 - Maintenance of Brick Masonry, Tech Notes 46 by the Brick Industry Association.

PART 2 - PRODUCTS

2.1 REPLACEMENT BRICKS

- A. Match Existing.

2.2 MORTAR MATERIALS

- A. Conform to Section 04 20 00 "Unit Masonry".

2.3 MORTAR MIXING

- A. Pointing Mortar: Conform to ASTM C270, Property Specification, Type N, unless noted otherwise.

PART 3 - EXECUTION

3.1 GENERAL

- A. Provide sheeting or other protection for adjacent and nearby surfaces as necessary to prevent damage as a result of grinding or mortaring.
- B. Conform to BIA 46.

3.2 BRICK REPLACEMENT

- A. Before beginning work, examine surfaces for damaged bricks.
- B. If bricks are found to be damaged or have open penetrations or holes, request direction from Architect.
- C. If directed by Architect, replace damaged brick with match bricks in good condition as a part of the repointing.

3.3 MORTAR JOINT PREPARATION

- A. Remove mortar from joints to depth of 2-1/2 times joint width, but 1) not less than 1/2 inch, or 2) not less than that required to expose sound, unweathered mortar.
- B. Remove additional loose or disintegrated mortar as necessary to reach sound mortar.
- C. Remove mortar from surfaces within raked-out joints to provide reveals with square backs and to expose masonry for contact with pointing mortar. Brush, vacuum, or flush joints to remove dirt and, loose debris.
- D. If it is clear that sound mortar will not be reached at an average depth of 1" or more from the face of the brick, advise the Owner and the Architect and await further instructions before re-pointing.
- E. Where existing reinforcing is encountered, do not damage or displace reinforcing during removal of old mortar or installation of new mortar.
- F. Do not damage or spall edges of masonry units or widen joints. Replace or patch damaged masonry units as directed by Architect. Use of one of the following procedures is recommended:
 - 1. Cut out center of mortar joints using angle grinders with diamond-impregnated metal blades. Remove remaining mortar by hand with chisel and mallet.
 - 2. Use only hand tools to remove mortar.
 - 3. Architect/Engineer will consider use of power tools designed for fine joint removal upon request and demonstration by the Contractor that such tools can be used without damage to the brick.

- G. Joint Cleaning: When mortar removal is complete, remove dust and loose material with air jet or very low pressure water jet.
- H. Notify Architect of unforeseen detrimental conditions including voids in mortar joints, cracks, loose stone, rotted wood, rusted metal, and other deteriorated items.

3.4 REPOINTING

- A. Point all joints in a manner that eliminates the need for high-pressure washing or the use of strong acidic compounds. Protect all ledges, sills, belt courses and other surfaces where mortar droppings might collect using poly plastic or other sheeting as necessary.
- B. Verify that joint is clean and ready for repointing. If joint cleaning after mortar removal occurred more than 24 hours before repointing begins, reclean joints before repointing.
- C. Pre-moisten all surfaces to be in contact with new mortar. Surfaces should be saturated with no standing water or "wet reflections" (SSD - saturated/surface dry).
- D. Apply mortar in maximum 1/4 inch layers, tightly packed.
- E. Apply pointing mortar first to areas where existing mortar was removed to depths greater than surrounding areas. Apply in layers not greater than 1/4 inch until a uniform depth is formed.
- F. If reinforcing is exposed during mortar removal, installation of new mortar shall include tightly packing all around existing reinforcing. Permit no voids.
- G. Allow each layer to dry to "thumb print hard" before applying next layer
- H. Where existing brick has worn or rounded edges, slightly recess finished mortar surface below face of stone to avoid widened joint faces. Take care not to spread mortar over edges onto exposed brick surfaces or to featheredge mortar.
- I. When final layer of mortar is thumb print hard, tool joints to match original appearance of joints. Remove excess mortar from edge of joint by brushing.
- J. Cure mortar by maintaining in thoroughly damp condition for at least 72 hours, including weekends and holidays.
 - 1. Acceptable curing methods include covering with wet burlap and plastic sheeting, periodic hand misting, and periodic mist spraying using system of pipes, mist heads, and timers.
 - 2. Adjust curing methods to ensure that pointing mortar is damp throughout its depth without eroding surface mortar.

3.5 SPECIAL JOINTS

- A. All upward facing joint (such as at brick sills) and all horizontal joints that are adjacent to a horizontal surface (such as at corbels) shall be filled with sealant.
 - 1. Remove mortar as required for installation of backer rod and sealant as specified. If mortar has to be removed deeper than required for backer rod, restore mortar to recommended depth as described for repointing.
 - 2. Install backer and sealant as specified in Section 07 90 00.

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SECTION 04 20 00

UNIT MASONRY

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes
 - 1. Concrete Block.
 - 2. Clay face brick.
 - 3. Reinforcement and Anchorage.
 - 4. Accessories.
- B. Related Requirements
 - 1. Section 04 01 27 - Masonry Repointing.

1.2 ACTION SUBMITTALS

- A. Product Data: Provide data for masonry units, fabricated wire reinforcement, mortar, and masonry accessories.
- B. Tests and Observation Reports:
 - 1. Concrete Masonry: Tests as required by ACI 530.1.
 - 2. Field Tests and Observations: Provide written record of tests and observations performed at the site, including report the results of any quantitative tests.
- C. Field Quality Control Proposal: Provide a description of how mortar will be evaluated in the field to ensure that mortar being used on the site conforms to the mix design and strength requirements of the project. Proposal must be approved the Design Professional before masonry work begins.
 - 1. Proposal shall include a schedule of periodic written reports during active times for masonry work at the site describing the conformance to the proposal.

1.3 INFORMATIONAL SUBMITTALS

- A. Manufacturer's Certificate: Certify that masonry units meet or exceed specified requirements.
- A. Reports: For factor blended mortar mixes, provide test results from the last 12 month period showing that the proportions conform to ASTM C 270 and the compressive strength conform to the requirement for the type of mortar indicated when tested according to ASTM C 780.
- B. Field Quality Control Reports.

1.4 QUALITY ASSURANCE

- A. Comply with provisions of TMS 402/602 "Building Code Requirements and Specification for Masonry Structures", except where exceeded by requirements of the contract documents.

1.5 FIELD CONDITIONS

- A. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 402/602.
- B. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 402/602.

PART 2 - PRODUCTS

2.1 CONCRETE MASONRY UNITS

- A. Concrete Block: Comply with referenced standards and as follows:
 - 1. Size: Standard units with nominal face dimensions of 16 x 8 inches (400 x 200 mm) and nominal depth of 8 inches (200 mm) and 6 inches (150 mm).
 - 2. Layout: Running bond.
 - 3. Non-Loadbearing Units: ASTM C129.
 - a. Hollow block.
 - 4. Interior Exposed Concrete Block:
 - a. Provide bull-nose units at all exposed outside corners and at opening jambs.

2.2 BRICK

- A. Modular Face Brick Basis-of-Design:
 - 1. Glen-Gery, Sioux City Brick: Red Velour
- B. Monarch Face Brick Basis-of-Design:
 - 1. Interstate Brick: Bronzestone (Utility)

2.3 MORTAR AND GROUT MATERIALS

- A. Portland Cement: ASTM C 150/C 150M, Type IL or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
- B. Hydrated Lime: ASTM C 207, Type S.
- C. Masonry Cement: ASTM C91, Types as indicate.
- D. Mortar Cement: ASTM C 1329, Types as indicated.
- E. Aggregate for Mortar: ASTM C 144.
- F. Aggregate for Grout: ASTM C 404.
- G. Packaged Dry Mortar: ASTM C387/C387M, Type as indicated, using gray color cement.
- H. Cold-Weather Admixture: Cold-weather admixtures shall not be used unless specifically approved in writing by the Architect. If used, they must be use consistently throughout the Project.

- I. Water: Potable.

2.4 REINFORCEMENT AND ANCHORAGE

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed, uncoated.
- B. Multiple Wythe Joint Reinforcement: Truss or ladder type; ASTM A 82/A 82M steel wire, hot dip galvanized after fabrication to ASTM A 153/153M, Class B; 0.1483 inch (3.8 mm) side rods with 0.1483 inch (3.8 mm) cross rods; width as required to provide not more than 1 inch (25 mm) and not less than 1/2 inch (13 mm) of mortar coverage at interior exposure and not less than 3/4 inch at exterior exposure.

2.5 MASONRY CLEANER

- A. Cleaner: Non-acidic, not harmful to masonry work or adjacent materials. Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.

2.6 MORTAR AND GROUT MIXES

- A. Contractor may use preblended, dry mortar mix or may site mix from raw portland cement, hydrated lime and sand.
- B. This Project will permit either ready-mix or site mixed mortar and grout at the Contractor's option.
- C. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.
 - 1. Do not use calcium chloride in mortar or grout.
- D. Mortar for Unit Masonry: Comply with ASTM C 270, Property Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.
 - 1. For exterior, above-grade, non-load-bearing walls, and for interior non-load-bearing partitions; and for other applications where another type is not indicated, use Type N.
 - 2. Pointing Mortar: use Type N.

2.7 MORTAR MIXING

- A. Thoroughly mix mortar ingredients using mechanical batch mixer, in accordance with ASTM C270 and in quantities needed for immediate use.
- B. Maintain sand uniformly damp immediately before the mixing process.
- C. Do not use anti-freeze compounds to lower the freezing point of mortar.
- D. If water is lost by evaporation, re-temper only within two hours of mixing.

2.8 GROUT MIXES

- A. Bond Beams, Lintels, and Reinforced Cores: 3,000 psi (21 MPa) strength at 28 days; 8-10 inches (200-250 mm) slump; mix in accordance with ASTM C 476.

2.9 GROUT MIXING

- A. Thoroughly mix grout ingredients in quantities needed for immediate use in accordance with ASTM C476 for fine and coarse grout.
- B. Do not use anti-freeze compounds to lower the freezing point of grout.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.
- B. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects are exposed in the completed Work and will be within 20 feet (6 m) vertically and horizontally of a walking surface.

3.2 COURSING AND BONDING

- A. Brick infill to match coursing of existing brick. CMU coursing to be established as necessary to accommodate brick coursing.
- B. Establish lines, levels, and coursing indicated. Protect from displacement.
- C. Maintain masonry courses to uniform dimension. Form vertical and horizontal joints of uniform thickness.
- D. Match existing brick bond and joint configuration.

3.3 PLACING

- A. Lay hollow masonry units with face shell bedding on head and bed joints.
- B. Lay hollow brick as follows:
 - 1. Bed face shells in mortar and make head joints of depth equal to bed joints.
 - 2. Bed webs in mortar in grouted masonry, including starting course on footings.
 - 3. Fully bed entire units, including areas under cells, at starting course on footings where cells are not grouted.
- C. Buttering corners of joints or excessive furrowing of mortar joints is not permitted.
- D. Remove excess mortar and mortar smears as work progresses.
- E. Interlock intersections and external corners.

- F. Do not shift or tap masonry units after mortar has achieved initial set. Where adjustment must be made, remove mortar and replace.
- G. Perform job site cutting of masonry units with proper tools to provide straight, clean, unchipped edges. Prevent broken masonry unit corners or edges.
- H. Where surround brick is being repointed, set new brick with mortar removed to 1/4 inch from brick face. Then point the new brick at the same time that the existing brick is pointed.
- I. Tool exposed joints to match existing when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.
- J. Inside corners to be raked and sealant installed at all locations where CMU walls abut adjacent CMU walls.

3.4 MASONRY-JOINT REINFORCEMENT

- A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 19 mm (3/4 inch) on exterior side of walls, 13 mm (1/2 inch) elsewhere. Lap reinforcement a minimum of 150 mm (6 inches).
 - 1. Space reinforcement not more than 406 mm (16 inches) o.c.
 - a. Where reinforcing is found in existing wall, match and tie into.
 - 2. Provide reinforcement in first two joints above and below wall openings and extending 305 mm (12 inches) beyond openings in addition to continuous reinforcement.
 - 3. Place continuous joint reinforcement in first and second joint below top of walls.
- B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.
- C. Cut and bend reinforcing units as directed by manufacturer for continuity at returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.5 VERTICAL REINFORCING

- A. Provide vertical bar in first core of CMU on each side or each open, where work is new or modified.

3.6 GROUTING

- A. Work grout into masonry cores and cavities to eliminate voids.
- B. Do not install grout in lifts greater than 16 inches (400 mm) without consolidating grout by rodding.
- C. Do not displace reinforcement while placing grout.

3.7 LINTELS

- A. Install loose steel lintels over openings.

3.8 BUILT-IN WORK

- A. As work progresses, install built-in metal door frames and anchor bolts and other items to be built into the work and furnished under other sections.
- B. Install built-in items plumb, level, and true to line.

- C. Bed anchors of metal door and glazed frames in adjacent mortar joints. Fill frame voids solid with grout.
 - 1. Fill adjacent masonry cores with grout minimum 12 inches (300 mm) from framed openings.
- D. Do not build into masonry construction organic materials that are subject to deterioration.

3.9 UPWARD EXPOSED JOINTS

- A. All upward facing joint (such as at brick sills) and all horizontal joints that are adjacent to a horizontal surface (such as the top side of corbels) shall be filled with sealant.
 - 1. Remove mortar as required for installation of backer rod and sealant as specified.
 - 2. Install backer and sealant as specified in Section 07 90 00.

3.10 TOLERANCES

- A. Conform to the most restrictive of tolerances as indicated in the following:
 - 1. TMS 402/602 s
 - 2. Brick Industry Association (BIA) Technical Notes 11C - Guide Specifications for Brick Masonry - Part 4

3.11 FIELD QUALITY CONTROL

- A. Provide all test and observations as required by ACI 530.1 and applicable building codes.
- B. Provide testing and observations as indicated in approved Field Quality Control Proposal.
- C. Grout Tests: Test each type of grout in accordance with ASTM C 1019, testing once every 5 cubic yards of grout used or at least once per day when grout is used.

3.12 CLEANING

- A. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
 - 1. Maintain cavity free of mortar droppings
- B. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
 - 1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
 - 2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes.
 - 3. Protect adjacent surfaces from contact with cleaner.
 - 4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water. Conform to recommendation of masonry

3.13 MASONRY WASTE DISPOSAL

- A. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.
- B. Masonry Waste Recycling: Return broken CMUs to manufacturer for recycling.

- C. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above or recycled, and other masonry waste, and legally dispose of off Owner's property.

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SECTION 05 50 00
METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Miscellaneous steel framing and supports.
 - 2. Loose bearing and leveling plates.

1.2 ACTION SUBMITTALS

- A. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable.

PART 2 - PRODUCTS

2.1 METALS

- A. 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.
- B. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- C. Steel Tubing: ASTM A 500/A 500M, cold-formed steel tubing.
- D. Steel Pipe: ASTM A 53/A 53M, Standard Weight (Schedule 40) unless otherwise indicated.
- E. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.

2.2 FASTENERS

- A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
- B. Cast-in-Place Anchors in Concrete: Either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F 2329.
- C. Post-Installed Anchors: Chemical anchors.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, unless otherwise indicated.

2.3 MISCELLANEOUS MATERIALS

- A. Shop Primers: Provide primers that are compatible with finish coatings specified in Section 09 90 00 "Painting and Coating."
- B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
 1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
- C. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.
- E. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.4 FABRICATION, GENERAL

- A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Use connections that maintain structural value of joined pieces.
- B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges. Remove sharp or rough areas on exposed surfaces.
- C. Weld corners and seams continuously to comply with the following:
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.
 4. At exposed connections, finish exposed welds and surfaces smooth and blended.
- D. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Locate joints where least conspicuous.
- E. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors not less than 8 inches (200 mm) from ends and corners of units and 24 inches (600 mm) o.c.

2.5 MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.
- B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.

- C. Lintels: Steel angles; galvanize and prime paint finish.

2.6 FINISHES, GENERAL

- A. Finish metal fabrications after assembly.

2.7 STEEL AND IRON FINISHES

- A. All steel to be galvanized and prime painted, unless noted otherwise.
- B. Galvanizing: Hot-dip galvanize all carbon steel items unless noted otherwise to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.
- C. Shop prime iron and steel items including those indicated to be galvanized unless they are to be embedded in or in bonding contact with concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.
 - 1. Shop prime with universal shop primer, compatible with galvanize substrate and any scheduled finish coating, unless indicated.
- D. Prepare for shop priming as recommended by primer manufacturer for substrate.
- E. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean and strip primed steel items to bare metal where site welding is required.
- B. Supply setting templates to the appropriate entities for steel items required to be cast into concrete or embedded in masonry.

3.2 INSTALLATION

- A. Install items plumb and level, accurately fitted, free from distortion or defects.
- B. Provide for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.
- C. Obtain approval prior to site cutting or making adjustments not scheduled.
- D. After erection, touch up damaged zinc coatings and prime welds, abrasions, and surfaces not shop primed or galvanized, except surfaces to be in contact with concrete.

3.3 TOLERANCES

- A. Maximum Variation from Plumb: 1/4 inch (6 mm) per story, non-cumulative.
- B. Maximum Offset from True Alignment: 1/4 inch (6 mm).

- C. Maximum Out-of-Position: 1/4 inch (6 mm).

3.4 ADJUSTING AND CLEANING

- A. Galvanized Surfaces: Clean field welds, bolted connections, abraded areas and repair galvanizing to comply with ASTM A 780/A 780M.
- B. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

END OF SECTION

SECTION 06 10 00
ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Minor framing for door, window and roof openings.
 - 2. Wood blocking and Nailers.
 - 3. Plywood backing panels.
 - 4. Wood treatments.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product.
 - 1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements

1.3 INFORMATIONAL SUBMITTALS

- A. Material Certificates: For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.

1.4 QUALITY ASSURANCE

- A. Lumber: Comply with PS 20 and approved grading rules and inspection agencies.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. General: Cover wood products to protect against moisture. Support stacked products to prevent deformation and to allow air circulation.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

- A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
 - 1. Factory mark each piece of lumber with grade stamp of grading agency.
 - 2. Provide dressed lumber, S4S, unless otherwise indicated.
- B. Maximum Moisture Content of Lumber: 19 percent unless otherwise indicated.
- C. Engineered Wood Products: Provide engineered wood products acceptable to authorities

having jurisdiction and for which current model code research or evaluation reports exist that show compliance with building code in effect for Project.

1. Allowable Design Stresses: Provide engineered wood products with allowable design stresses, as published by manufacturer that meet or exceed those indicated. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.

2.2 WOOD-PRESERVATIVE-TREATED LUMBER

- A. Preservative Treatment by Pressure Process: AWPAC U1; Use Category UC2 for interior construction not in contact with the ground, Use Category UC3b for exterior construction not in contact with the ground, and Use Category UC4a for items in contact with the ground.
 1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium. Do not use inorganic boron (SBX) for sill plates.
- B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or that does not comply with requirements for untreated material.
- C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
- D. Application: All wood to be installed in the Project is to be preservative treated.

2.3 DIMENSION LUMBER FRAMING

- A. Non-Load-Bearing Interior Partitions: Construction, Stud, or No. 3 grade.
- B. Structural Framing including Jamb and Header Framing at Openings:
 1. Species: One of the following
 - a. Southern pine; SPIB.
 - b. Douglas fir-larch; WCLIB or WWPA.
 2. Grade: No. 2.

2.4 MISCELLANEOUS LUMBER

- A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including for blocking and nailers:
- B. For items of dimension lumber size, provide Standard, Stud, or No. 3 grade lumber of any species.

2.5 PLYWOOD BACKING PANELS

- A. Equipment Backing Panels: Exterior, A-C plywood, in thickness indicated or, if not indicated, not less than 3/4-inch (19-mm) nominal thickness.

2.6 FASTENERS

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

1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.
- B. Power-Driven Fasteners: NES NER-272.
- C. Bolts: Steel bolts complying with ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers.

2.7 METAL FRAMING ANCHORS

- A. Provide all metal framing anchors as indicated or reasonably implied in drawing.
- B. Allowable design loads, as published by manufacturer, shall meet or exceed those of basis-of-design products. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency. Framing anchors shall be punched for fasteners adequate to withstand same loads as framing anchors.
- C. Hot-Dip, Heavy-Galvanized Steel Sheet: ASTM A653/A653M; structural steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); G185 (Z550) coating designation; and not less than 0.036 inch (0.9 mm) thick.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.
- B. Select material sizes to minimize waste.
- C. Reuse scrap to the greatest extent possible; clearly separate scrap for use on site as accessory components, including shims, bracing, and blocking.
- D. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry to other construction; scribe and cope as needed for accurate fit. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.
- E. Comply with AWP A M4 for applying field treatment to cut surfaces of preservative-treated lumber.
- F. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
 1. NES NER-272 for power-driven fasteners.
 2. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.

3.2 BLOCKING, NAILERS, AND SUPPORTS

- A. Provide framing and blocking members as indicated or as required to support finishes, fixtures,

specialty items, and trim.

3.3 INSTALLATION OF CONSTRUCTION PANELS

- A. Communications and Electrical Room Mounting Boards: Secure with screws to studs with edges over firm bearing; space fasteners at maximum 24 inches (610 mm) on center on all edges and into studs in field of board.
- B. Paint with fire retardant paint. See Section 09 90 00 "Painting and Coating".

3.4 CLEANING

- A. Comply with applicable regulations.
- B. Do not burn scrap on project site.
- C. Do not send materials treated with pentachlorophenol, CCA, or ACA to co-generation facilities or "waste-to-energy" facilities.
- D. Do not leave any wood, shavings, sawdust, etc. on the ground or buried in fill.
- E. Prevent sawdust and wood shavings from entering the storm drainage system.

END OF SECTION

SECTION 06 20 23
INTERIOR FINISH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Plastic-laminate-clad architectural cabinets.
 - 2. Cabinet hardware and accessories.
 - 3. Miscellaneous materials.
- B. Related Requirements:
 - 1. Section 06 10 00 "Rough Carpentry" for wood furring, blocking, shims, and hanging strips required for installing cabinets that are concealed within other construction before cabinet installation.
 - 2. Section 06 61 13 "Solid Surface Fabrications" for countertops.

1.2 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to support loads imposed by installed and fully loaded cabinets.
 - 1.

1.3 ACTION SUBMITTALS

- A. Product Data:
 - 1. Plastic-laminate-clad architectural cabinets.
 - 2. Cabinet hardware and accessories.
 - 3. Miscellaneous materials.
- B. Product Data Submittals: For each product.
 - 1. Include data for fire-retardant treatment from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.
- C. Shop Drawings:
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
 - 3. Show locations and sizes of cutouts and holes for items installed in plastic-laminate architectural cabinets.

1.4 CLOSEOUT SUBMITTALS

- A. Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Do not deliver cabinets until painting and similar finish operations that might damage architectural cabinets have been completed in installation areas. Store cabinets in installation areas or in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.

1.6 FIELD CONDITIONS

- A. Environmental Limitations without Humidity Control: Do not deliver or install cabinets until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during the remainder of the construction period.
- B. Field Measurements: Where cabinets are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
 - 1. Locate concealed framing, blocking, and reinforcements that support cabinets by field measurements before being enclosed/concealed by construction and indicate measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS

- A. Quality Standard: Unless otherwise indicated, comply with the Architectural Woodwork Standards for grades of cabinets indicated for construction, finishes, installation, and other requirements.
- B. Architectural Woodwork Standards Grade: Custom.
- C. Door and Drawer-Front Style: Flush overlay.
 - 1. Reveal Dimension: 1/2 inch (13 mm).
- D. High-Pressure Decorative Laminate: ISO 4586-3, grades as indicated or if not indicated, as required by quality standard.
- E. Exposed Surfaces:
 - 1. Plastic-Laminate Grade: VGS
 - 2. Edges: PVC edge banding, 3.0 mm thick, matching laminate in color, pattern, and finish].
 - 3. Pattern Direction: Vertically for drawer fronts, doors, and fixed panels.
- F. Semiexposed Surfaces:
 - 1. Surfaces Other Than Drawer Bodies: High-pressure decorative laminate, ISO 4586-3.
 - a. Edges of Plastic-Laminate Shelves: PVC edge banding, 3.0 mm thick, matching laminate in color, pattern, and finish.
 - b. Edges of Thermally Fused Laminate Panel Shelves: PVC or polyester edge banding.

- c. For semiexposed backs of panels with exposed plastic-laminate surfaces, provide surface of high-pressure decorative laminate, ISO 4586-3, grade to match exposed surface.
- 2. Drawer Sides and Backs: Thermally fused laminate panels with PVC or polyester edge banding.
- 3. Drawer Bottoms: Thermally fused laminate panels.
- G. Drawer Construction: Fabricate with exposed fronts fastened to subfront with mounting screws from interior of body.

2.2 CABINET PANEL MATERIALS

- A. Core: Medium Density Fiberboard (MDF): ANSI A208.2; type as specified in AWI/AWMAC Architectural Woodwork Quality Standards Illustrated; composed of wood fibers pressure bonded with moisture resistant adhesive to suit application; sanded faces; thickness as required. Wood plywood also permitted.
 - 1. At wet location, including at sinks, provide water resistant MDF Board as follows:
 - a. Medium Density Fiberboard engineered for high moisture resistance.
 - b. Water Absorption: 5% maximum when tested per ASTM D 1037.
 - c. Thickness Swell: 3% maximum when tested per ASTM D 1037.
 - d. Design Basis: Medex by SierraPine Composite Solutions.
- B. High-Pressure Decorative Laminate (HPDL): NEMA LD 3, grades as indicated or if not indicated, as required by woodwork quality standard.
 - 1. Colors, Patterns, and Textures: As selected by Architect from manufacture's full range
- C. Thermoset Decorative Panels (Melamine, LPDL): Particleboard or medium-density fiberboard finished with thermally fused, melamine-impregnated decorative paper complying with requirements of NEMA LD 3, Grade VGL, for test methods 3.3, 3.4, 3.6, 3.8, and 3.10.
 - 1. Semi-Exposed: Color as approved by Architect.
 - 2. Concealed: [Manufacturer's standard] [White] [Black].
 - 3. Edge Banding: Flexible, flat PVC banding, nominally 0.118 inches (3 mm), thick with eased edges. Provide on exposed shelf edges.

2.3 CABINET HARDWARE AND ACCESSORIES

- A. Cabinet Hardware: Provide cabinet hardware and accessory materials associated with architectural cabinets except for items specified in Section 08 71 00 "Door Hardware."
- B. Frameless Concealed Hinges (European Type): ANSI/BHMA A156.9, B01602, 100 degrees of opening.
- C. Wire Pulls: Back mounted, solid metal, 4 inches (100 mm) long, 5/16 inch (8 mm) in diameter.
- D. Shelf Rests: ANSI/BHMA A156.9, B04013; metal.
- E. Drawer Slides: ANSI/BHMA A156.9.
 - 1. Standard Duty (Grade 1 and Grade 2): Side mount.

2. General-purpose drawers more than 3 inches (75 mm) high, but not more than 6 inches (150 mm) high and not more than 24 inches (600 mm) wide, provide 75 lb (34 kg) load capacity.
 3. Stops: Integral type.
 4. Provide self-closing/stay closed type.
- F. Door and Drawer Silencers: ANSI/BHMA A156.16, L03011.
- G. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with ANSI/BHMA A156.18 for ANSI/BHMA finish number indicated.
1. Satin Chromium Plated: ANSI/BHMA 626 for brass or bronze base; ANSI/BHMA 652 for steel base.

2.4 MISCELLANEOUS MATERIALS

- A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln-dried to less than 15 percent moisture content.
- B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.
- C. Adhesives: Do not use adhesives that contain urea formaldehyde.

2.5 FABRICATION

- A. Fabricate architectural cabinets to dimensions, profiles, and details indicated.
- B. Complete fabrication, including assembly and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
- C. Shop-cut openings to maximum extent possible to receive hardware, appliances, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Before installation, condition cabinets to humidity conditions in installation areas for not less than 72 hours.

3.2 INSTALLATION

- A. Architectural Woodwork Standards Grade: Install cabinets to comply with quality standard grade of item to be installed.

- B. Assemble cabinets and complete fabrication at Project site to extent that it was not completed in the shop.
- C. Anchor cabinets to anchors or blocking built in or directly attached to substrates. Secure with wafer-head cabinet installation screws.
- D. Install cabinets level, plumb, and true in line to a tolerance of 1/8 inch in 96 inches (3 mm in 2400 mm) using concealed shims.
 - 1. Scribe and cut cabinets to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
 - 2. Install cabinets without distortion so doors and drawers fit openings and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.

3.3 ADJUSTING AND CLEANING

- A. Repair damaged and defective cabinets, where possible, to eliminate functional and visual defects. Where it is not possible to repair, replace architectural cabinets. Adjust joinery for uniform appearance.
- B. Clean, lubricate, and adjust hardware.
- C. Clean cabinets on exposed and semi exposed surfaces.

END OF SECTION

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SECTION 06 61 13
SOLID SURFACE FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes
 - 1. Solid polymer counter tops and windowsills.
- B. Related Requirements
 - 1. Section 06 10 00 - Rough Carpentry
 - 2. Section 06 20 23 – Interior Finish Carpentry

1.2 ACTION SUBMITTALS

- A. Product data: Indicate product description, fabrication information and compliance with specified performance requirements.
- B. Shop drawings: Indicate dimensions, component sizes, fabrication details, attachment provisions and coordination requirements with adjacent work.
- C. Samples: Submit minimum 6" x 6" (50 mm x 50 mm) samples, in specified color and gloss. Where variation occurs in the pattern or color, provide a sample or samples showing the full range. Approved samples will be retained as standards for work.

1.3 CLOSEOUT SUBMITTALS

- A. Maintenance data: Submit manufacturer's care and maintenance data, including repair and cleaning instructions. Include in project close-out documents.

1.4 QUALITY ASSURANCE

- A. Fabricator/installer shall have a minimum of three years of experience working with solid surface materials and shall be able to show a minimum of at least three successfully fabricated and installed projects of similar size and scope.

1.5 DELIVERY, STORAGE, AND PROTECTION

- A. Deliver no components to project site until areas are ready for installation. Store components indoors prior to installation.
- B. Handle materials to prevent damage to finished surfaces. Provide protective coverings to prevent physical damage or staining following installation for duration of project.

1.6 WARRANTY

- A. Provide manufacturers' 10-year warranty against defects in materials. Warranty shall provide material and labor to repair or replace defective materials. Damage caused by physical or chemical abuse or damage from excessive heat is excluded.

PART 2 - PRODUCTS

2.1 MANUFACTURERS/PRODUCTS

- A. See Section 09 06 00 – Schedule of Finishes

2.2 MATERIALS

- A. Solid Polymer Surfaces must be homogeneous non-porous filled acrylic and aluminum trihydrate filler and pigment. Body color and pattern must be through color and pattern; not coated, laminated or of composite construction. Must meet the requirements of ANSI Z124.3 & .6, Type Six.
 - 1. Superficial damage to a depth of 0.010 inch shall be repairable by sanding and polishing.
- B. Performance characteristics:
 - 1. Tensile Strength: 6000 psi min per ASTM D 638
 - 2. Tensile Modulus: 1.5×10^6 psi min per ASTM D 638
 - 3. Flexural Strength: 10000 psi min per ASTM D 790.
 - 4. Flexural Modulus: 1.2×10^6 psi min per ASTM D 790
 - 5. Elongation: 0.4% min. per ASTM D 638
 - 6. Color Stability: No change, 100 hours min. per NEMA LD3-3.10.
 - 7. Wear and Cleanability: Passes ANSI Z124.3
 - 8. Boiling water Surface Resistance: No Change per NEMA LD3-3.05
 - 9. High Temperature Resistance: No Change per NEMA LD3-3.06
 - 10. Impact Resistance: Notched Izod Gardner 0.24 ft.-lbs. min. per ASTM D256, Method A.
 - 11. Stain Resistance: Passes ANSI Z124.3
 - 12. Fungi: No Attack per ASTM G21.
 - 13. Specific Gravity: 1.7 min
 - 14. Water Absorption: maximum 0.06% of weight long term for 1/2 inch per ASTM D 570
 - 15. Flammability, ASTM E84,
 - a. Flame spread: 25 max
 - b. Smoke Developed: 25 max

2.3 COMPONENTS

- A. Countertops: Solid surfacing sheet or plastic resin casting self-supporting over structural members.
 - 1. Flat Sheet Thickness: 1/2 inch (12 mm), minimum.
 - 2. Exposed Edge Treatment: Built up to minimum 1½ inch (38 mm) thick unless indicated otherwise on Drawings; radiused edge.
 - 3. Back and End Splashes: Same sheet material, square top; minimum 4 inches (102 mm) high.
- B. Windowsills:
 - 1. Flat Sheet Thickness: 1/2 inch (12 mm), minimum.
 - 2. Exposed Edge Treatment: Built up to minimum 1½ inch (38 mm) thick unless indicated otherwise on Drawings; radiused edge.
- C. Wood blocking and support as required conforming Section 06 10 00.

2.4 ACCESSORIES

- A. Joint adhesive: Manufacturer's standard two-part adhesive kit to create inconspicuous, non-porous joints, with a chemical bond.
- B. Sealant: Manufacturer's standard mildew-resistant, FDA/UL recognized silicone sealant in color matching or clear formulations.

2.5 FABRICATIONS

- A. Fabricate components in shop to greatest extent practical to sizes and shapes indicated, in accordance with approved shop drawings and solid polymer manufacturer requirements.
- B. Counter tops eight feet long and under shall be formed of a single piece (no joints).
- C. Form joints between components using manufacturer's standard joint adhesive. Joints shall be inconspicuous in appearance and without voids. Attach 2" wide reinforcing strip of solid polymer material under each joint.
- D. Provide holes and cutouts for scheduled penetrations, including for plumbing fixtures and fittings, as indicated on the drawings.
- E. Rout and finish component edges to a smooth, uniform finish. Rout all cutouts, then sand all edges smooth. Repair or reject defective or inaccurate work.
- F. Ease all exposed edges.
- G. Backsplash to be glued to countertop.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify adequacy of backing and support framing.

3.2 INSTALLATION

- A. Install plumb and level components, in accordance with approved shop drawings and product installation details.
- B. Keep components and hands clean during installation. Remove adhesives, sealants and other stains. Components shall be clean on date of Substantial Completion.

3.3 TRAINING

- A. Fabricator/Installer is to provide a commercial care and maintenance video, review maintenance procedures and warranty details with the Owner's maintenance personnel upon completion of project.

3.4 CLEANING AND PROTECTION

- A. Clean casework, counters, shelves, hardware, fittings, and fixtures.

- B. Protect surfaces from damage until date of Substantial Completion. Repair or replace damaged work that cannot be repaired to Owner and Architect's satisfaction.

END OF SECTION

SECTION 07 21 00
THERMAL INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Rigid insulation
 - 2. Glass-fiber blanket.
- B. Related Requirements:
 - 1. Section 07 25 00 - Weather Barriers: Separate air barrier and vapor retarder materials.
 - 2. Section 09 21 16 - Gypsum Board Assemblies: Installation in both thermal and acoustical applications.

1.2 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate installation of insulation with specified weather barrier, air barriers and vapor barriers.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each product, for tests performed by a qualified testing agency.
- B. Manufacturer's Installation Instructions.
- C. Evaluation Reports: For foam-plastic insulation, from ICC-ES.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.
- B. Protect foam-plastic board insulation as follows:
 - 1. Do not expose to sunlight except to necessary extent for period of installation and concealment.
 - 2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site until just before installation time.
 - 3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

PART 2 - PRODUCTS

2.1 RIGID FOAM BOARD INSULATION MATERIALS

- A. Polyisocyanurate Board Insulation: Rigid closed-cell foam, complying with ASTM C1289; Type I, aluminum foil both faces; Class 1, non-reinforced foam core.
 - 1. Properties:
 - a. Flame Spread Index: 75 or less, when tested in accordance with ASTM E84.
 - b. Smoke Developed Index: 450 or less, when tested in accordance with ASTM E84.

2.2 GLASS-FIBER BLANKET

- A. Glass-Fiber Board, Unfaced: ASTM C 612, Type IA; unfaced, with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84. Nominal density of 2.25 lb/cu. ft. (36 kg/cu. m), thermal resistivity of 4.3 deg F x h x sq. ft./Btu x in. at 75 deg F per inch (29.8 K x m/W at 24 deg C).
 - 1. Application: Thermal Insulation in 3-5/8" metal stud framed walls.
 - 2. Application: Acoustical Insulation in stud walls of various depths.

2.3 ACCESSORIES

- A. Insulation for Miscellaneous Voids: Provide one of the following:
 - 1. Glass-Fiber Insulation: ASTM C 764, Type II, loose fill; with maximum flame-spread and smoke-developed indexes of 5, per ASTM E 84.
 - 2. Spray Polyurethane Foam Insulation: ASTM C 1029, Type II, closed cell, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84.
- B. Sheet Vapor Retarder: Specified in Section 07 25 00.
- C. Adhesive for Rigid Insulation: As recommended by manufacture for the application and compatible with the air barrier membrane.
- D. Insulation Fasteners for Batt Insulation: Impaling clips, spindle fasteners, or similar anchoring devices to prevent batt insulation from sagging and bunching in cavities.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean substrates of substances that are harmful to insulation, including removing projections capable of puncturing insulation or vapor retarders, or that interfere with insulation attachment.

3.2 INSTALLATION, GENERAL

- A. Comply with insulation manufacturer's written instructions applicable to products and applications.
- B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.

- C. Extend insulation to envelop entire area to be insulated. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
- D. Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total thickness or to achieve R-value.

3.3 BOARD INSTALLATION IN SPACES BETWEEN TRUSSES

- A. Cut and fit insulation tightly to trusses, protrusions or interruptions to the insulation plane.
- B. Maintain continuous air space below roof deck sheathing.
- C. Secure in place by anchoring ceiling sheathing material through insulation to roof deck.

3.4 BATT INSULATION INSTALLATION IN FRAMED CONSTRUCTION

- A. Blanket Insulation: Install in cavities formed by framing members according to the following requirements:
 - 1. Install in exterior wall cavities without gaps or voids. Do not compress insulation.
 - 2. Trim insulation neatly to fit spaces. Insulate miscellaneous gaps and voids.
 - 3. Fit insulation tightly in cavities and tightly to exterior side of mechanical and electrical services within the plane of the insulation.
 - 4. Retain insulation batts in place with spindle fasteners or similar within 12 inches (300 mm) of the top.
- B. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:
 - 1. Glass-Fiber Insulation: Compact to approximately 40 percent of normal maximum volume equaling a density of approximately 2.5 lb/cu. ft. (40 kg/cu. m).
 - 2. Spray Polyurethane Insulation: Apply according to manufacturer's written instructions.

3.5 PROTECTION

- A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

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SECTION 07 21 26

BLOWN IN INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Attic: Loose insulation pneumatically placed and poured into joist spaces.

1.2 ACTION SUBMITTALS

- A. Product Data: Provide data on product characteristics, performance criteria, and limitations.

1.3 INFORMATIONAL SUBMITTALS

- A. Manufacturer's Installation Instructions: Indicate procedure for preparation and installation.
- B. Certificates: Certify that products of this section meet or exceed specified requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Blown Insulation: Acceptable manufactures include, but are not limited to:
 - 1. Advancd Fiber Technologies: www.advanced-fiber.com.
 - 2. Champion Cellulose Fiber Insulation: www.championinsulation.com
 - 3. Fiberlite Technologies, Inc.: www.fiberlitetech.com.
 - 4. GreenFiber: www.greenfiber.com
 - 5. Modern Insulation: www.moderninsulationinc.com.
 - 6. Nu-Wool Inc: www.nuwool.com.
 - 7. Tascon Industries Inc: www.tasconindustries.com.
 - 8. Thermocell.com: www.thermocell.com

2.2 MATERIALS

- A. Loose Fill Insulation: ASTM C739, cellulose fiber type, nodulated for pour and bulk for pneumatic placement.
 - 1. Total Thermal Resistance: 38 (deg F hr sq ft)/Btu (6.7 (K sq m)/W).
 - 2. Settled Density: Between 1.2 and 1.6 lb/ft³ (19.22 and 25.63 kg/m³)
 - 3. Fire Resistance: Flame Spread Index less than 25, Smoke Development less than 100 per ASTM E84.

2.3 AUXILIARY MATERIALS

- A. If required at wall louvers, provide metal, rigid fiberboard or plastic sheets designed to act as baffles.
- B. Eave Ventilation Troughs (Rafter Vents): Preformed, metal rigid fiberboard or plastic sheets designed and sized to fit between roof framing members and to provide cross ventilation between insulated attic spaces and vented eaves.
 - 1. Vents must not permit cellulose insulation to pass through into the vent passageway.

2. Provide length required to ensure that upper end is at least 6 inches vertically above blown-in insulation.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that substrate, adjacent materials, and insulation are dry and ready to receive insulation.
- B. Verify that light fixtures have thermal cut-out device to restrict over-heating in soffit or ceiling spaces.
- C. Verify spaces are unobstructed to allow placement of insulation.
- D. Verify that all joints and penetrations in the gypsum board plane of the ceiling are sealed air tight. Ceiling plane must be air tight before insulation is installed.

3.2 INSTALLATION

- A. Install insulation and ventilation baffle in accordance with ASTM C1015 and manufacturer's instructions.
- B. Pour or pneumatically place insulation to completely fill joist and rafter spaces.
- C. Do not impede natural attic ventilation. Provide baffles at wall louvers, if required.
- D. Place against and behind mechanical and electrical services within the plane of insulation.
- E. Completely fill intended spaces. Leave no gaps or voids.

3.3 CLEANING

- A. Remove loose insulation residue.

END OF SECTION

SECTION 07 25 00

WEATHER BARRIERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes weather barriers and air barriers including:
 - 1. Vapor permeable, weather-air barriers.
 - 2. Interior vapor resistant sheet barrier.

1.2 DEFINITIONS

- A. Air-Barrier Material: A primary element that provides a continuous barrier to the movement of air.
- B. Air-Barrier Accessory: A transitional component of the air barrier that provides continuity.
- C. Air-Barrier Assembly: The collection of air-barrier materials and accessory materials applied to an opaque wall, including joints and junctions to abutting construction, to control air movement through the wall.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include data on air and water-vapor permeance based on testing according to referenced standards. Include data on how the vapor barrier will be anchored/installed.
- B. Shop Drawings: Provide details showing how barrier will meet and tie into adjacent construction.

1.4 INFORMATIONAL SUBMITTALS

- A. Manufacturer's Installation Instructions: Indicate surface preparation.
- B. Product certificates.
- C. Product test reports.

1.5 QUALITY ASSURANCE

- A. Provide all products of a specific type from a single manufacturer.

PART 2 - PRODUCTS

2.1 VAPOR-PERMEABLE MEMBRANE WEATHER / AIR-BARRIER

- A. Building Wrap: ASTM E 1677, Type I air barrier; with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, when tested according to ASTM E 84; UV stabilized; and acceptable to authorities having jurisdiction.

1. Water-Vapor Permeance: Not less than 20 perms (1150 ng/Pa x s x sq. m) per ASTM E 96/E 96M, Desiccant Method (Procedure A).
2. Air Permeance: Not more than 0.004 cfm/sq. ft. at 0.3-inch wg (0.02 L/s x sq. m at 75 Pa) when tested according to ASTM E 2178.
3. Tensile Strength: 29/27 lbs/in., when tested in accordance with ASTM D 882, Method A.
4. Tear Resistance: 12/7 lbs., when tested in accordance with ASTM D 1117.
5. Allowable UV Exposure Time: Not less than three months.
6. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.
7. Design Basis: Tyvek Commercial Wrap

- B. Use vapor-permeable weather / air barrier membrane at exterior walls.

2.2 SHEET VAPOR BARRIER MATERIALS

- A. Vapor Retarder Sheet: ASTM D4397 polyethylene film, clear.
1. Thickness: 10 mil (0.25 mm).
 2. Water Vapor Permeance: As required by referenced standard for thickness specified.
 3. Use: Applied to interior of new studs before gypsum board is installed.

2.3 MISCELLANEOUS MATERIALS

- A. Joint Adhesives and Tapes: As recommended by material manufacturer.
- B. Flashings and Transitions: As recommended by material manufacturer.
- C. Fasteners: As recommended by material manufacturer.
- D. Sealants and Fillers: As recommended by material manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with manufacturer's requirements and other conditions affecting performance of the Work.
1. Verify that substrates are sound and free of oil, grease, dirt, excess mortar, or other contaminants.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SURFACE PREPARATION

- A. Prepare surface to conform to weather-air barrier manufacturer's recommendations.
- B. At changes in substrate plane, apply sealant or termination mastic beads at sharp corners and edges to form a smooth transition from one plane to another.
- C. Cover gaps in substrate plane and form a smooth transition from one substrate plane to another to provide continuous support for air barrier.

3.3 INSTALLATION, GENERAL

- A. Install materials in accordance with manufacturer's instructions.
- B. Barriers systems shall be continuous. Provide all transition between materials, at opening, at changes in plane, at construction pieces (such as windows, electrical boxes, etc.) as necessary to provide a continuous barrier. Seal all seams.
- C. Fluid Applied Air Barrier Membrane:
 - 1. Prime as required by membrane manufacturer.
 - 2. Install as recommended by membrane manufacturer.
 - 3. Provide manufacturer's recommended details and accessories at transitions between materials and planes in order to ensure a continuous air barrier.
- D. Mechanically Fastened Sheets - Vapor Retarder on Interior:
 - 1. When insulation is to be installed in assembly, install vapor retarder over insulation.
 - 2. Seal seams, laps, perimeter edges, penetrations, tears, and cuts with self-adhesive tape, making airtight seal.
 - 3. Locate laps at a framing member; at laps fasten one sheet to framing member then tape overlapping sheet to first sheet.
 - 4. Seal entire perimeter to structure, window and door frames, and other penetrations.
 - 5. Where conduit, pipes, wires, ducts, outlet boxes, and other items are installed in insulation cavities, pass vapor retarder sheet behind item but over insulation and maintain air tight seal.

3.4 PROTECTION

- A. Protect barrier systems from damage during application and remainder of construction period.
- B. Verify condition of barrier and repair any tears or any other forms of damage or discontinuity before covering with additional materials.

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SECTION 07 31 13
ASPHALT SHINGLES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes
 - 1. Asphalt shingle roofing.
 - 2. Flexible sheet membranes for eave protection, underlayment, and valley protection.
- B. Related Requirements
 - 1. Section 07 62 00 "Sheet Metal Flashing and Trim" for edge and cap flashings.

1.2 GENERAL REQUIREMENTS

- A. Verify existing warranty with owner's representative. All work shall be done by the original roofing installer and in compliance with the current warranty.
- B. Roofing Repair must:
 - 1. Match the existing roofing system wherever possible.
 - 2. All patch and repair work must conform to the current warranty.

1.3 INSTALLER QUALIFICATIONS

- A. All contractors must be certified by the shingle manufacturer as an approved applicator of the products specified within these contract documents. Must be a CertainTeed Credentialed Contractor in good standing to meet this requirement.
- B. All Contractors shall use a contractor or be a Contractor holding a current permit in the state of Iowa to remove asbestos, with all employees on site holding a current license in the State of Iowa for the removal of the caulking / sealant / tar type material.
 - 1. As part of the submittal package to the owner, copies of permits and licenses, as well as a copy of the notifications to the proper state and federal agencies will be required.
 - 2. After completion of the project a copy of the waste shipment report and landfill receipts will be required with all close out documents.
- C. The bidding entity will have never defaulted on, failed to complete, or requested to be relieved of the responsibilities of a contract with a public entity.

1.4 EXTRA MATERIALS

- A. Provide 200 square feet of extra shingles in unopened packages in good condition.
- B. Deliver to and unload shingles at location on Camp Dodge directed by owner.

1.5 ACTION SUBMITTALS

- A. Product Data: Provide data indicating material characteristics.

- B. Samples: Submit two samples of each shingle color indicating color range and finish texture/pattern; for color selection.

1.6 INFORMATIONAL SUBMITTALS

- A. Manufacturer's Instructions: Indicate installation criteria and procedures.

1.7 QUALITY ASSURANCE

- A. Perform Work in accordance with the recommendations of NRCA Steep Roofing Manual.

1.8 FIELD CONDITIONS

- A. Do not install shingles, underlayment or eave protection membrane when surface temperatures are below 45 degrees F (7 degrees C).
- B. Do not install shingle, underlayment or flexible flashing protection membrane when raining, likely to rain or when deck is wet.

1.9 WARRANTY

- A. Material Warranty Period: 40 years from date of Substantial Completion.
- B. Extended Warranty: Provide 4-Star SureStart Plus (25 years) extended non-prorated coverage for materials and labor, tear-off, and disposal (requires installer to be a CertainTeed credentialed contractor).
- C. Algae Resistance Warranty: 10 years

PART 2 - PRODUCTS

2.1 SHINGLES

- A. Acceptable Manufacturers include:
 - 1. Atlas Roofing Corporation: www.atlasroofing.com.
 - 2. CertainTeed Corporation: www.certainteed.com.
 - 3. GAF Materials Corporation: www.gaf.com.
 - 4. Owens Corning Corporation: www.owenscorning.com.
 - 5. Tamko Roofing Products, Inc: www.tamko.com.
- B. Asphalt Shingles: Asphalt-coated glass felt, mineral granule surfaced, complying with ASTM D 3462; Class A fire resistance.
 - 1. Wind Resistance: Class D, when tested in accordance with ASTM D 3161.
 - 2. Algae Resistant.
 - 3. Three Tab, Self-sealing type.
 - 4. Color: Match existing shingles on this and nearby buildings.
- C. Design Basis: CertainTeed Corporation, Landmark. Color: Max Def Red Oak.

2.2 SHEET MATERIALS

- A. Underlayment: Smooth Surfaced Roll Roofing: Asphalt-coated organic felt, with smooth asphalt coating both sides, complying with ASTM D 6380, Class S, Type IV, 39.8 lb/100 sq ft (1943 g/sq m).
 - 1. "Roofers Select" or "DiamondDeck" as manufactured by CertainTeed. No substitutions. (required for extended warranty).
- B. Flexible Flashing (Eave Protection Membrane): Self-adhering polymer-modified asphalt sheet complying with ASTM D 1970; 40 mil (1 mm) total thickness; with strippable treated release paper and polyethylene sheet top surface.
- C. Ice and Water Shield
 - 1. "WinterGuard" as manufactured by CertainTeed. No substitutions. (required for extended warranty).

2.3 ACCESSORIES

- A. Nails, adhesives, and other anchoring accessories to be as recommended by the shingle or sheeting material manufacturer.
- B. Ridge Vents: Plastic, extruded with vent openings that do not permit direct water or weather entry; flanged to receive shingles
 - 1. Design Basis: Mid-America Building Products "Ridge Master Plus" or equal.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions prior to beginning work.
- B. Verify that deck is of sufficient thickness to accept fasteners.
- C. Verify that roof penetrations and plumbing stacks are in place and flashed to deck surface.
- D. Verify roof openings are correctly framed.
- E. Verify deck surfaces are dry, free of ridges, warps, or voids.

3.2 PREPARATION

- A. Seal roof deck joints wider than 1/16 inch (1.5 mm) with deck tape.
- B. At areas where eave protection membrane is to be adhered to substrate, fill knot holes and surface cracks with latex filler.
- C. Broom clean deck surfaces before installing underlayment or eave protection.

3.3 INSTALLATION - FLEXIBLE FLASHING PROTECTION MEMBRANE

- A. Install flexible flashing protection membrane in accordance with manufacturer's instructions.

- B. Install flexible flashing membrane from eave edge to minimum 4 ft (1 200 mm) up-slope at roof edges.
- C. Install protection membrane 2 feet either side of valleys and 2 feet either side of hip ridges.
- D. Install protection membrane from edge to minimum 2 feet in from each end gable.

3.4 INSTALLATION - UNDERLAYMENT

- A. Install underlayment perpendicular to slope of roof, with ends and edges weather lapped minimum 4 inches (100 mm). Stagger end laps of each consecutive layer. Nail in place. Weather lap minimum 4 inches (100 mm) over eave protection.
- B. Items projecting through or mounted on roof: Weather lap and seal watertight with plastic cement.

3.5 INSTALLATION - SHINGLES

- A. Install shingles in accordance with manufacturer's instructions.
 - 1. Fasten strip shingles using 4 nails per strip, or as required by code, whichever is greater.
- B. Place shingles in straight coursing pattern with 5 inch (125 mm) weather exposure to produce double thickness over full roof area. Provide double course of shingles at eaves.
- C. Project first course of shingles 3/4 inch (19 mm) beyond fascia boards.
- D. Extend shingles 1/2 inch (13 mm) beyond face of gable edge fascia boards.
- E. Valleys: Extend shingles on both slopes across valley in a weave pattern and fasten. Extend shingles a minimum of 12 inches (300 mm) beyond valley center line to achieve woven valley, concealing the valley protection.
- F. Cap hips with individual shingles, maintaining 5 inch (125 mm) weather exposure. Place to avoid exposed nails.
- G. Coordinate installation of roof mounted components or work projecting through roof with weather tight placement of counterflashings.
- H. Complete installation to provide weather tight service.

END OF SECTION

SECTION 07 46 46
FIBER CEMENT SIDING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Fiber cement horizontal lap siding
 - 2. Trim and accessories.
- B. Related Requirements:
 - 1. Section 07 25 00, Weather Barriers: Weather barrier under siding.
 - 2. Section 07 90 01, Joint Sealers.
 - 3. Section 07 67 00, Sheet Metal Flashing and Trim: Flashing.

1.2 ALTERNATES

- A. Work in this section is a part of an alternate. See Section 01 23 00 "Alternates" for description of alternates.

1.3 SUBMITTALS

- A. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Manufacturer's requirements for related materials to be installed by others.
 - 2. Preparation instructions and recommendations.
 - 3. Storage and handling requirements and recommendations.
 - 4. Installation methods, including nail patterns.
- B. Maintenance Instructions: Periodic inspection recommendations and maintenance procedures.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing work of the type specified in this section with minimum 3 years of experience.

1.5 WARRANTY

- A. Siding: Manufacturer's non-pro-rated, transferable, 30-year warranty.
- B. Trim Board: Manufacturer's non-pro-rated, transferable, 15-year warranty.

PART 2 - PRODUCTS

2.1 GENERAL SIDING PERFORMANCE REQUIREMENTS

- A. Conforming to ASTM C1186, Type A, Grade II, fiber-cement board,

- B. Noncombustible when tested according to ASTM E136; with a flame-spread index of 25 or less when tested according to ASTM E84.
- C. Labeling: Provide fiber-cement siding that is tested and labeled according to ASTM C1186 by a qualified testing agency acceptable to authorities having jurisdiction.
- D. Shall contain no asbestos.

2.2 TRIM BOARDS

- A. Trim Boards: Individual horizontal boards made of cement and cellulose fiber formed under high pressure, designed to be installed as trim in select locations.
 - 1. Style: 5/4 Rustic.
 - 2. Texture: Cedarmill.
 - 3. Length: 144" nominal.
 - 4. Width (Height): 5-1/2" and 3-1/2".
 - 5. Thickness: 5/16 inch (8 mm), nominal.
 - 6. Finish: Arctic White.
- B. Design Basis: James Hardie Statement Collection Trim Boards. Alternative product will be considered only if approved by the Architect in writing before bid is submitted.

2.3 PANEL VERTICAL SIDING

- A. Textured Vertical Siding: Vertical siding boards made of cement and cellulose fiber formed under high pressure, designed to be installed as vertical siding in select locations.
 - 1. Style: Sierra 8.
 - 2. Texture: Cedarmill.
 - 3. Length: 120" nominal.
 - 4. Width: 48" nominal.
 - 5. Thickness: 5/16 inch (8 mm), nominal.
 - 6. Finish: Primed for paint
- B. Design Basis: James Hardie "Sierra 8" and "Smooth" Vertical Panel Boards. Alternative product will be considered only if approved by the Architect in writing before bid is submitted.

2.4 ACCESSORIES

- A. Trim: Siding manufacturer's board like planks of the same material, texture and finish as siding for which is it providing trim.
- B. Fasteners: Galvanized or corrosion resistant; length as required to penetrate minimum 1-1/4 inch (32 mm).
- C. Joint Sealer: As specified in Section 07 90 05 and as recommended by fiber cement siding manufacturer.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Examine substrate and clean and repair as required to eliminate conditions that would be detrimental to proper installation.
- B. Verify that weather barrier has been installed over substrate completely and correctly.
- C. Do not begin until unacceptable conditions have been corrected.
- D. If substrate preparation is the responsibility of another installer, notify Architect/Engineer of unsatisfactory preparation before proceeding.

3.2 PREPARATION

- A. Install sheet metal flashing:
 - 1. Above door and window trim and casings.
 - 2. Above horizontal trim in field of siding.
 - 3. At points where wall meets roof.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions and recommendations.
 - 1. Read warranty and comply with all terms necessary to maintain warranty coverage.
 - 2. Use trim details indicated on drawings.
 - 3. Touch up all field cut edges before installing.
 - 4. Pre-drill nail holes if necessary to prevent breakage.
- B. Over Wood and Gypsum Sheathing: Fasten siding through sheathing into studs.
- C. Joints in Horizontal Siding: Avoid joints in lap siding except at corners; where joints are inevitable stagger joints between successive courses and conform to manufacturer's recommendations for sealing joints.
- D. Do not install siding less than 6 inches (150 mm) from surface of ground nor closer than 1 inch (25 mm) to roofs, patios, porches, and other surfaces where water may collect.
- E. After installation, seal all joints except lap joints of lap siding. Seal around all penetrations. Paint all exposed cut edges.
- F. Finish Touch-Up: Conform to manufacturer's requirements for sealing cut ends and patching damage to prefinished surfaces.

3.4 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

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SECTION 07 62 00

SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Formed roof-drainage sheet metal fabrications.
 - 2. Miscellaneous sheet metal flashing, counterflashing and trim.
- B. Related Requirements:
 - 1. Section 07 31 13 "Asphalt Shingles".
 - 2. Section 08 52 13 "Metal-Clad Wood Windows".
 - 3. Section 08 91 19 "Fixed Louvers".

1.2 COORDINATION

- A. Pre-Installation Meeting: Convene at the construction site at least one week before executing Work of this section.
- B. Coordinate sheet metal flashing and trim layout and seams with sizes and locations of penetrations to be flashed, and joints and seams in adjacent materials.
- C. Coordinate sheet metal flashing and trim installation with adjoining roofing and wall materials, joints, and seams to provide leakproof, secure, and noncorrosive installation.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each manufactured product and accessory.
- B. Shop Drawings:
 - 1. For gutters and downspouts. Include plans, elevations, sections, and attachment details.
 - 2. For splash blocks and installation of splash blocks.
- C. Samples for Verification: Submit 2 samples 3 x 6 inches (76 x 152 mm) in size illustrating metal color and finish.

1.4 INFORMATIONAL SUBMITTALS

- A. Sample Warranty: For special warranty.
- B. Qualification Data: For fabricator / installer.

1.5 QUALITY ASSURANCE

- A. Perform work in accordance with SMACNA Architectural Sheet Metal Manual requirements and standard details, except as otherwise indicated.
- B. Fabricator and Installer: Trained by ITI, having successfully completed the Architectural Sheet Metal module, and have at least three-year experience in architectural sheet metal.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage. Store sheet metal flashing and trim materials away from uncured concrete and masonry. Support as necessary to prevent deformation.
- B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to extent necessary for period of sheet metal flashing and trim installation.

1.7 WARRANTY

- A. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Finish Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General: Sheet metal flashing and trim assemblies shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.
- B. Sheet Metal Standard for Flashing and Trim: Comply with NRCA's "The NRCA Roofing Manual" and SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

2.2 SHEET METALS

- A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.

- B. Metallic-Coated Steel Sheet: Provide zinc-coated (galvanized) steel sheet according to ASTM A 653/A 653M, G90 (Z275) coating designation or aluminum-zinc alloy-coated steel sheet according to ASTM A 792/A 792M, Class AZ50 (Class AZM150) coating designation, Grade 40 (Grade 275); prepainted by coil-coating process to comply with ASTM A 755/A 755M.
1. Surface: Smooth, flat.
 2. Exposed Coil-Coated Finish: Two or Three-Coat Fluoropolymer conforming to performance requirements of AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat, thermally cured. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 3. Color: As selected by Architect from manufacturer's full range.
 4. Concealed Finish: Manufacturer's standard.

2.3 UNDERLAYMENT MATERIALS

- A. Self-Adhering, High-Temperature Sheet: Minimum 30 mils (0.76 mm) thick, consisting of a slip-resistant polyethylene- or polypropylene-film top surface laminated to a layer of butyl- or SBS-modified asphalt adhesive, with release-paper backing; specifically designed to withstand high metal temperatures beneath metal roofing. Provide primer according to written recommendations of underlayment manufacturer.
1. Thermal Stability: ASTM D 1970; stable after testing at 240 deg F (116 deg C) or higher.
 2. Low-Temperature Flexibility: ASTM D 1970; passes after testing at minus 20 deg F (29 deg C) or lower.
- B. Slip Sheet: Rosin-sized building paper, 3 lb/100 sq. ft. (0.16 kg/sq. m) minimum.

2.4 MISCELLANEOUS MATERIALS

- A. General: Provide materials and types of fasteners, solder, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal or by SMACNA unless otherwise indicated.
- B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.
1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
 - a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.
 - b. Blind Fasteners: High-strength stainless-steel rivets suitable for metal being fastened.
 2. Fasteners for Zinc-Coated (Galvanized) or Aluminum-Zinc Alloy-Coated Steel Sheet: Series 300 stainless steel or hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329.
- C. Sealant: As specified in Section 07 92 00.
- D. Protective Backing Paint: Zinc molybdate alkyd.
- E. Bituminous Coating: Cold-applied asphalt emulsion according to ASTM D 1187.

- F. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

2.5 FABRICATION, GENERAL

- A. General: Custom fabricated sheet metal flashing and trim to comply with details shown and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required. Fabricate sheet metal flashing and trim in shop to greatest extent possible.
 - 1. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
 - 2. Obtain field measurements for accurate fit before shop fabrication.
 - 3. Form pieces in longest possible lengths.
 - 4. Form sheet metal flashing and trim to fit substrates without excessive oil canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
 - 5. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.
- B. At Contractor's option, sheet metal may be site formed, if done so with continuous forming machines and if resulting formed pieces conform to the requirements of this section.
- C. Hem exposed edges on underside 1/2 inch (13 mm), miter and seam corners.
- D. Fabricate vertical faces with bottom edge formed outward 1/4 inch (6 mm) and hemmed to form drip.
- E. Fabrication Tolerances: Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified in MCA's "Guide Specification for Residential Metal Roofing."
- F. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.
 - 1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with butyl sealant concealed within joints.
 - 2. Use lapped expansion joints only where indicated on Drawings.
- G. Sealant Joints: At joints anticipated to experience movement, form joints to receive non-drying, non-skinning butyl or synthetic butyl type sealants.
- H. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
- I. Fabricate cleats and attachment devices of sizes as recommended by cited sheet metal standard for application, but not less than thickness of metal being secured.
- J. Seams: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. Rivet joints where necessary for strength.
- K. Do not use graphite pencils to mark metal surfaces.

2.6 ROOF-DRAINAGE SHEET METAL FABRICATIONS

- A. Provide either pre-manufactured, shop formed or site formed gutters and downspouts, zinc or zinc-aluminum coated steel only
- B. Hanging Gutters: Fabricate to cross section required, complete with end pieces, outlet tubes, and other accessories as required. Fabricate in minimum 96-inch- (2400-mm-) long sections. Furnish flat-stock gutter brackets and flat-stock gutter spacers and straps fabricated from same metal as gutters, of size recommended by cited sheet metal standard but with thickness not less than twice the gutter metal thickness. Fabricate expansion joints, expansion-joint covers, and gutter accessories from same metal as gutters. Shop fabricate interior and exterior corners.
 - 1. Gutter Profile: SMACNA Style I.
 - 2. Expansion Joints: Lap type.
 - 3. Accessories: Provide all accessories as recommended by SMACNA and as necessary for proper installation.
 - 4. Metal Gage: As recommended by SMACNA. Oversize by one gage size.
- C. Downspouts: Fabricate rectangular downspouts to dimensions indicated, complete with mitered elbows. Furnish with metal hangers from same material as downspouts and anchors. Shop fabricate elbows.
 - 1. Fabricated Hanger Style: Fig 1-35G according to SMACNA's "Architectural Sheet Metal Manual."
- D. Seal and mechanically attach metal joints.

2.7 MISCELLANEOUS SHEET METAL FLASHING AND TRIM

- A. Provide flashing and trim at window, doors and louvers and at roof edges and patches as necessary to provide for positive drainage and protections construction and interior spaces.
- B. Exposed flashing and trim to be prefinished metal conforming to this section or stainless steel.
- C. None exposed metal to conform to the requirements for metallic-coating as indicated in this section, unless stainless steel.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, substrate, and other conditions affecting performance of the Work.
 - 1. Verify compliance with requirements for installation tolerances of substrates.
 - 2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
 - 3. Verify that air- or water-resistant barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
 - 1. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.
 - 2. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
 - 3. Install exposed sheet metal flashing and trim as required to avoid oil canning, and free of buckling and tool marks.
 - 4. Torch cutting of sheet metal flashing and trim is not permitted.
 - 5. Do not use graphite pencils to mark metal surfaces.
- B. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.
- C. Fasteners: Use fastener sizes that penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.
- D. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a watertight installation.
- E. Seal joints as required for watertight construction.
 - 1. In concealed locations where movement is anticipated, use only non-drying, non-skinning butyl type sealant. Form metal and install sealant to ensure that sealant does not seep out of the joint onto exposed surfaces or drip.

3.3 ROOF-DRAINAGE SYSTEM INSTALLATION

- A. General: Install sheet metal roof-drainage items to produce complete roof-drainage system according to cited sheet metal standard unless otherwise indicated. Coordinate installation of roof perimeter flashing with installation of roof-drainage system.
- B. Hanging Gutters: Join sections with joints sealed with sealant. Provide for thermal expansion. Attach gutters at eave or fascia to firmly anchor them in position. Provide end closures and seal watertight with sealant. Slope to downspouts.
 - 1. Anchor to fascia and strap back to roof deck similar to Fig 1-17 A or B in SMACNA's "Architectural Sheet Metal Manual".
- C. Install to properly drain on to splash blocks as indicated on drawings.

3.4 CLEANING AND PROTECTION

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. Clean off excess sealants.

- C. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of sheet metal flashing and trim installation, remove unused materials and clean finished surfaces as recommended by sheet metal flashing and trim manufacturer. Maintain sheet metal flashing and trim in clean condition during construction.
- D. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

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SECTION 07 90 00

JOINT SEALERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Urethane joint sealants.
 - 2. Silyl-terminated polyether joint sealants.
 - 3. Butyl type sealants.
 - 4. Latex joint sealants.
 - 5. Mildew-Resistant sealants.
 - 6. Silicon rubber strips.

1.2 ACTION SUBMITTALS

- A. Product Data: For each joint-sealant product. Coordinate product data with required Joint-Sealant Schedule.
- B. Samples for Initial Selection: Manufacturer's color charts showing the full range of colors available for each product exposed to view.
- C. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- (13-mm-) wide joints formed between two 6-inch- (150-mm-) long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- D. Joint-Sealant Schedule: Include the following information:
 - 1. Joint-sealant application, joint location, substrate, and designation.
 - 2. Joint-sealant manufacturer and product name.
 - 3. Joint-sealant color.

1.3 INFORMATIONAL SUBMITTALS

- A. Manufacturer's Installation Instructions: Indicate special procedures.
- B. Sample Warranties: For special warranties.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience.
- B. Applicator Qualifications: Company specializing in performing the work of this section with minimum five years' experience.

1.5 FIELD CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F (5 deg C).
2. When joint substrates are wet.
3. Where joint widths are less or greater than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.6 WARRANTY

- A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that fail to achieve and maintain airtight seal and watertight seal, exhibit loss of adhesion or cohesion, or do not cure properly and other requirements specified in this Section within specified warranty period.
 1. Warranty Period: Two years from date of Substantial Completion.
- B. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:
 1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
 2. Disintegration of joint substrates from causes exceeding design specifications.
 3. Mechanical damage caused by individuals, tools, or other outside agents.
 4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 JOINT SEALANTS, GENERAL

- A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.
- B. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 URETHANE JOINT SEALANTS

- A. Urethane, S, NS, 25, NT: Single-component, nonsag, nontraffic-use, plus 25 percent and minus 25 percent movement capability, urethane joint sealant; ASTM C 920, Type S, Grade NS, Class 25, Use NT.
- B. At the Contractor's option, a two-part sealant meeting the other requirement of this Article may be submitted.

2.3 SILYL-TERMINATED POLYETHER (STPE) JOINT SEALANTS

- A. STPE, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, silyl-terminated polyether joint sealant; ASTM C 920, Type S, Grade NS, Class 25, Use NT.

2.4 BUTYL JOINT SEALANTS

- A. Butyl-Rubber-Based or Synthetic Butyl Joint Sealants: ASTM C 1311.

1. Non-drying, non-skinning.
2. Service Temperature Range: -40°F (-40°C) to 200°F (93°C)

2.5 ACRYLIC LATEX JOINT SEALANTS

- A. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.

2.6 MILDEW-RESISTANT SEALANT

- A. White silicone; ASTM C920, Uses I, M and A; single component, mildew resistant.

2.7 JOINT-SEALANT BACKING

- A. Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. Cylindrical Sealant Backings: ASTM C 1330, Type B (bicellular material with a surface skin), and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance. Oversized 30 to 50 percent larger than joint width
- C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or surface(s) at back of joint. Use tape only where approved by the Architect.

2.8 MISCELLANEOUS MATERIALS

- A. Rubber Seals (for where walls must seal to equipment): Silicone Rubber Strips 40A Medium Hardness, 1/2 inch thickness, minimum 2 inches wide.
- B. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated.
- C. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.
- D. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
 - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
 - 2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air.
 - 3. Remove laitance and form-release agents from concrete.
 - 4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants.
- B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 - 1. Do not leave gaps between ends of sealant backings.
 - 2. Do not stretch, twist, puncture, or tear sealant backings.
 - 3. Remove absorbent sealant backings that have become wet before sealant application, and replace them with dry materials.
- D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints. Obtain permission from the Architect before using.
- E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
 - 1. Place sealants so they directly contact and fully wet joint substrates.
 - 2. Completely fill recesses in each joint configuration.
 - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

- F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
1. Remove excess sealant from surfaces adjacent to joints.
 2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
 3. Provide concave joint profile per Figure 8A in ASTM C 1193 unless otherwise indicated.
 - a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

3.4 CLEANING

- A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.6 JOINT-SEALANT SCHEDULE

- A. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces.
1. Joint Locations: All exterior joints unless noted otherwise or recommended otherwise by manufacturers of the surfaces being sealed.
 2. Joint Sealant: Urethane or STPE.
 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- B. Joint-Sealant Application: Concealed sealant bead in movement joints sheet metal work and bedding.
1. Joint Locations:
 - a. Concealed sealant bead in movement joints sheet metal work
 - b. Bedding of door sills.
 2. Joint Sealant: Butyl.
- C. Joint-Sealant Application: Exposed interior, low movement joints.
1. Joint Locations: Interior joint at door frames and other low movement joints
 2. Joint Sealant: Acrylic Latex.
- D. Joint-Sealant Application: Mildew resistant.
1. Joint Locations: Pipe penetrations, back splashes and other locations where moisture is likely.
 2. Joint Sealant: Silicone, mildew resistant.
- E. At window use sealant recommended by window manufacturer.

END OF SECTION

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SECTION 08 11 13

HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes hollow-metal work.
- B. Related Requirements:
 - 1. Section 08 71 11 "Door Hardware" for door hardware for hollow-metal doors.
 - 2. Section 09 90 00 "Painting and Coating" for field painting and varnishing.

1.2 DEFINITIONS

- A. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or SDI A250.8.

1.3 COORDINATION

- A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, core descriptions, and finishes. Include data on thermal performance.
- B. Schedule: Provide a schedule of hollow-metal work prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Include wood doors in the schedule. Coordinate with final Door Hardware Schedule.

1.6 INFORMATIONAL SUBMITTALS

- A. Manufacturer's Certificates: Certify the products meet or exceed the performance requirements of this section.

1.7 CLOSEOUT SUBMITTALS

- A. Revised Data: Submit a revised schedule and product data as a part of Record Documents showing all corrections and modifications.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Store in accordance with NAAMM HMMA 840.

- B. Protect with resilient packaging; avoid humidity build-up under coverings; prevent corrosion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Ceco Door; ASSA ABLOY.
 - 2. Curries Company; ASSA ABLOY.
 - 3. Republic Doors and Frames.
 - 4. Steelcraft; an Ingersoll-Rand brand.
- B. Source Limitations: Obtain hollow-metal work from single source from single manufacturer.

2.2 DOORS AND FRAMES - GENERAL

- A. Requirements for All Doors and Frames:
 - 1. All seams to be continuously welded and ground smooth.
 - 2. Hardware Preparation: In accordance with ANSI A250.8, with reinforcement welded in place.

2.3 HOLLOW-METAL DOORS AND FRAMES

- A. Construct exterior doors and frames to comply with the standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
- B. Exterior Doors to be SDI Level 3, Extra Heavy Duty, Model 2, seamless design, 0.053 inch (nom. 16-gage) thick, zinc coated steel. "Seamless design" means all seams on the vertical edges are continuously welded the full height of the door, filled, and finished smooth for no visible seams.
 - 1. All exterior doors shall be closed flush at the top and bottom edges. Install minimum 20 gauge channels (legs down at top of door, legs up at bottom of door) even with the top and bottom edges of door face sheets (no recesses). Seam wire weld continuous or spot weld around entire perimeter of channel. Fill all welds and seams and finish smooth for no visible seams. Provide openings in the bottom closure channel to permit the escape of entrapped moisture.
- C. Interior Doors to be SDI Level 2, Heavy Duty, Model 2, seamless design, 0.042 inch (nom. 18 gage) thick zinc coated steel. "Seamless design" means all seams on the vertical edges are continuously welded the full height of the door, filled, and finished smooth for no visible seams.
- D. Extra-Heavy-Duty Doors and Frames: SDI A250.8, Level 3 and Physical Performance Level A.
 - 1. Frames:
 - a. Exterior frames to be 0.067 inch (nom. 14 gage) thick, zinc coated steel.
 - b. Interior frames to be 0.053 inch (nom 16 gage) thick zinc coated steel.
 - c. Face dimension of frame heads shall be increased to align with masonry coursing.
 - d. All frames to be full-profile welded; grind, fill, dress, and make smooth, flush and invisible.
 - e. All frames in new masonry walls to be filled with cementitious based grout (mortar) as walls are laid up. Rubber door silencer buttons **MUST** be installed prior to filling. Gypsum based grout in frames is prohibited.

- f. All frames in non-masonry walls or frames inserted into existing openings or openings cut into existing masonry walls shall be un-grouted. Stuff with fiberglass batt insulation for sound deadening.
 - g. Frames identified to receive rough-in for Electronic Security Systems shall have the mortar boxes and conduits within the frames installed by the frame manufacturer. Install mortar boxes regardless of whether or not the frame will be grouted.
 - h. Coat the inside of exterior frames with a corrosion inhibiting bituminous material.
 - i. Frames to be securely anchored to the structural portion of the wall and not the brick veneer.
 - j. Knock-down frames are not acceptable.
 - k. Countersink anchors, fill and make smooth, flush, and invisible on exposed faces.
 - l. Cut ends of material (i.e. glazing stops) must be primed and painted.
2. Exposed Finish: Prime for field painting.

2.4 FRAME ANCHORS

- A. Provide jamb and floor anchors as required for the specific application. Conform to SDI A250.8.

2.5 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
- B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
- C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B.
- D. Frame Anchors: ASTM A 879/A 879M, Commercial Steel (CS), 12G (04Z) coating designation; mill phosphatized.
 - 1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.
- E. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.
- F. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.
- G. Coating for Inside of Frames:
 - 1. For frames to be filled with cementitious grout, coat inside of frame with asphalt emulsion or other high-build, water-resistant, resilient coating.
 - 2. For frames to be filled with expansive polyurethane foam, coat inside of frame if recommended by the frame manufacture and with materials as recommended by the frame manufacture.

2.6 FABRICATION

- A. Fabricate hollow-metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for metal thickness. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.

- B. Hollow-Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
 - 1. All joints fully welded and ground smooth.
 - 2. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be filled.
- C. Fabricate concealed stiffeners and edge channels from either cold- or hot-rolled steel sheet.
- D. Hardware Preparation: Factory prepare hollow-metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to SDI A250.6, the Door Hardware Schedule, and templates.
 - 1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
 - 2. Comply with applicable requirements in SDI A250.6 and BHMA A156.115 for preparation of hollow-metal work for hardware.

2.7 ACCESSORY MATERIALS

- A. Silencers: Resilient rubber, fitted into drilled hole; 3 on strike side of single door, 3 on center mullion of pairs, and 2 on head of pairs without center mullions.
- B. Temporary Frame Spreaders: Provide all factory- or shop-assembled frames.

2.8 STEEL FINISHES

- A. All frames to be metallic coated and primed.
- B. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.
 - 1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.
 - 2. Verify compatibility with metallic coating and all scheduled finish coatings.
- C. Factory Finish: Finish coat(s) may be factory or site applied.
- D. Coat inside of all frames as necessary for grouting.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for embedded and built-in anchors to verify actual locations before frame installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.
- B. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.3 INSTALLATION

- A. General: Install hollow-metal work plumb, rigid, properly aligned, and securely fastened in place. Comply with Drawings and manufacturer's written instructions.
- B. Hollow-Metal Frames: Install hollow-metal frames for doors, transoms, sidelites, borrowed lites, and other openings, of size and profile indicated. Comply with SDI A250.8 and A250.11 or NAAMM-HMMA 840 as required by standards specified.
 - 1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set.
 - 2. Anchor frames in place with concealed anchors.
 - a. Where countersunk anchors must be used, fill, grind smooth and prime to match the rest of the frame.
 - 3. After wall construction is complete and frame is fully anchored, remove temporary braces, leaving surfaces smooth and undamaged.
 - 4. Installation Tolerances: Conform to Appendix A of SDI A250.11
- C. Grout all frames in masonry walls with cementitious grout
- D. Fill all other frames after installation with expansive polyurethane foam.

3.4 ADJUSTING AND CLEANING

- A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow-metal work that is warped, bowed, or otherwise unacceptable.
 - 1. Final adjustments are to be made after HVAC system testing and balancing is complete.
- B. Remove urethane foam and other bonding material from hollow-metal work immediately after installation.
- C. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.
- D. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.
- E. Finish Coat: Touchup factory applied finish to match original coating. Apply field finished as indicated in Section 09 90 00.

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SECTION 08 14 16
FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes
 - 1. Flush wood doors; non-rated.
- B. Related Requirements
 - 1. Section 08 11 13 - Hollow Metal Doors and Frames.
 - 2. Section 08 71 00 - Door Hardware.

1.2 ACTION SUBMITTALS

- A. Product Data: Indicate door core materials and construction; veneer species, type and characteristics.
- B. Sample of warranty.
- C. Shop Drawings: Illustrate door opening criteria, elevations, sizes, types, swings, undercuts required, special beveling, special blocking for hardware, factory machining criteria, factory finishing criteria, identify cutouts for glazing and louvers.
- D. Unified Schedule: Unified door, frame, and hardware schedule prepared in accordance with DHI "Sequence and Format for the Hardware Schedule".
- E. Samples: Submit two samples of door construction, 6 x 6 inch (152 x 152 mm) in size cut from top corner of door.
- F. Warranty, executed in Owner's name.

1.3 INFORMATIONAL SUBMITTALS

- A. Manufacturer's Certificates: Certifying compliance with the requirements of this Specification.

1.4 QUALITY ASSURANCE

- A. Maintain one copy of the specified door quality standard on site for review during installation and finishing.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Package, deliver and store doors in accordance with specified quality standard.
- B. Accept doors on site in manufacturer's packaging. Inspect for damage.

- A. Protect doors with resilient packaging sealed with heat shrunk plastic. Do not store in damp or wet areas; or in areas where sunlight might bleach veneer. Seal top and bottom edges with tinted sealer if stored more than one week. Break seal on site to permit ventilation.

1.6 WARRANTY

- A. Interior Doors: Provide manufacturer's warranty for the life of the installation.
- B. Include coverage for delamination of veneer, warping beyond specified installation tolerances, defective materials, and telegraphing core construction.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Wood Veneer Faced Doors:
 - 1. Graham Wood Doors: www.grahamdoors.com.
 - 2. Algoma Hardwoods, Inc.: www.algomahardwoods.com
 - 3. Marshfield Door Systems, Inc: www.marshfielddoors.com.
 - 4. VT Industries: www.vtindustries.com/doors.

2.2 FLUSH WOOD DOORS, GENERAL

- A. Quality Standard: In addition to requirements specified, comply with AWI's, AWMAC's, and WI's "Architectural Woodwork Standards." (AWS)
 - 1. Quality Level: Custom Grade, with A Grade veneer, in accordance with AWS, Section 9.
 - 2. Wood Veneer Faced Doors: 5-ply unless otherwise indicated.
 - 3. Edges: Beveled.

2.3 DOOR AND PANEL CORES

- A. Non-Rated Solid Core and 20-Minute Rated Doors: Type PC (Particle Board) or SLC (Stave), plies and faces as indicated above.

2.4 DOOR FACINGS

- A. Wood Veneer Facing for Transparent Finish: Red oak, veneer grade as specified above, plain sliced, book veneer match, balance assembly match; unless otherwise indicated.
 - 1. Vertical Edges: Any option allowed by quality standard for grade.

2.5 DOOR CONSTRUCTION

- A. Fabricate doors in accordance with door quality standard specified.
- B. Provide solid blocking as required to receive specified hardware.
- C. Factory machine doors for hardware other than surface-mounted hardware, in accordance with hardware requirements and dimensions.
- D. Provide edge clearances in accordance with the quality standard specified.

2.6 FACTORY FINISHING - WOOD VENEER DOORS

- A. Transparent Finish:
 - 1. Grade: Premium.
 - 2. Finish: Manufacture's standard finish conforming to AWI's, AWMAC's, and WI's "Architectural Woodwork Standards", Premium grade.
 - 3. Staining: As selected by Architect.
 - 4. Effect: Semi filled finish, produced by applying an additional finish coat to partially fill the wood pores.
 - 5. Sheen: Satin.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that opening sizes and tolerances are acceptable.
- C. Do not install doors in frame openings that are not plumb or are out-of-tolerance for size or alignment.
- D. Verify that Heating Ventilating and Air Conditioning System has been tested and is fully operational. Doors shall not be installed unless HVAC system is operating and spaces where doors are installed shall be maintained within 10 (±) degrees of the design conditions and humidity must be within the design range.

3.2 INSTALLATION

- A. Install doors in accordance with manufacturer's instructions and specified quality standard.
- B. Factory-Finished Doors: Do not field cut or trim; if fit or clearance is not correct, replace door.
- C. Field-Finished Doors: Trimming to fit is acceptable.
 - 1. Adjust width of non-rated doors by cutting equally on both jamb edges.
 - 2. Trim door height by cutting bottom edges to a maximum of 3/4 inch (19 mm).
- D. Use machine tools to cut or drill for hardware.
- E. Coordinate installation of doors with installation of frames and hardware.

3.3 TOLERANCES

- A. Conform to specified quality standard for fit and clearance tolerances.
- B. Conform to specified quality standard for telegraphing, warp, and squareness.

3.4 ADJUSTING

- A. Adjust doors for smooth and balanced door movement.
- B. Final adjustments are to be made after HVAC system testing and balancing is complete.

END OF SECTION

SECTION 08 31 13
ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Access doors and frames for walls and ceilings.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
- C. Schedule: Types, locations, sizes, latching or locking provisions, and other data pertinent to installation.

PART 2 - PRODUCTS

2.1 ACCESS DOORS AND FRAMES FOR WALLS AND CEILINGS

- A. Source Limitations: Obtain each type of access door and frame from single source from single manufacturer.
- B. Flush Access Doors with Exposed Flanges:
 - 1. Assembly Description: Fabricate door to fit flush to frame. Provide manufacturer's standard-width exposed flange, proportional to door size.
 - 2. Locations: Walls and ceilings.
 - 3. Door Size: See Drawings.
 - 4. Metallic-Coated Steel Sheet for Door: Not less than 0.064 inch (1.63 mm), 16 gage.
 - a. Finish: Factory prime; baked on.
 - 5. Frame Material: Same material, thickness, and finish as door.
 - 6. Hardware
 - a. Hinges: Concealed, continuous, stainless steel, 175 degree swing.
 - b. Lock: Cylinder lock with latch and interchangeable cylinders. Provide a cylinder lock which will accept removable keyways as described in Section 08 71 00 - Door Hardware.
 - 7. Insulation: 3/4" Type 3 Expanded Polystyrene Foil Lined Insulation, with 3.18 R Value.

2.2 MATERIALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- B. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.

- C. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A 879/A 879M, with cold-rolled steel sheet substrate complying with ASTM A 1008/A 1008M, Commercial Steel (CS), exposed.
- D. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.
- E. Frame Anchors: Same type as door face.
- F. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329.

2.3 FABRICATION

- A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.
- B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
- C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access doors to types of supports indicated.
- D. Recessed Access Doors: Form face of panel to provide recess for application of applied finish. Reinforce panel as required to prevent buckling.
 - 1. For recessed doors with plaster infill, provide self-furring expanded metal lath attached to door panel.
- E. Latching Mechanisms: Furnish number required to hold doors in flush, smooth plane when closed.
 - 1. For cylinder locks, furnish two keys per lock and key all locks alike.
 - 2. For recessed panel doors, provide access sleeves for each locking device. Furnish plastic grommets and install in holes cut through finish.

2.4 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- D. Steel and Metallic-Coated-Steel Finishes:
 - 1. Factory Prime: Apply manufacturer's standard, fast-curing, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with manufacturer's written instructions for installing access doors and frames.
- B. Install doors flush with adjacent finish surfaces or recessed to receive finish material.

3.2 ADJUSTING

- A. Adjust doors and hardware, after installation, for proper operation.
- B. Remove and replace doors and frames that are warped, bowed, or otherwise damaged.

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SECTION 08 52 13

METAL-CLAD WOOD WINDOWS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes
 - 1. Factory fabricated metal clad wood windows with fixed, and operating sash.
 - 2. Operating hardware.
- B. Related Requirements
 - 1. Section 06 10 00 - Rough Carpentry: Rough opening framing.
 - 2. Section 07 25 00 - Weather Barriers: Perimeter air and vapor seal between window frame and adjacent construction.
 - 3. Section 07 90 00 - Joint Sealers: Perimeter sealant and back-up materials.
 - 4. Section 08 80 00 – Glazing, requirement for glass to be provided by window manufacturer.

1.2 PRE-INSTALLATION MEETING

- A. Convene one week before starting work of this section.

1.3 SUBMITTALS

- A. Product Data: Describe materials and finishes. Show component dimensions.
- B. Shop Drawings: Indicate opening dimensions.
- C. Manufacturer's Certificate: Certify that products furnished meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

- A. Manufacturer and Installer Qualifications: Company specializing in manufacturing residential wood windows with minimum ten years of documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect factory finished surfaces with wrapping. Do not use adhesive papers or sprayed coatings that bond when exposed to sunlight or weather.

1.6 FIELD CONDITIONS

- A. Do not install sealants when ambient temperature is less than 40 degrees F (5 degrees C).
- B. Maintain this minimum temperature during and after installation of sealants.

1.7 WARRANTY

- A. Correct defective Work within a five-year period after Date of Substantial Completion.
- B. Provide five-year manufacturer warranty for insulated glass units from seal failure, interpane dusting or misting, and replacement of same.

- C. Finish: 10-year minimum.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Performance Requirements: As specified in PART 2, with the following additional requirements:
- B. Deflection: Limit member deflection to flexure limit of glass with full recovery of glazing materials.
- C. Design windows to accommodate, without damage to components or deterioration of seals, movement between window and perimeter framing and deflection of lintel.
- D. Air Infiltration: Limit air leakage through assembly to 0.05 cu ft/min/sq ft (1.57 L/s/sq m) of wall area, measured at a reference differential pressure across assembly of 1.57 psf (75 Pa) as measured in accordance with ASTM E 283.
- E. Water Leakage: None, when measured in accordance with ASTM E 331 at 7.5 psf.
- F. Thermal Performance (Total Window):
 - 1. U Value (Winter) = 0.35 Max.
 - 2. SHGC - 0.38 Max.
- G. Light Transmission (Visible) = 65% Min.

2.2 MANUFACTURERS

- A. Other Acceptable Manufacturers:
 - 1. Andersen Windows Corp: www.andersenwindows.com.
 - 2. Marvin Windows and Doors: www.marvin.com
 - 3. Pella Corp: www.pella.com.

2.3 WOOD WINDOWS

- A. Windows: Wood frame and sash, factory fabricated and assembled.
 - 1. Performance Requirements: AAMA/WDMA/CSA 101/I.S.2/A440 LC-PG50 –AP & FW.
 - 2. Exterior Surfaces: Metal clad, 70% Fluoropolymer, meeting or exceeding AAMA 2605. Color: To be selected by Architect.
 - 3. Interior Surfaces: Fir, clear coat varnish, factory applied.
 - 4. Configuration: (See also Drawings).
 - a. WINDOW A: Fixed.
 - b. WINDOW B: Fixed.
 - 5. Weather Stop Flange: Continuous at perimeter of unit.
 - 6. Clearances and Shim Spacing: Minimum required for installation and dynamic movement of perimeter seal.
 - 7. Internal Drainage of Glazing Spaces to Exterior: Weep holes.

2.4 ACCESSORIES

- A. Provide window manufacturer's standard flashing and extension and panning material to accommodate and trim out new windows in existing openings

2.5 MATERIALS

- A. Wood: Fir, clear preservative treated using treatment type suitable for transparent or opaque finish.
- B. Metal Cladding: Formed aluminum, factory finished, factory fit to profile of wood members.
- C. Glass and Glazing Materials: As specified in Section 08 80 00 and provided by window manufacturer.
- D. Sealant and Backing Materials: As specified in Section 07 90 05 and as recommended by window manufacturer.

2.6 HARDWARE

- A. Sash lock: Lever handle with cam lock.

2.7 FABRICATION

- A. Fabricate frame and sash members with mortise and tenon joints. Glue and steel pin joints to hairline fit, weather tight.
- B. Provide weather stop flange at entire perimeter of unit.
- C. Fabricate components with minimum clearances and shim spacing around perimeter of assembly yet allowing installation and dynamic movement of perimeter seal.
- D. Arrange fasteners to be concealed from view.
- E. Provide internal drainage of glazing spaces to exterior through weep holes.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify wall openings and adjoining air and vapor seal materials are ready to receive work of this section.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Attach window frame and shims to perimeter opening to accommodate construction tolerances and other irregularities.
- C. Align window plumb and level, free of warp or twist. Maintain dimensional tolerances and alignment with adjacent work.
- D. Provide thermal isolation where components penetrate or disrupt building insulation. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.
- E. Coordinate attachment and seal of perimeter air and vapor barrier materials.
- F. Install operating hardware.

- G. Install glass and infill panels in accordance with Section 08 80 00, if not factory glazed.

3.3 ADJUSTING

- A. Adjust hardware for smooth operation and secure weathertight closure.

3.4 CLEANING AND PROTECTION

- A. Remove protective material from factory finished surfaces.
- B. Wash surfaces by method recommended and acceptable to sealant and window manufacturer; rinse and wipe surfaces clean.
- C. Remove excess sealant by moderate use of mineral spirits or other solvent acceptable to sealant manufacturer.
- D. Final clean windows and frames not more than one week before Substantial Completion.
- E. Protect glazing and finishes until Substantial Completion.

END OF SECTION

SECTION 08 71 00

DOOR HARDWARE

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Mechanical door hardware.
 - 2. Weatherstripping, door seals, gaskets and thresholds.
- B. Related Requirements
 - 1. Section 08 11 13 "Hollow Metal Doors and Frames".

1.2 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate the manufacture, fabrication, and installation of products onto which door hardware will be installed.
- B. Furnish templates for door and frame preparation to manufacturers and fabricators of products requiring internal reinforcement for door hardware.
- C. Preinstallation Meeting: Convene a preinstallation meeting one week prior to commencing work of this section; require attendance by all affected installers.
 - 1. Initiate and conduct with supplier, installer and related trades.
 - 2. Coordinate materials and techniques and sequence hardware items and systems installation.
- D. Keying Conference: Conduct conference at Project site. See additional requirements in this section.

1.3 ACTION SUBMITTALS

- A. Product Data: Include a "Catalog Cut" or brochure showing product picture and data for each different type of hardware item used in Hardware Schedule submitted. If multiple products appear on the literature submitted, clearly indicate which items are to be reviewed for inclusion in the Project.
- B. Door Hardware Schedule: Prepared by or under the supervision of an Architectural Hardware Consultant, detailing fabrication and assembly of door hardware, as well as installation procedures and diagrams. Coordinate final door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
 - 1. Format: Use same scheduling sequence and use same door numbers as in the Contract Documents.
 - 2. Content: Include the following information:
 - a. Identification number, location, hand, fire rating, size, and material of each door and frame.
 - b. Locations of each door hardware set, cross-referenced to Drawings on floor plans and to door and frame schedule.
 - c. Complete designations, including name and manufacturer, type, style, function, size, quantity, function, and finish of each door hardware product.

3. Coordinate and submit with the Door and Frame Schedule required in Section 08 11 13 "Hollow Metal Doors and Frames".

1.4 INFORMATIONAL SUBMITTALS

- A. Certification: Submit name and proof of certification of the Architectural Hardware Consultant.

1.5 CLOSEOUT SUBMITTALS

- A. Schedule: Submit a Door Hardware Schedule modified to show actual hardware installed and location of concealed items.
- B. Maintenance Data: Include data on operating hardware, lubrication requirements, and inspection procedures related to preventative maintenance.
- C. Maintenance Products: After installation, Contractor shall turn over to owner all manufacturer supplied installation tools, templates and installation instructions.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Supplier of products and an employer of workers trained and approved by product manufacturers and an Architectural Hardware Consultant who is available during the course of the Work to consult with Contractor, Architect, and Owner about door hardware and keying.
- B. Architectural Hardware Consultant Qualifications: A person who is currently certified by DHI as an Architectural Hardware Consultant (AHC). AHC shall review and sign all required submittals in the section.
- C. Accessibility Requirements: Comply with applicable provisions in the DOJ's 2010 ADA Standards for Accessible Design and ICC A117.1 .

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver keys, blanks and uninstalled cores to Owner by secure means agreed to with the Owner in advance. Obtain proof of receipt.

1.8 FIELD QUALITY CONTROL

- A. Hardware Supplier's Architectural Hardware Consultant shall field inspect and certify hardware and installation has been furnished and installed in accordance with manufacturer's instructions and as specified.

1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.
 1. Hinges: Life of Building
 2. Locksets: 3-Years
 3. Exit Devices: 3-Years Mechanical.
 4. Hydraulic Closers: 10-Years

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

- A. Provide door hardware for each door as scheduled in Part 3 "Door Hardware Schedule" Article to comply with requirements in this Section.
- B. Designations: Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of door hardware are indicated in Part 3 "Door Hardware Schedule" Article. Products are identified by descriptive titles corresponding to requirements specified in Part 2.

2.2 MANUFACTURERS

- A. Hinges: Stanley CB Series or Bommer Industries
- B. Mortise Locks: Falcon MA Series / AN Lever
- C. Exit Devices: Von Duprin 99 Series (No Substitutions)
- D. Surface Closers: LCN 4040 Series or Dorma
- E. Overhead Stops: Glynn-Johnson, ABH
- F. Wall Stops: Ives, Rockwood, Trimco
- G. Protection Plates: Burns, Ives, Rockwood
- H. Thresholds: National Guard, Pemko, Reese.
- I. Weatherstripping: National Guard, Pemko, Reese
- J. Sweeps: National Guard, Pemko, Reese

2.3 GENERAL REQUIREMENTS FOR DOOR HARDWARE PRODUCTS

- A. Provide ANSI/BHMA A156, Class 1 or Grade 1 Hardware Products unless noted otherwise.

2.4 HINGES

- A. Hinges: BHMA A156.1. Provide template-produced hinges for hinges installed on hollow-metal doors and hollow-metal frames.
- B. Antifriction-Bearing Hinges:
 - 1. Mounting: Full mortise (butts).
 - 2. Bearing Material: Ball bearing.
 - 3. Grade: Grade 1 (heavy weight).
 - 4. Base and Pin Metal: Stainless steel.
 - 5. Pins: NRP (Non-Removable Pin) on all Exterior Doors.
 - 6. Tips: Flat button.
 - 7. Corners: Square.
 - 8. Size: 4½" x 4½" unless otherwise noted.

- C. Provide the number hinges indicated in the Hardware Schedule but not less than the number of hinges recommended by the manufacturer for the size of door.

2.5 MECHANICAL LOCKS AND LATCHES

- A. Lock Functions: As indicated in door hardware schedule.
- B. Lock Throw: Comply with testing requirements for length of bolts required as follows:
 - 1. Mortise Locks: Minimum 3/4-inch (19-mm) latchbolt throw.
- C. Lock Backset: 2-3/4 inches (70 mm), unless otherwise indicated.
- D. Strikes: Provide manufacturer's standard strike for each lock bolt or latchbolt complying with requirements indicated for applicable lock or latch and with strike box and curved lip extended to protect frame; finished to match lock or latch.
- E. Mortise Locks: BHMA A156.13; Operational and Security Grade 1; stamped steel case with steel or brass parts; Series 1000.
- F. Trim: Lever handles conforming to requirements of ANSI A117.1.
 - 1. Provide trim similar to Falcon AN level and plate.
 - 2. All Locksets that provide access to electrical rooms, mechanical rooms, janitorial areas or other rooms containing hazardous material shall have Knurled Levers

2.6 PANIC EXIT DEVICES

- A. All Exit Devices shall conform to ANSI/BHMA A156.3, Grade 1.
- B. All Exit Devices to be push pad type similar to Von Duprin 99 series. Opposite side hardware to be RFID locking device.

2.7 RADIO FREQUENCY IDENTIFICATION LOCKING DEVICE

- A. KABA Saflok RT RFID Series security locking device.

2.8 CYLINDERS, CORES, AND KEYING

- A. All locks accept interchangeable cores and cylinders.
 - 1. ANSI A156.5, Grade 1, 7-pin type, A2 System, Small Format Interchangeable Core (SFIC).
- B. Keyway "Q" verify with Owner.
- C. Locks to be security keyed with restricted keyway to Owner's requirements. All keying and coordination shall be by hardware supplier. Coordinate Owner's keying requirements during course of Work. Upon return of reviewed finish hardware schedule, arrange a meeting between the Owner, hardware supplier, manufacturer, and other involved parties to establish a keying schedule based on Owner's project requirements.
- D. Provide temporary construction cores for all key removable core cylinders.
- E. Furnish and install final approved cores.

- F. Provide 3 cut keys per door plus an additional 3 blank keys per door to be cut as directed by Owner.
- G. Provide bitting list with set-up chart to Owner at Project Closeout.
- H. Provide one additional core for Owner's future use.
- I. Deliver key, key blanks and additional core(s) to Owner as directed.

2.9 SURFACE CLOSERS

- A. Surface Closers: BHMA A156.4; rack-and-pinion hydraulic type with adjustable sweep and latch speeds controlled by key-operated valves and with forged-steel main arm. Comply with manufacturer's written recommendations for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.
- B. Surface Closer with Cover: Grade 1; Modern Type with mechanism enclosed in cover.
 - 1. Construction:
 - a. Cast iron body.
 - b. Heat treated steel working parts.
 - c. Non-Sized, Non-Handed and Fully Adjustable.
 - 2. Mounting: Mount on interior side of door.
 - 3. Backcheck: Adjustable, effective between 60 and 85 degrees of door opening.
 - 4. Cover Material: Plated steel.
 - 5. Closing Power Adjustment: At least 15 percent more than minimum tested value.
- C. Closer shall be rated for exterior exposure.
- D. Provide drop plates, special templating and similar items as necessary to coordinate mounting with adjacent hardware, walls or headers.

2.10 MECHANICAL STOPS AND HOLDERS

- A. Wall-Mounted Stops: BHMA A156.16; stainless steel base metal.
- B. Wall Bumpers: Grade 1; with rubber bumper; 2-1/2-inch (64-mm) diameter, minimum 3/4-inch (19-mm) projection from wall; with backplate for concealed fastener installation; with concave bumper configuration.
- C. Overhead Stops
 - 1. All Overhead Stops shall comply with ANSI/BHMA A165.8, Grade 1
 - a. Overhead Stops shall be Glynn-Johnson 90 Series or equivalent
 - 2. Each Overhead Stop shall be properly sized for the specific door to which it is applied
 - 3. Provide each Overhead Stop with the appropriate fasteners and appurtenances for the proper operation and attachment to the type of door and frame scheduled.

2.11 PROTECTION PLATES

- A. All Kickplates shall conform to ANSI/BHMA A156.6, Type J102, Brass.
 - 1. Thickness: 0.050 Inches
 - 2. Width: 2 Inches Less Than Door Width (LDW) on single doors; 1½" LDW on each leaf of pairs.

- B. Provide each Protection Plate with the proper type of fastener for mounting securely to the door. Exposed fasteners to be countersunk with heads flush and finish to match the plate.

2.12 DOOR GASKETING

- A. Door Gasketing: BHMA A156.22; air leakage not to exceed 0.50 cfm per foot (0.000774 cu. m/s per m) of crack length for gasketing other than for smoke control, as tested according to ASTM E 283; with resilient or flexible seal strips that are easily replaceable and readily available from stocks maintained by manufacturer.
- B. Rigid, Housed, Perimeter Gasketing: Sponge neoprene gasket material held in place by aluminum housing; fastened to frame stop with screws.
 - 1. Provide gasketing of sufficient lengths to be continuously applied to the perimeter height and width of the opening without being pieced together
 - 2. Design Basis: National Guard 120NB.
- C. Door Sweeps: Neoprene gasket material held in place by flat aluminum housing or flange; surface mounted to face of door with screws.
 - 1. Provide Door Sweeps of sufficient length to completely seal the bottom edge of each door leaf.
 - 2. Design Basis: National Guard 200N.

2.13 THRESHOLDS

- A. Thresholds: BHMA A156.21; fabricated to full width of opening indicated.
- B. Comply with the requirements of ANSI A117.1.
- C. Saddle Thresholds:
 - 1. Type: Thermal break and fluted top.
 - 2. Base Metal: Aluminum, mill finish.
 - 3. Design Basis: Pemko 253X3_FG.
- D. Provide Thresholds in sufficient length to span the entire opening. Thresholds may not be butted to meet in the middle of pairs of doors.
- E. Provide anchoring of the appropriate type to fasten securely to the substrate.

2.14 MISCELLANEOUS WEATHER TRIM

- A. Rain Drip: BHMA A156.22.
 - 1. Minimum 2-inch extension, rain drip cap, full width of door.
 - 2. Design Basis: Pemko 346.

2.15 ACCESSORIES

- A. Fasteners: Provide door hardware manufactured to comply with published templates prepared for machine and sheet metal screws. Provide screws that comply with commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware, unless otherwise indicated. Provide stainless steel fasteners for connecting aluminum pieces to steel doors or frames.
- B. Use concealed fasteners wherever possible.

- C. Through Bolts.
 - 1. Provide at closers to door.
 - 2. Provide spacers or sex bolts for through bolting of hollow-metal doors.
- D. Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.

2.16 FINISHES

- A. Provide finishes complying with BHMA A156.18.
- B. Finishes: All finishes to be bright stainless (BHMA 629, US32) or satin chrome (BHMA 625, US26) or equivalent, except as noted otherwise.
- C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that doors and frames are square and plumb.
- B. Verify that doors and frames are ready to receive work and that dimensions are as indicated on shop drawings.
- C. Verify that all door and frame reinforcing is properly installed.

3.2 INSTALLATION

- A. Steel Doors and Frames: For surface applied door hardware, drill and tap doors and frames according to ANSI/SDI A250.6.
- B. Mounting Heights: Mount door hardware units at heights (to center of hardware item) to comply with the following unless otherwise indicated or required to comply with governing regulations.
 - 1. For steel doors and frames: Comply with DHI "Recommended Locations for Architectural Hardware for Steel Doors and Frames."
 - 2. For wood doors and frames: Comply with DHI "Recommended Locations for Architectural Hardware for Flush Wood Doors", where possible to do so and unless noted otherwise.
 - 3. Wall Bumpers: Set to allow knob/lever to strike bumper.
 - 4. Kick plates: 3/4 inch from bottom of door to bottom of kickplate
- C. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work. Do not install surface-mounted items until finishes have been completed on substrates involved.
 - 1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
 - 2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
 - 3. Use manufacturer's fasteners furnished with hardware items. Replace fasteners damaged during installation.

- D. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than the number recommended by manufacturer for application indicated or one hinge for every 30 inches (750 mm) or part thereof of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.
- E. Thresholds: Set thresholds for exterior doors and other doors indicated in full bed of non-drying, non-skinning butyl sealant complying with requirements specified in Section 07 92 00 "Joint Sealants."
 - 1. Openings to 6'-0" width shall be of one piece.
 - 2. Cope thresholds to fit tightly to door frames
 - 3. Provide closure at any point where threshold protrudes beyond frame or wall and resulted in an "open end".
- F. Stops: Provide wall stops for doors unless other type stops are indicated in door hardware schedule. Do not provide floor mounted stops unless directed to do so. If a wall mounted stop is indicated but will not function properly because of the door/wall configuration, provide an overhead stop.
- G. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
- H. Install Door Sweeps on 'outside' of door to seal bottom of door to threshold in the closed position.
- I. All thru-bolts to be sex bolts or installed with tube separators to prevent deformation of the door faces.
- J. Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

3.3 FIELD QUALITY CONTROL

- A. Provide an Architectural Hardware Consultant to inspect installation and certify that hardware and installation has been furnished and installed in accordance with manufacturer's instructions and provide written report.
- B. Provide written report to Architect and to Owner at completion of inspection.

3.4 ADJUSTING, CLEANING AND INSTRUCTION

- A. Adjust and check each operating item of hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate freely and smoothly or as intended.
 - 1. When door hardware is installed more than one month prior to acceptance or occupancy of a space or area, return to installation during the week prior to acceptance or occupancy and make final check and adjustment of all such hardware items. Adjust door control devices to compensate for final operation of heating and ventilating equipment. Final adjustments must be made after the HVAC testing and balancing are complete.
- B. Clean operating items as necessary to restore proper function and finish of hardware and doors.

3.5 DOOR HARDWARE SCHEDULE

A. Manufacturers/Products

1. Products appearing in the hardware schedule are example products. Unless noted elsewhere as no substitutions, similar product complying with the requirements of this section may be submitted.

Quantity	Item
HARDWARE SET HW 01	
3 EA	Hinges
1 EA	Exit Device – Type 1-Rim – Function 08 (Entrance) PROVIDE with KABA Saflok RT RFID Series Security locking device on corridor side.
1 EA	Closer
1 EA	Overhead Stop
1 EA	Kickplate
1 SET	Weather Gasketing
1 EA	Door Bottom Sweep
1 EA	Rain Drip Cap
1 EA	Threshold
HARDWARE SET HW 02	
3 EA	Hinges
1 EA	Exit Device – Type 1-Rim – Function 08 (Entrance) PROVIDE with KABA Saflok RT RFID Series Security locking device on corridor side.
1 EA	Closer
1 EA	Overhead Stop
1 EA	Kickplate
HARDWARE SET HW 03	
3 EA	Hinges
1 EA	Mortise Lockset – Classroom Function (ANSI F05)
1 EA	Closer
1 EA	Overhead Stop
1 EA	Kickplate
HARDWARE SET HW 04	
3 EA	Hinges
1 EA	Set Push/Pull
1EA	Closer
1 EA	Wall Stop
1 EA	Kickplate
HARDWARE SET HW 05	
3 EA	Hinges
1 EA	Mortise Lockset – Classroom Function (ANSI F05)
1 EA	Wall Stop
HARDWARE SET HW 06	
4 EA	Hinges
1 EA	Exit Device – Type 1-Rim – Function 08 (Entrance)
1 EA	Closer
1 EA	Overhead Stop
1 EA	Kickplate
1 SET	Weather Gasketing

1 EA	Door Bottom Sweep
1 EA	Rain Drip Cap
1 EA	Threshold
2 EA	Manual Flush Bolt

HARDWARE SET HW 07

3 EA	Hinges
1 EA	Exit Device – Type 1-Rim – Function 08 (Entrance)
1 EA	Closer
1 EA	Overhead Stop
1 EA	Kickplate

HARDWARE SET HW 08

3 EA	Hinges
1 EA	Exit Device – Type 1-Rim – Function 08 (Entrance)
1 EA	Closer
1 EA	Overhead Stop
1 EA	Kickplate

END OF SECTION

SECTION 08 80 00

GLAZING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Glass for windows.
 - 2. Glass in doors.
 - 3. Glazing sealants
 - 4. Glazing accessories, including opaque window film

1.2 COORDINATION

- A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Submit data on thermal and solar properties of each glazing unit as a part of the door/window in which it will be installed. Values must be whole window or whole door. Calculated values signed by an engineer are acceptable.

1.4 QUALITY ASSURANCE

- A. Perform Work in accordance with GANA Glazing Manual and FGMA Sealant Manual for glazing installation methods.

1.5 WARRANTY

- A. Manufacturer's Special Warranty for Laminated Glass: Manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.
 - 1. Warranty Period: 10-years from date of Substantial Completion.
- B. Manufacturer's Special Warranty for Insulating Glass: Manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.
 - 1. Warranty Period: 10-years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined according to the International Building Code and ASTM E 1300.
 - 1. Design Wind Pressures: As required by code.
 - 2. Differential Shading: Design glass to resist thermal stresses induced by differential shading within individual glass lites.
- B. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II, for the size specified.
- C. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:
 - 1. U-Factors: Center-of-glazing and whole-window values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. x h x deg F (W/sq. m x K).
 - 2. Solar Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.
 - 3. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

2.2 GLASS PRODUCTS, GENERAL

- A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.
 - 1. GANA Publications: "Laminated Glazing Reference Manual" and "Glazing Manual."
 - 2. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."
- B. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
- C. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.
- D. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass that complies with performance requirements and is not less than the thickness indicated.
- E. Strength: Where annealed float glass is indicated, provide annealed float glass, heat-strengthened float glass, or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where heat-strengthened float glass is indicated, provide heat-strengthened float glass or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where fully tempered float glass is indicated, provide fully tempered float glass.

2.3 GLASS PRODUCTS

- A. Clear Annealed Float Glass: ASTM C 1036, Type I, Class 1 (clear), Quality-Q3.
- B. Strengthened Glass: ASTM C 1048, Kind FT (fully tempered) or HS (heat strengthened), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.

2.4 LAMINATED GLASS

- A. Laminated Glass: ASTM C 1172. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.

2.5 INSULATING GLASS

- A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E 2190.
 - 1. Sealing System: Dual seals.
 - 2. Spacer: Manufacturer's standard spacer material and construction.

2.6 GLAZING SEALANTS

- A. General:
 - 1. Compatibility: Compatible with one another and with other materials they contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
 - 2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
 - 3. Field-applied sealants shall have a VOC content of not more than 250 g/L.
 - 4. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range.
- B. Type: As recommended by manufacturer of the glass and of the receiver (door, window, etc.).

2.7 MISCELLANEOUS GLAZING MATERIALS

- A. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
- B. Glazing Tapes, Setting Blocks, Spacers, Edge Blocks, and Related Items: As recommended by manufacturer of the glass and of the receiver (door, window, etc.).

PART 3 - EXECUTION

3.1 GLAZING, GENERAL

- A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, other glazing materials and the receiver (door, window, etc.), unless more stringent requirements are indicated, including those in referenced glazing publications.
- B. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with

edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.

- C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.
- D. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
- E. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
- F. Provide spacers for glass lites where length plus width is larger than 50 inches (1270 mm).
- G. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.

3.2 GLAZING METHODS

- A. Use glazing method recommended by the manufacturers of the glass and the receiver (door, window, etc.).
- B. Glass panels to be removable from the interior (secure) side by non-destructive means.

3.3 CLEANING AND PROTECTION

- A. Immediately after installation remove nonpermanent labels and clean surfaces.
- B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.
 - 1. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.
- C. Remove and replace glass that is damaged during construction period.

3.4 INSULATING GLASS SCHEDULE

- A. Glazing for Windows (Fixed): As required to resist wind loads and meet safety glazing requirements, where applicable and the following:
 - 1. Overall Unit Thickness: 1 inch (25 mm) Maximum.
 - 2. Minimum Thickness of Each Glass Lite: 6 mm.
 - 3. Interspace Content: Gas as required to meet performance requirements.
 - 4. Performance: As required to produce overall U-Value and SHGC values as indicated in Section 08 52 13.
- B. Glazing for Exterior HM Doors & Sidelights: As required to resist wind loads and meet code safety glazing requirements, where applicable and the following:
 - 1. Overall Unit Thickness: 3/4 inch Maximum.

2. Make-Up:
 - a. 1/4 inch tinted glass (Bronzelite)
 - b. 1/4 inch gas interspace
 - c. 1/4 inch clear polished
 - 1) Interior lite of unit to be laminated glass.
3. Minimum Performance Characteristics:
 - a. U-factor COG: 0.29
 - b. U-factor Unit: 0.42
 - c. SHGC: 0.38
 - d. Visual Transmission: 0.70

END OF SECTION

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SECTION 08 91 19

LOUVERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes
 - 1. Louvers, frames, and accessories.

1.2 ACTION SUBMITTALS

- A. Product Data: Provide data describing design characteristics, maximum recommended air velocity, design free area, materials and finishes.
- B. Shop Drawings: Indicate louver layout plan and elevations, opening and clearance dimensions, tolerances; head, jamb and sill details; blade configuration, screens, blank out areas required, and frames.
- C. Samples: Submit two samples 2 by 2 inches in size illustrating finish and color of exterior and interior surfaces.

1.3 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with minimum three years of documented experience.

1.4 WARRANTY

- A. Provide twenty year manufacturer warranty against distortion, metal degradation, and failure of connections. Include coverage against degradation of exterior finish.

PART 2 - PRODUCTS

2.1 LOUVERS

- A. Basis of Design: Greenheck ESD-635.
- B. Louvers, General: Factory fabricated and assembled, complete with frame, mullions, and accessories; AMCA Certified under AMCA 511.
 - 1. Wind Load Resistance: Design to resist positive and negative wind load of 25 psf plus load produced by operation of air handling equipment without damage or permanent deformation.
 - 2. Intake Louvers: Design to allow maximum of 0.01 oz/sq ft water penetration at calculated intake design velocity based on design air flow and actual free area, when tested in accordance with AMCA 500-L.
 - 3. Screens: Provide insect screens at intake louvers and bird screens at exhaust louvers.

- C. Stationary Louvers: Horizontal blade, drainable, extruded aluminum construction, with intermediate mullions matching frame.
 - 1. Free Area Velocity: 550 fpm maximum.
 - 2. Blades: Straight.
 - 3. Frame: 6 inches deep, channel profile; corner joints mitered and welded, with continuous recessed caulking channel each side.
 - 4. Metal Thickness: Frame 0.081 inch; blades 0.081 inch.
 - 5. Finish: Fluoropolymer coating, finished after fabrication. Custom Color to match approved sample.

2.2 MATERIALS

- A. Extruded Aluminum: ASTM B221 (ASTM B221M),
- B. Bird Screen: Interwoven wire mesh of aluminum or stainless steel, 0.063 inch (1.6 mm) diameter wire, 1/2 inch (13 mm) open weave, diagonal design.
- C. Insect Screen: 18 x 16 size aluminum or stainless steel mesh.

2.3 ACCESSORIES

- A. Screens: Frame of same material as louver, with reinforced corners; removable, screw attached; installed on inside face of louver frame.
- B. Provide all flashing to match louver finish.

2.4 FINISHES

- A. High-Performance Organic Finish: Complying with AAMA 2605.
 - 1. Color and Gloss: Match paint color of door and color of roof panels.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that prepared openings and flashings are ready to receive work and opening dimensions are as indicated on shop drawings.

3.2 INSTALLATION

- A. Install louver assembly in accordance with manufacturer's instructions.
- B. Install louvers level and plumb.
- C. Install flashings and align louver assembly to ensure moisture shed from flashings and diversion of moisture to exterior.
- D. Secure louver frames in openings with concealed fasteners.
- E. Provide sealant according to Section 07 90 00.

3.3 CLEANING

- A. Strip protective finish coverings only after louver finish is unlikely to be damaged by on-going construction activities.
- B. Clean surfaces and components.

END OF SECTION

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SECTION 09 06 00

SCHEDULE OF FINISHES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section included a list of finished for materials specified in other sections.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Products shown are "Basis of Design" unless noted otherwise.
B. Color, patterns or textures indicated are to be matched exactly.
C. See individual Sections for detailed description of materials listed in this Section.

PART 3 - EXECUTION

3.1 GENERAL

- A. Number in parenthesis following the item descriptions is the Specification section in which the material/product is specified.
B. See Drawings for locations to be installed.

3.2 FLOOR FINISHES

CPTT-1	Carpet Tile	Manufacturer Collection Style Color Backing Size	Shaw Contract All Access Entryway Carpet Tile 5T034 Sterling 34557 Synthetic 24" X 24"
CT-2	Porcelain Tile	Manufacturer Style Color Size	Daltile Volume 1.0 Intensity Pebble VL72 12" X 24"
SC	Sealed Concrete	See Section	03 01 35 – Cleaning and Resurfacing of CIP Concrete

3.3 WALL BASE

CT-2	Porcelain Tile	Manufacturer Style Color Size	Daltile Cove Base Intensity Pebble VL72 6" x 12"
RB-1	Resilient Base	Manufacturer Type Thickness Size Color	Johnsonite Traditional Wall Base, straight toeless 1/8" 4" high, coil goods (not 4' sections) 71 Storm

3.4 WALL FINISHES

CT-1	Porcelain Tile	Manufacturer Style Color Size	Daltile Volume 1.0 Degrees Silver VL71 12" x 24"
PNT-5	Paint - General	Color Finish	Sherwin Williams SW7065 "Argos" Eggshell

3.5 CEILING FINISHES

ACT-1	Acoustical Ceiling Tile	Manufacturer Tile Size Grid	Armstrong Mesa 681, Angled Tegular 24" x 24" 15/16" Prelude
PNT-1	Paint - Ceiling	Color Finish	Sherwin Williams SW042 "Shoji White" Flat

3.6 DOOR FRAMES

PNT-2	Paint - HM Frames Interior	Color Finish	Sherwin Williams SW7075 "Web Gray" Semi-gloss
PNT-3	Paint - HM Frames Exterior	Color Finish	Sherwin Williams SW7757 "High Reflective White" Semi-gloss

3.7 DOORS

PNT-2	Paint - HM Door Interior	Color Finish	Sherwin Williams SW7075 "Web Gray" Gloss
PNT-3	Paint - HM Door Exterior	Color Finish	Sherwin Williams SW7757 "High Reflective White" Gloss
Doors	Wood	Species Stain	Plain Sliced Birch Honey

3.8 OTHER

SS-1	Solid Surface Countertops & Sills	Manufacturer Style Color	Formica Everform Solid Surface 607 "Ashen Concrete"
PNT-4	Paint – Exterior Concrete Lintels & Sills	Color Finish	Sherwin Williams SW6327 "Bold Brick" Flat
PNT-6	Paint – Exterior Fiber Cement Siding & Trim	Color Finish	Sherwin Williams SW6252 "Ice Cube" Flat
Reducer	Carpet	Manufacturer Style Color	Shaw Contract Carpet Reducer 144VS (Carpet to Concrete) "Night" 00066
Transition	Tile to Carpet	Manufacturer Style Color	Shaw Contract 2" Snap-Down T-Molding 147VS (Carpet to Tile) "Night" 00066

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SECTION 09 21 16

GYPSUM BOARD ASSEMBLIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes
 - 1. Non-structural, metal stud wall framing.
 - 2. Gypsum wallboard.
 - 3. Joint treatment and accessories.

1.2 ACTION SUBMITTALS

- A. Product Data: Provide data on metal framing, gypsum board, accessories, and joint finishing system.

1.3 INFORMATIONAL SUBMITTALS

- A. Test Reports: For all stud framing products that do not comply with ASTM C645 or C 754, provide independent laboratory reports showing maximum stud heights at required spacings and deflections.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing gypsum board application and finishing, with minimum five years of documented experience.

PART 2 - PRODUCTS

2.1 GYPSUM BOARD ASSEMBLIES

- A. Provide completed assemblies complying with ASTM C840 and GA-216.
 - 1. See PART 3 for finishing requirements.

2.2 METAL FRAMING MATERIALS

- A. Non-Loadbearing Framing System Components: ASTM C 645; galvanized sheet steel, of size and properties necessary to comply with ASTM C 754 for the spacing indicated, with maximum deflection of wall framing of L/240 at 5 psf (240 Pa) but not less than 20 gage.
 - 1. Exception: The minimum metal thickness and section properties requirements of ASTM C 645 are waived provided steel of 40 ksi (275 MPa) minimum yield strength is used, the metal is continuously dimpled, the effective thickness is at least twice the base metal thickness, and maximum stud heights are determined by testing in accordance with ASTM E 72 using assemblies specified by ASTM C 754.
 - 2. Studs: "C" shaped with flat or formed webs with knurled faces.
 - 3. Runners: U shaped, sized to match studs.
- B. Framing Accessories

1. Provide sheet metal strips, sheet metal strips with wood attached or wood blocking to anchor attached items (such as shelving or cabinets).

2.3 BOARD MATERIALS

- A. Gypsum Board, Type X: ASTM C 1396/C 1396M.
 1. Thickness: 5/8 inch (15.9 mm).
 2. Long Edges: Tapered and featured (rounded or beveled) for prefilling.
 3. Use: Walls and ceilings, unless noted otherwise.
- B. Moisture- and Mold-Resistant Gypsum Board: ASTM C 1396/C 1396M. With moisture- and mold-resistant core and paper surfaces.
 1. Core: 5/8 inch (15.9 mm), Type X.
 2. Long Edges: Tapered.
 3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.
 4. Location: At wet walls behind sinks or drinking fountains or other wet plumbing penetrations or fixtures. Extend minimum 3 feet on all sides of any water source. Provide at the lower 4 feet of all walls in toilet rooms. And wherever indicated on drawings.

2.4 TILE BACKING PANELS

- A. Cementitious Backer Units: ANSI A118.9 and ASTM C 1288 or ASTM C 1325, with manufacturer's standard edges.
 1. Thickness: 1/2 inch (12.7 mm).
 2. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

2.5 TRIM ACCESSORIES

- A. Interior Trim: ASTM C 1047.
- B. Edge Bead:
 1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc.
 2. LC-Bead: J-shaped; exposed long flange receives joint compound. Provide at all exposed ends of gypsum board, including where gypsum board meets glass, storefront, door frame or other surface which cannot be taped.
- C. Corner Bead (for Exterior Corners On the Interior of the Building):
 1. Material: Structural laminated copolymer.
 - a. Copolymer thickness at center for lengths of less than 10 feet: 0.044" (1.12mm)
 - b. Copolymer thickness at center for lengths of greater than 10 feet: 0.64" (1.6 mm)
 2. Approved Product: Utraflex Structural Laminated Corner System by Certaineed No-Coat
- D. Control Joints:
 1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc.
 2. Configuration: "V" shaped with mud flanges and paper cover to protect during installation.

2.6 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C 475/C 475M.
- B. Joint Tape:

1. Interior Gypsum Board: Paper or coated glass fiber tape for joints and corners; 2 inches (50 mm) wide unless noted otherwise.
- C. Joint Compound for Interior Gypsum Board:
1. Tape to be set and holes over 1/4 inch (6 mm) in smallest dimension to be filled with chemical setting type compound.
 2. Successive coats may be with ready-mixed or powder-mixed vinyl-based joint compound, as recommended by the gypsum board manufacturer.

2.7 AUXILIARY MATERIALS

- A. Screws for Attachment to Steel Members Less Than 0.03 inch (0.7 mm) In Thickness and to Gypsum Board: ASTM C 1002; self-piercing tapping type. Provide screw with approved anticorrosion coating for exterior locations.
- B. Screws for Attachment to Steel Members From 0.033 to 0.112 inch (0.8 to 2.8 mm) in Thickness: ASTM C 954; steel drill screws for application of gypsum board to steel studs.
- C. Sound Attenuation Blankets:
1. Unfaced rock wool batts, sized to fill cavity.
 2. Provide impalers or similar devices to ensure that batts do not sag in cavity.
- D. Acoustical Joint Sealant: ASTM C 834. Product which has been shown to effectively reduce airborne sound transmission through perimeter joints and openings as demonstrated by testing according to ASTM E 90.

PART 3 - EXECUTION

3.1 FRAMING INSTALLATION

- A. Metal Framing: Install in accordance with ASTM C754 and manufacturer's instructions.
- B. Studs: Space studs as permitted by standard.
1. Extend partition framing to structure above, unless noted otherwise.
- C. Install supplementary framing around openings and as required for blocking, bracing, and support of gravity and pullout loads of fixtures, equipment, handrails, and similar items.
- D. Penetrations: Install supplementary steel framing around perimeter of penetration behind boxes containing wiring devices, elevator call buttons, elevator floor indicators, and similar items.

3.2 BOARD INSTALLATION

- A. Comply with ASTM C 840, GA-216, and manufacturer's instructions. Install to minimize butt end joints, especially in highly visible locations.
- B. Single-Layer Non-Rated: Install gypsum board in most economical direction, with ends and edges occurring over firm bearing.

3.3 TILE BACKING PANEL INSTALLATION

- A. Install panels and treat joints according to ANSI A108.11 and manufacturer's written instructions for type of application indicated.

3.4 INSTALLATION OF TRIM AND ACCESSORIES

- A. Install trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
 - 1. Corner Beads: Install at external corners, using longest practical lengths.
 - 2. Edge Trim: Install at locations where exposed edge of gypsum board abuts dissimilar materials and as indicated.
- B. Control Joints: Install control joints according to ASTM C 840 while maintaining fire-resistance rating of gypsum board shaft wall assemblies. Locate where shown on drawings. Where not shown on drawings, request approval from Architect for proposed locations and layout. In no case exceed 30 feet (10 meters) apart on walls and ceilings over 50 feet (16 meters) long.
 - 1. Locate at the corner of doors or windows wherever possible.

3.5 JOINT TREATMENT

- A. Tape, fill, and sand exposed joints, edges, and corners to produce smooth surface ready to receive finishes, except for trim products specifically indicated as not intended to receive tape.
 - 1. Tape to be set and holes over 1/4 inch (6 mm) in smallest dimension to be filled with chemical setting type compound.
 - 2. Successive coats may be with ready-mixed or powder-mixed vinyl-based joint compound, as recommended by the gypsum board manufacturer.
 - 3. Feather coats of joint compound so that camber is maximum 1/32 inch (0.8 mm).
 - 4. Tape, fill, and sand exposed joints, edges, and corners to produce smooth surface ready to receive finishes.
- B. Finish gypsum board in accordance with levels defined in ASTM C840, as follows:
 - 1. Level 4: (GA-214) Walls and ceilings to receive paint finish or wall coverings, unless otherwise indicated.
 - 2. Level 2: In utility areas, behind cabinetry, and on backing board to receive tile finish and fire walls in concealed locations.

3.6 FINISH

- A. Provide "light orange peel" surface texture.
- B. All data cabling (including concealed or above ceilings) shall be protected from drywall mud or paint overspray or installed after drywall finishing and painting is completed. Paint or drywall mud on data cabling voids the cable manufacturer's warranty. Any data cabling with paint or drywall mud on them shall be replaced by the contractor at no additional cost to the Owner.

3.7 TOLERANCES

- A. Maximum Variation of Finished Gypsum Board Surface from True Flatness: 1/8 inch in 10 feet (3 mm in 3 m) in any direction.

END OF SECTION

SECTION 09 30 13

CERAMIC TILING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Ceramic tile.
 - 2. Tile backing panels.
 - 3. Crack isolation membrane.
 - 4. Metal edge strips.
- B. Related Requirements:
 - 1. Section 09 21 16 "Gypsum Board Assemblies" for cementitious backer board.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples:
 - 1. Mount tile and apply grout on two plywood panels, minimum 18 x 18 inches (450 x 450 mm) in size illustrating pattern, color variations, and grout joint size variations.

1.3 INFORMATIONAL SUBMITTALS

- A. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Tile and Trim Units: Furnish quantity of full-size units equal to 5 percent of amount installed for each type, composition, color, pattern, and size indicated.

1.6 QUALITY ASSURANCE

- A. Maintain one copy of TCNA Handbook and ANSI A108 Series/A118 Series on site.
- B. Installer Qualifications: Company specializing in performing tile installation, with minimum of 5 years of documented experience.
- C. All tile of a single pattern and color shall have the same batch number.

PART 2 - PRODUCTS

2.1 PRODUCTS, GENERAL

- A. ANSI Ceramic Tile Standard: Provide Standard-grade tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.
- B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.

2.2 TILE PRODUCTS

- A. Ceramic Mosaic Tile: ANSI A137.1
 - 1. Size and Shape: 12" x 24" rectangular
 - 2. Type: Color-body porcelain Mosaic
 - 3. Finish: Unglazed, matte.
 - 4. Slip Resistance: CDOF greater than 0.42 when tested per ANSI 137.1-2012, Section 9.6.
 - 5. Design Basis: Dal-Tile, Volume 1.0

2.3 TILE BACKING PANELS

- A. See Section 09 21 16 "Gypsum Board Assemblies".
 - 1. Thickness: 1/2 inch (12.7 mm).

2.4 CRACK ISOLATION MEMBRANE

- A. General: Manufacturer's standard product that complies with ANSI A118.12 for high performance and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.

2.5 SETTING MATERIALS

- A. Latex-Portland Cement Mortar (Thinset): ANSI A118.4.
 - 1. For wall applications, provide nonsagging mortar.

2.6 GROUT MATERIALS

- A. Standard Grout: Any type specified in ANSI A118.6 or A118.7, unsanded.

2.7 MISCELLANEOUS MATERIALS

- A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.
- B. Metal Edge Strip: Provide a metal edge cap similar to Bengard Manufacturing model CM2196 where tile transitions to concrete and where indicated. Finish to be similar to Bengard HS Hammered Silver finish.
- C. Grout Sealer: Clear acrylic sealer design to protect grout from organic stained including cooking grease and uretic acid.

1. Design Basis: Glaze'n'Seal Acrylic Grout Sealer

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 1. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials, including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
 2. Verify that concrete substrates for tile floors comply with surface finish requirements in ANSI A108.01 for installations indicated.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Fill cracks, holes, and depressions in concrete substrates with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.
- B. Where indicated, prepare substrates to receive waterproofing by applying a reinforced mortar bed that complies with ANSI A108.1A and is sloped 1:50 (1/4 inch per foot) toward drains.
- C. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.
- D. Existing Concrete Block Substrates: Prepare as recommended by tile and mortar manufacturer.

3.3 CERAMIC TILE INSTALLATION

- A. Comply with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 series "Specifications for Installation of Ceramic Tile" that are referenced in TCNA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.
 1. For the following installations, follow procedures in the ANSI A108 series of tile installation standards for providing 95 percent mortar coverage:
 - a. Tile floors in wet areas.
- B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
- C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.

- D. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.
- E. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.
- F. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:
 - 1. Ceramic Mosaic Tile: 1/8 inch (3.2 mm).
- G. Metal Edge Strips: Install where exposed edge of tile flooring meets carpet, wood, or other flooring that finishes flush with or below top of tile and no threshold is indicated.
- H. Install panels and treat joints according to ANSI A108.11 and manufacturer's written instructions for type of application indicated. Use latex-portland cement mortar for bonding material unless otherwise directed in manufacturer's written instructions.
- I. Install crack isolation membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness that is bonded securely to substrate.

3.4 INTERIOR CERAMIC TILE INSTALLATION SCHEDULE

- A. Interior Floor Installations, Concrete Subfloor:
 - 1. Ceramic Tile Installation: TCNA F113; thinset mortar.
 - a. Tile Type: Ceramic Mosaic.
 - b. Thinset Mortar: Latex-portland cement mortar.
 - c. Grout: Standard grout.
- B. Interior Wall Installations, Cementitious backer on wood or Metal Studs or Furring:
 - 1. Ceramic Tile Installation: TCNA W244C; thinset mortar on cementitious backer units.
 - a. Tile Type: Ceramic Mosaic.
 - b. Thinset Mortar: Latex-portland cement mortar.
 - c. Grout: Standard grout.

3.5 CLEANING AND FINISHING

- A. Clean tile and grout surfaces.

3.6 PROTECTION

- A. Do not permit traffic over finished floor surface for 4 days after installation.
- B. Protect areas of patch tile on walls and floor in existing toilet room from traffic/contact for 4 days.

END OF SECTION

SECTION 09 51 00
ACOUSTICAL CEILINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes
 - 1. Suspended metal grid ceiling system.
 - 2. Acoustical units.

1.2 ADMINISTRATIVE REQUIREMENTS

- A. Sequence work to ensure acoustical ceilings are not installed until building is enclosed, sufficient heat is provided, dust generating activities have terminated, and overhead work is completed, tested, and approved.
- B. Do not install acoustical units until after interior wet work is dry.

1.3 ACTION SUBMITTALS

- A. Product Data: Provide data on suspension system components and acoustical units.
- B. Shop Drawings: Indicate grid layout and related dimensioning.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. Extra Acoustical Units: Quantity equal to 5 percent of total installed.

1.5 QUALITY ASSURANCE

- A. Suspension System Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- B. Acoustical Unit Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.6 FIELD CONDITIONS

- A. Maintain uniform temperature of minimum 60 degrees F (16 degrees C), and maximum humidity of 40 percent prior to, during, and after acoustical unit installation.

PART 2 - PRODUCTS

2.1 ACOUSTICAL UNITS

- A. Acoustical Units - General: ASTM E1264, Class A.

- B. Acoustical Panels: Painted mineral fiber, ASTM E1264 Type III, with the following characteristics:
 - 1. Design Basis: "ClimaPlus Frost" by USG.
 - 2. Size: 24 x 24 inches (600 x 600 mm).
 - 3. Thickness: 3/4 inches (19 mm).
 - 4. Light Reflectance: Not less than 70 percent, determined as specified in ASTM E1264.
 - 5. NRC Range: 0.65 to 0.70, determined as specified in ASTM E1264.
 - 6. Ceiling Attenuation Class (CAC): 35, determined as specified in ASTM E1264.
 - 7. Edge: Reveal edge (tegular).
 - 8. Surface Color: White.

2.2 SUSPENSION SYSTEM(S)

- A. Suspension Systems - General: ASTM C635; die cut and interlocking components, with stabilizer bars, clips, splices, perimeter moldings, and hold down clips as required.
- B. Exposed Steel Suspension System: Formed galvanized steel, commercial quality cold rolled; intermediate-duty.
 - 1. Profile: Tee; 9/16 inch (14 mm).
 - 2. Construction: Single web.
 - 3. Finish: White painted.

2.3 ACCESSORIES

- A. Support Channels and Hangers: Galvanized steel; size and type to suit application and ceiling system flatness requirement specified.
- B. Provide hold-down clips at all ceiling tile within 20-feet of exterior doors.
- C. Perimeter Moldings: Same material and finish as grid.
 - 1. At Exposed Grid: Provide L-shaped molding for mounting at same elevation as face of grid.
- D. Touch-up Paint: Type and color to match acoustical and grid units.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that layout of hangers will not interfere with other work.

3.2 PREPARATION

- A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders, and comply with layout shown on reflected ceiling plans.

3.3 INSTALLATION - SUSPENSION SYSTEM

- A. Rigidly secure system, including integral mechanical and electrical components, for maximum deflection of 1:360.

- B. Install after major above-ceiling work is complete. Coordinate the location of hangers with other work.
- C. Hang suspension system independent of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.
- D. Where ducts or other equipment prevent the regular spacing of hangers, reinforce the nearest affected hangers and related carrying channels to span the extra distance.
- E. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability.
- F. Support fixture loads using supplementary hangers located within 6 inches (150 mm) of each corner, or support components independently.
- G. Do not eccentrically load system or induce rotation of runners.
- H. Perimeter Molding: Install at intersection of ceiling and vertical surfaces and at junctions with other interruptions.
 - 1. Use longest practical lengths.
 - 2. Overlap and rivet corners.

3.4 INSTALLATION - ACOUSTICAL UNITS

- A. Install acoustical units in accordance with manufacturer's instructions. Install units after above-ceiling work is complete.
- B. Fit acoustical units in place, free from damaged edges or other defects detrimental to appearance and function.
- C. Fit border trim neatly against abutting surfaces.
- D. Install acoustical units level, in uniform plane, and free from twist, warp, and dents.
- E. Cutting Acoustical Units:
 - 1. Make field cut edges of same profile as factory edges. Paint exposed edges wherever factory cut units are painted.
- F. Install hold-down clips on panels within 20 ft (6 m) of an exterior door.

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SECTION 09 65 13
RESILIENT BASE AND TRIM

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes
 - 1. Resilient base.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples for Initial Selection: For each type of product indicated.

1.3 CLOSEOUT SUBMITTALS

- A. Maintenance data.
- B. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. Resilient Base: Quantity equivalent to 5 percent of each type and color.

PART 2 - PRODUCTS

2.1 THERMOSET-RUBBER BASE

- A. Product Standard: ASTM F 1861, Type TS (vulcanized, thermoset).
 - 1. Group: I (solid, homogeneous).
 - 2. Style: B, Cove.
- B. Thickness: 0.125 inch (3.2 mm).
- C. Height: 4 inches (102 mm).
- D. Finish: Matte
- E. Lengths: Coils in manufacturer's standard length (4 foot lengths not acceptable).
- F. Colors: As selected by Architect from full range of industry colors.

2.2 INSTALLATION MATERIALS

- A. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Prepare wall substrates to manufacturer's written instructions to ensure adhesion of resilient products. Verify that wall provides continuous support for base.

3.2 INSTALLATION, GENERAL

- A. Comply with manufacturer's written instructions for installation.
- B. Do not install base covering materials over expansion joints in floors or wall. Cut covering cleanly and stop on either side of joint.

3.3 RESILIENT BASE INSTALLATION

- A. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.
- B. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.
- C. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
- D. Scribe and fit to door frames and other interruptions.
- E. Fit joints tightly and make vertical. Maintain minimum dimension of 18 inches (45 mm) between joints.
- F. Do not stretch resilient base during installation.
- G. Job-Formed Corners:
 - 1. Outside Corners: 'V' cut back of base strip to 2/3 of its thickness and fold.
 - 2. Inside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 12 inches (300 mm) in length.
 - a. Miter corners to minimize open joints.

3.4 CLEANING AND PROTECTION

- A. Remove excess adhesive from floor, base, and wall surfaces without damage. Comply with manufacturer's written instructions for cleaning and protecting resilient base.
- B. Protect all adjacent surfaces from damage and from excess adhesive. Remove excess adhesive. If adhesive cannot be removed without damaging surface, material or finish, replace as require to product a finish surface.

END OF SECTION

SECTION 09 68 13

TILE CARPETING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes modular carpet tile.

1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture required.

1.4 INFORMATIONAL SUBMITTALS

- A. Sample warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance data.
- B. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. Carpet Tiles: Quantity equal to 5 percent of each product/design type installed.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Minimum 5 years experience and at least 5 similar successful projects.

1.7 WARRANTY

- A. 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.
 - 1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE CHARACTERISTICS

- A. Critical Radiant Flux Classification: Not less than 0.45 W/sq. cm according to NFPA 253.

- B. Electrostatic Propensity: Less than 3.5 kV according to AATCC 134.

2.2 CARPET TILE

- A. See Section 09 06 00 "Schedule of Finishes" for specific product descriptions and designations.

2.3 INSTALLATION ACCESSORIES

- A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.
- B. Attachment Device: Adhesive corner tab for modular carpet similar to Shaw LokDots.
- C. Resilient-Carpet Reducer. See section 09 06 00 "Schedule of Finishes" for specific product descriptions and designations.
- D. Carpet to Tile Transition Strip. See section 09 06 00 "Schedule of Finishes" for specific product descriptions and designations.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Concrete Slabs:
 - 1. Moisture and Alkalinity Testing: Test floor for moisture content and alkalinity using the test recommended by the carpet manufacturer. Verify that both moisture level and alkalinity are within the limits recommended by the carpet and attachment manufacturer. If no recommendation is given conform to the following.
 - a. Anhydrous Calcium Chloride Test: ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 5 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) in 24 hours.
 - 1) Perform additional moisture tests recommended in writing by adhesive and carpet tile manufacturers. Proceed with installation only after substrates pass testing.
 - b. Alkalinity: Test according to ASTM F 710.
 - 1) If reading is lower than 5.0 or greater than 9.0, take corrective measures as directed by manufacturer.
- B. Verify floor flatness meets carpet manufacturer's recommendations.

3.2 PREPARATION

- A. General: Comply with CRI's "CRI Carpet Installation Standards" and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile.
- B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch (3 mm) wide or wider, and protrusions more than 1/32 inch (0.8 mm) unless more stringent requirements are required by manufacturer's written instructions.

1. See also Section 09 60 01 "Floor Patching and Leveling" for additional requirements.
- C. Concrete Substrates: Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by adhesive and carpet tile manufacturers.
- D. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

3.3 INSTALLATION

- A. General: Comply with CRI's "CRI Carpet Installation Standard," Section 18, "Modular Carpet" and with carpet tile manufacturer's written installation instructions.
- B. Installation Method: Partial glue down using LokDots or similar dry applied adhesive.
- C. Maintain dye-lot integrity. Do not mix dye lots in same area.
- D. 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 by carpet tile manufacturer.
- E. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- F. Install pattern parallel to walls and borders.
- G. 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.
- H. See Section 09 65 01 "Resilient Base and Trim" for vinyl reducer strips at exposed edges of carpet.

END OF SECTION

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SECTION 09 90 00

PAINTING AND COATING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes surface preparation and the application of paint and coating systems on interior and exterior substrates.

1.2 DEFINITIONS

- A. Conform to ASTM D 16 for interpretation of terms used in this section.
- B. Gloss Level: As defined by "MPI Architectural Painting Specification Manual".

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate primers of products to be shop primed under other sections and scheduled to receive finish paint under this section.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
- B. Paint System Schedule: Provide a schedule listing each paint system, each paint to be used in the system (referring to product data sheets submitted), and where each system is to be used on the Project.
- C. Samples: Submit two painted samples, illustrating selected colors and textures for each color and system selected with specified coats cascaded. Submit on heavy, non-absorbent cardstock, 8½ x 11 inch (216 x 280 mm) in size with at least one black line printed on a white background.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Manuals: Include in the operation and maintenance manuals a list of all paints actually used on the job and where used. Provide list by system including primer or filler, intermediate coats and top coat. Provide a 8½ x 11 inch paint sample ("draw down") for each finish color keyed to the paint system list.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Paint: 5 percent, but not less than one gallon of each material and color applied, unopened.
 - 2. In addition to the manufacturer's label, label each container with color formula and where used.

1.7 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified, with minimum three years documented experience.
- B. Applicator Qualifications: Company specializing in performing the type of work specified with minimum five years of experience.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.
- B. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.
- C. Paint Materials: Store at minimum ambient temperature of 45 degrees F (7 degrees C) and a maximum of 90 degrees F (32 degrees C), in ventilated area, and as required by manufacturer's instructions.

1.9 FIELD CONDITIONS

- A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.
- B. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.
- C. Do not apply exterior coatings during rain or snow, or when relative humidity is outside the humidity ranges required by the paint product manufacturer.
- D. Do not apply coating where dust is being or is likely to be generated during painting and curing.
- E. Do not apply paint on surfaces exposed to hot sun.
- F. Provide lighting level of 80 ft candles (860 lx) measured mid-height at substrate surface.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Benjamin Moore & Co.
 - 2. Diamond Vogel Paints.
 - 3. Glidden Professional.
 - 4. PPG Architectural Finishes, Inc.
 - 5. Pratt & Lambert.
 - 6. Sherwin-Williams Company (The).
 - 7. Tnemec Company, Inc.

2.2 PAINT, GENERAL

- A. Material Compatibility:
 - 1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 - 2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
- B. Paints and Coatings: Ready mixed, unless intended to be a field-catalyzed coating.
 - 1. Provide paints and coatings of a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating, with good flow and brushing properties, and capable of drying or curing free of streaks or sags.
 - 2. Supply each coating material in quantity required to complete entire project's work from a single production run.
 - 3. Do not reduce, thin, or dilute coatings or add materials to coatings unless such procedure is specifically described in manufacturer's product instructions.
- C. Primers: Where the manufacturer offers options on primers for a particular substrate, use primer categorized as "best" by the manufacturer.

2.3 PAINT SYSTEMS, GENERAL

- A. General Exterior Paint System Notes:
 - 1. Specific products listed (if any) are for reference only. Other similar products are also acceptable. Similar shall be understood to be paints of similar or greater solids content, similar depth of application (DFT) and similar in-service performance record.
 - 2. All paints are to be applied at the manufacturer's suggested depth (DFT) level for the substrate and type of application.

2.4 PAINT SYSTEMS

- A. Paint WI-OP-2F - Wood, Opaque, 2 Coat Flame Resistant
 - 1. One coat of primer sealer as recommended by finish paint manufacturer.
 - 2. Semi-gloss: One coats of Flame Resistant coating conforming to the following:
 - a. Flame spread less than 10; smoke development less than 50 when tested according to ASTM E 84.
- B. Paint WI-OP-3LA -Wood, Opaque, Acrylic Latex, 3 Coat:
 - 1. Primer: Latex primer for wood surfaces.
 - 2. Semi-Gloss: Two coats of acrylic latex: ProMar 200 Zero VOC, B31-2600 Series, by Sherwin Williams.
- C. Paint WI-TR-VS - Wood, Transparent, Varnish, Stain:
 - 1. Stain.
 - 2. One coat sealer. Sealer may be a thinned versions of the finish varnish or may be a separate product as recommended by the varnish manufacturer.
 - 3. Gloss: Two coats of polyurethane varnish.

- D. Paint MI-OP-3LA - Ferrous or Galvanized Metals, Unprimed, 100% Acrylic, 3 Coat:
 - 1. Primer: If shop primed coordinate and verify primer compatibility. If unprimed, Pro-Cryl Universal Primer, B66-310 by Sherwin Williams or as recommended by the finish paint manufacturer.
 - 2. Gloss: Two coats of acrylic latex enamel; Pro Industrial Acrylic, B66-650 Series, by Sherwin Williams.
- E. Paint GI-OP-3LA - Gypsum Board/Plaster, Acrylic, 3 Coat:
 - 1. One coat of finish paint manufacturer's recommended latex primer / sealer.
 - 2. Semi-Gloss: Two coats of acrylic; ProMar 200 Zero VOC, B31-2600 Series, by Sherwin Williams.
- F. Paint CI-OP-3E - Masonry/Concrete, Opaque, Epoxy, 3 Coat:
 - 1. One coat acrylic block filler: Loxon Block Surfacer, A24W200 by Sherwin Williams.
 - 2. Semi-Gloss: Two coats of epoxy; Pro-Industrial Pre-Catalyzed Waterbased Epoxy, K46-450 Series, by Sherwin Williams.

2.5 ACCESSORY MATERIALS

- A. Accessory Materials: Linseed oil, shellac, turpentine, paint thinners and other materials not specifically indicated but required to achieve the finishes specified; commercial quality. Comply with manufacturer's product data for product to be thinned or tinted.
- B. Patching Material: Latex filler.
- C. Fastener Head Cover Material: Latex filler.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 - 1. Gypsum Board: 12 percent, measured in accordance with ASTM D4442.
- C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- D. Test shop-applied primer for compatibility with subsequent cover materials.
- E. Proceed with coating application only after unsatisfactory conditions have been corrected.
 - 1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Manual" applicable to substrates indicated.

- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
- C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
 - 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.
- D. Remove mildew from impervious surfaces by scrubbing with solution of tetra-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.
- E. Existing painted surfaces:
 - 1. Inspect entire surface.
 - 2. Remove all materials or coating that will interfere with the paint bond.
 - 3. Remove all loose paint.
 - 4. Fill / patch areas where loose paint is removed or other depressions as necessary to produce a continuous, even surface.
 - 5. Prime fill / patch areas before applying bond coat to the entire wall surface.
- F. Gypsum Board Surfaces to be Painted: Fill minor defects with filler compound. Spot prime defects after repair.
- G. Galvanized Surfaces to be Painted: Remove surface contamination and oils and wash with solvent.
- H. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.

3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual."
- B. Apply paints to produce surface films of uniform appearance, without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
- C. Apply each coat of paint slightly darker than preceding coat unless otherwise approved. Tint primer and succeeding coatings by approximately 2 shades on a 10 point scale to provide a uniform progression to the final coat and to make each coat visually distinguishable.
- D. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.
- E. Comply with manufacturer's recommendations for curing time between coats; if not stated, minimum 48 hours for exterior paint and minimum 24 hours for interior paint.
- F. Where adjacent sealant is to be painted, do not apply finish coats until sealant is applied.

- G. Additional Coats: Regardless of number of coats specified, apply as many coats as necessary for complete hide imperfections and produce and uniform finish coat.
- H. Paint (or varnish) doors open or removed from frame; paint door edges and frames without sealing joints. Do not close doors until paint is dry.
- I. Paint (or varnish) bottoms of doors before they are installed.
- J. Prime paint surfaces to receive adhered resilient base.
- K. Scope: Finish all interior and exterior surfaces exposed to view, unless fully factory-finished and unless otherwise indicated, including the following:
 - 1. Both sides and edges of plywood backboards for electrical and telecom equipment before installing equipment.
 - 2. Exposed surfaces of steel lintels and ledge angles.
 - 3. Mechanical and Electrical:
 - a. In finished areas, paint all insulated and exposed pipes, conduit, boxes, insulated and exposed ducts, hangers, brackets, collars and supports, mechanical equipment, and electrical equipment, unless otherwise indicated.
 - b. Paint interior surfaces of air ducts and convector and baseboard heating cabinets that are visible through grilles and louvers with one coat of flat black paint to visible surfaces.
 - c. Paint dampers exposed behind louvers, grilles, and convector and baseboard cabinets to match face panels.
- L. Do Not Paint or Finish the Following Items:
 - 1. Required labels including: fire rating labels, equipment serial number and capacity labels.
 - 2. Items fully factory-finished unless specifically so indicated; materials and products having factory-applied primers are not considered factory finished.
 - 3. Items indicated to receive other finishes.
 - 4. Items indicated to remain unfinished.
 - 5. Finished metals including: Stainless steel, anodized aluminum, terne metal, chromium plated metals, copper, bronze, brass and similar items.
 - 6. Floors, unless specifically so indicated.
 - 7. Ceramic and other tiles.
 - 8. Brick, architectural concrete, cast stone, integrally colored plaster and stucco.
 - 9. Glass.
 - 10. Surfaces in concealed areas and inaccessible areas such as furred spaces, utility tunnels, pipe spaces, and duct shafts except where visible through grilles, registers or the like. Do not paint pipes, ducts or conduit located in such spaces.
 - 11. Ductwork, piping, conduits, hangers, equipment supports, and equipment in rooms devoted primarily to mechanical and electrical equipment.

3.4 CLEANING AND PROTECTION

- A. Painting equipment is to be cleaned in Contractor furnished receptacles with waste being properly disposed. The waste is not to be poured down the sanitary sewer, storm sewer or poured out on the ground. Any costs incurred by Owner for clean up will be charged to the Contractor.
- B. In event of accidental spilling of paint, immediately remove spilled paint and wash surfaces to original undamaged condition.

- C. Following completion of painting in each area, reinstall items which were removed for painting by the Contractor.
- D. Upon completion of this portion of work, visually inspect surfaces and remove paint from surfaces not scheduled to be painted.
- E. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- F. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.
- G. As work progresses, promptly remove paint where spilled, splashed or spattered.
- H. During progress of work, maintain premises free of unnecessary accumulation of tools, equipment, surplus materials, and debris. Do not allow accumulation of empty containers or other excess items except in areas designated for that purpose.
- I. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.

3.5 PROTECTION AND CORRECTION

- A. Protect finished coatings until completion of project.
- B. Touch-up damaged coatings after Substantial Completion.
- C. Following completion of painting in each area, reinstall items which were removed for painting by the Contractor.
- D. Upon completion of this portion of work, visually inspect surfaces and remove paint from surfaces not scheduled to be painted.
- E. In event that system does not cover and achieve finish in accordance with manufacturer's claims, apply corrective material to achieve required finish.
- F. Spot painting to correct soiled or damaged paint surfaces will be allowed only when touch-up spot is blended into surrounding finish and is not visible to normal viewing. If not possible, re-coat entire surface to corners or visible stopping point.

3.6 PAINTING SCHEDULE

- A. For Gypsum board walls
 - 1. Substrate: Gypsum board
 - 2. System: GI-OP-3LA (Acrylic Latex)
 - 3. Gloss/Sheen: Semi-Gloss (35-70)
- B. For Gypsum board ceilings
 - 1. Substrate: Gypsum board
 - 2. System: GI-OP-3LA (Acrylic Latex)
 - 3. Gloss/Sheen: Flat (0-10)

- C. For Steel door frames and other exposed steel, interior
 - 1. Substrate: Steel
 - 2. System: MI-OP-3LA (Acrylic Latex)
 - 3. Gloss/Sheen: Semi-Gloss (35-70)
- D. For Steel door frames and other exposed steel, exterior
 - 1. Substrate: Painted metal
 - 2. System: ME-OP-3LA (Acrylic Latex)
 - 3. Gloss/Sheen: Gloss (70-85)
- E. For Plywood Equipment Boards:
 - 1. System: WI-OP-2F (Fire Retardant/Flame Resistant)
 - 2. Gloss/Sheen: Gloss (70-85)
- F. For exposed Concrete Masonry Walls
 - 1. Substrate: CMU
 - 2. System: CI-OP-3E (Epoxy)
 - 3. Gloss/Sheen: Semi-Gloss (20-35)

END OF SECTION

SECTION 10 14 00

INTERIOR SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Interior signage for code required signs.

1.2 ADMINISTRATIVE REQUIREMENTS

- A. Pre-installation Meeting: Conduct a pre-installation meeting two weeks prior to the start of the work of this section; require attendance by Owner's Representative, A/E, and installers.

1.3 SUBMITTALS

- A. Samples: Sign panels and frames, with letters and symbols, each type.
 - 1. Sample Materials:
 - a. Sample of typeface, arrow and symbols in a typical full size layout.
 - b. Samples of all colored materials.
 - c. Samples of all colored finishes.
- B. Manufacturer's Literature:
 - 1. Showing the methods and procedures proposed for the concealed anchorage of the signage system to each surface type.
 - 2. Manufacturer's printed specifications, anchorage details, installation and maintenance instructions.
- C. Shop Drawings: Scaled for manufacture and fabrication of sign types. Identify materials, show joints, welds, anchorage, accessory items, mounting and finishes.
- D. Full size layout patterns for dimensional letters.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A company regularly and presently manufacturing signs similar to those specified in this section as one of their principal products. Provide evidence to document this.
- B. Regulatory Requirements: Products shall meet requirements of the American Disabilities Act

1.5 DELIVERY AND STORAGE

- A. Deliver materials to job in manufacturer's original sealed containers with brand name marked thereon. Protect materials from damage.

- B. Package to prevent damage or deterioration during shipment, handling, storage and installation. Maintain protective covering in place and in good repair until removal is necessary.
- C. Deliver signs only when the site and mounting services are ready for installation work to proceed.
- D. Store products in dry condition inside enclosed facilities.

1.6 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Deterioration of finishes beyond normal weathering.
 - b. Deterioration of embedded graphic image.
 - c. Separation or delamination of sheet materials and components.
 - 2. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Provide signs complete with lettering (vinyl or tactile and Braille, as identified), framing and related components for a complete installation, including necessary mounting accessories, fittings and fastenings.
- B. Provide graphics items as completed units produced by a single manufacturer, including necessary mounting accessories, fittings and fastenings.
- C. Do not scale drawings for dimensions. Contractor to verify and be responsible for all dimensions and conditions shown by these drawings. Owner's Representative to be notified of any discrepancy in drawing, in field directions or conditions, and/or of any changes required for all such construction details.
- D. The Sign Contractor, by commencing work of this section, assumes overall responsibility, as part of his warranty of work, to assure that assemblies, components and parts shown or required within the work of the section, comply with the Contract Documents. The Contractor shall further warrant: That all components, specified or required to satisfactorily complete the installation are compatible with each other and with conditions of installations.

2.2 SIGN TYPES, GENERAL

- A. Photopolymer ADA-Ready interior signage.
 - 1. Design Basis: ASI "InTouch"

2.3 SIGN MATERIALS

- A. Photopolymer:
 - 1. Interior-rated, single-piece photopolymer sign.
 - 2. Tactile lettering with Grade 2 Braille integral to the surface of the sign.
 - 3. Color to be selected by Architect from manufacturer's full range of finish options.

2.4 MOUNTING MATERIALS

- A. Adhesives:
 - 1. Adhesives for Field Application: Mildew-resistant, nonstaining adhesive for use with specific type of panels, sheets, or assemblies; and for substrate application; as recommended in writing by signage manufacturer.
 - 2. Adhesives to have VOC content of 50 g/L or less when calculated according to 40 CFR 59, (EPA Method 24).
- B. Double-Faced Tape: 3M VHB4611 or equal
- C. Accessories, anchorage, mounting devices and spacers shall be non-staining to adjacent surfaces for a period of five years.
- D. Ferrous mountings shall be sleeved with non-ferrous metal covers matching adjacent finishes, cemented with non-hydroscopic glue, or other suitable protective measures.
- E. All aluminum in contact with ferrous metals shall be separated with sheet neoprene.
- F. Adhesives for plastic shall be non-staining and warranted for life of plastic product.
- G. All fasteners to be non-corrosive and concealed.

2.5 SIGN STANDARDS

- A. Typography:
 - 1. Type Style: Font and size(s) as indicated on Drawings. Initial caps or all caps as indicated on drawings.
 - 2. Arrow: See graphic standards on Drawings.
 - 3. Letter spacing: See graphic standards on Drawings.
 - 4. All text, arrows, and symbols to be provided in size, colors, typefaces and letter spacing shown. Text shall be a true, clean, accurate reproduction of typeface(s) shown. Text shown on Drawings for layout purposes only; verify final text.
- B. Project Colors and Finishes:
 - 1. See graphic standards on Drawings and notes.
 - 2. Aluminum, metal and fastener finish coated with appropriate primer & color coat with corrosion inhibitors warranted for 8 years against fading, chipping, cracking, peeling and discoloration.

2.6 FABRICATION

- A. Design components to allow for expansion and contraction for a minimum material temperature range of 56 °C (100 °F), without causing buckling, excessive opening of joints or over stressing of adhesives, welds and fasteners. Contractor is responsible to provide proper thickness to eliminate waviness or other deformations in materials.
- B. Form work to required shapes and sizes, with true curve lines and angles. Provide necessary rebates, lugs and brackets for assembly of units. Use concealed fasteners whenever and wherever possible.

- C. Shop fabricate to the greatest extent practicable. Joints fastened flush to conceal reinforcement, or welded where thickness or section permits, ground smooth, filled, primed & finish painted to match. All seams to be straight & symmetrical.
 - 1. Aluminum plate: Cut all edges in continuous lines and sanded smooth to finish.
- D. Contact surfaces of connected members shall be true. Assemble so joints will be tight and practically unnoticeable, without use of filling compound.
- E. Signs shall have fine, even texture and be flat or continuously contoured and sound. Lines and miters sharp, arrises unbroken, profiles accurate and ornament true to pattern. Plane surfaces shall be smooth flat and without oil-canning, free of rack and twist. Maximum variation from plane of surface plus or minus 0.3 mm (0.015 inches). Restore texture to filed or cut areas.
- F. Level or straighten wrought work. Members shall have sharp lines and angles and smooth surfaces.
- G. Extruded members to be free from extrusion marks. Square turns and corners sharp, curves true.
- H. Drill holes for bolts and screws. Conceal fastenings where possible. Exposed ends and edges mill smooth, with corners slightly rounded. Form joints exposed to weather to exclude water.
- I. Finish hollow signs with matching material on all faces, tops, bottoms and ends. Edge joints tightly mitered to give appearance of solid material.
- J. Ensure all holes, cut edges and penetrations of metal surfaces are free from burrs, primed and painted to maintain corrosion-proof finish.
- K. All painted surfaces properly primed. Finish coating of paint to have complete coverage with no light or thin applications allowing substrate or primer to show. Finished surface smooth, free of scratches, gouges, drips, bubbles, thickness variations, foreign matter and other imperfections.
- L. Pre-assemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for re-assembly and coordinated installation.
- M. No signs are to be manufactured until final sign message schedule and location review has been completed by the Owner's Representative & forwarded to contractor.
- N. Cut-out letters, numbers & images shall be cut in continuous, even lines as indicated on drawings.
- O. Exposed Metal Surfaces:
 - 1. Exposed metal surfaces shall be reinforced, braced & securely fastened to provide rigid assembly.
 - 2. Sign faces shall be free of all holes, except those required to install letters or weep-holes.
 - 3. Flush-butt locked seams and fillers shall be metal screwed & bolted on filler edges to provide smooth faces, free of unsightly rivets.
 - 4. Exposed joints shall be continuously welded, ground & polished smooth and shall not be visible. Mitered corners shall be snug, neat & tight fitting in an even, smooth plane.
- P. Plastics:
 - 1. Embossed or flat sheet plastic shall be free of wrinkles or imperfections from forming or fabrication.

2. All surfaces shall be free of scratches and shall be clean & polished per manufacturer's instruction and protected until installation is complete.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Conform to manufacturer's recommendations.
- B. Protect products against damage during field handling and installation. Protect adjacent existing and newly placed construction, landscaping and finishes as necessary to prevent damage during installation. Paint and touch up any exposed fasteners and connecting hardware to match color and finish of surrounding surface.
- C. Mount signs in proper alignment, level and plumb according to the sign location plan and the dimensions given on elevation and sign location drawings. Where otherwise not dimensioned, signs shall be installed where best suited to provide a consistent appearance throughout the project. When exact position, angle, height or location is in doubt, contact Owner's Representative for clarification.
- D. Contractor shall be responsible for all signs that are damaged, lost or stolen while materials are on the job site and up until the completion and final acceptance of the job.
- E. Remove or correct signs or installation work Owner's Representative determines as unsafe or as an unsafe condition.
- F. At completion of sign installation, clean exposed sign surfaces. Clean and repair any adjoining surfaces and landscaping that became soiled or damaged as a result of installation of signs.
- G. Locate signs as shown on the Sign Location Plans.
- H. Contractor will be responsible for verifying that behind each sign location there are no utility lines that will be affected by installation of signs. Any damage during installation of signs to utilities will be the sole responsibility of the Contractor to correct and repair.
- I. Provide all supporting & anchoring means as required for proper installation. Furnish inserts and anchoring devices which must be set in concrete or other material for installation of signs. Provide setting drawings, templates, instructions and directions for installation of anchorage devices which may involve other trades.
- J. Accessories, anchorage, mounting devices & spacers shall be warranted as non-staining to adjacent walls and sign finishes for a period of five years after acceptance.
- K. Ferrous mountings may be sleeved with non-ferrous metal covers matching adjacent finishes, cemented with non-hydroscopic glue, or other suitable protective measures may be proposed to comply with this specification.
- L. At completion of installation turn over to Owner's Representative additional stock of signs and sign components. Individually box or crate by Sign Type or Part Number and labeled accordingly.

3.2 CLEANING

- A. Final cleaning of all surfaces shall be carefully done strictly in accordance with the manufacturers or consultant's instructions.

3.3 PROTECTION

- A. All exposed surfaces and sign components shall be protected until final installation and approval by the Owner's Representative. Any work damaged or discolored in any way before approval occurs shall be the replaced by the Contractor.

3.4 SCHEDULE

- A. Type A - Interchangeable Room Signs:
 - 1. Acrylic plastic, 8 1/2" high x 8 1/2" wide overall. Provide 2 1/4" high clear "window" across bottom of sign to receive interchangeable paper inserts for room name.
 - 2. Room Number:
 - a. 1" high raised text with Braille beneath at upper left of sign.
 - b. White text on panel color selected by Architect.
 - c. Text Copy: Match room numbers on floor plan.
 - 3. Room Name:
 - a. 1 or 2 rows of 3/4" high text.
 - b. Print black text on white card stock inserts.
 - c. Provide a Microsoft Word template for use in creating future inserts.
 - d. Text Copy: As scheduled.
 - 4. Mounting: double-faced VHB tape.
- B. Type B - Permanent Room Signs:
 - 1. Acrylic plastic, 9 1/2" high x 6 1/2" wide.
 - 2. Provide raised white International ADA approved symbols centered.
 - 3. Room Number:
 - a. 1" high raised text with Braille beneath at upper left of sign.
 - b. White text on panel color selected by Architect.
 - c. Text Copy: Match room numbers on floor plan.
 - 4. Room Name:
 - a. 1" high raised text with Braille beneath centered at bottom of sign.
 - b. White text on panel color selected by Architect.
 - c. Text Copy: Match room names on floor plan.
 - 5. Mounting: double-faced VHB tape.
- C. Type C - Door Number Signs:
 - 1. Laminated acrylic plastic, 1 1/2" high x 6" wide.
 - 2. Engraved 1" high text centered.
 - 3. Face color selected by Architect over white backing.
 - 4. Text Copy: Match door numbers on door schedule.
 - 5. Mounting: double-faced VHB tape.
 - 6. Mount on door head frame on exterior side of interior doors and interior side of exterior doors.

END OF SECTION

SECTION 10 21 19

PLASTIC TOILET COMPARTMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes
 - 1. Solid plastic (HDPE) toilet compartments.
 - 2. Urinal screens.
- B. Related Requirements
 - 1. Section 10 28 00 – Toilet Room Accessories.

1.2 ACTION SUBMITTALS

- A. Shop Drawings: Indicate partition plan, elevation views, dimensions, details of wall supports, door swings.
- B. Product Data: Provide data on panel construction, hardware, and accessories.
- C. Samples: Submit two samples of partition panels, 5 x 3 inch (127 x 76 mm) in size illustrating panel finish, color, and sheen.

1.3 INFORMATIONAL SUBMITTALS

- A. Manufacturer's Installation Instructions: Indicate special procedures.

PART 2 - PRODUCTS

2.1 COMPONENTS

- A. Toilet Compartments: Solid molded high density polyethylene (HDPE) plastic panels, doors, and pilasters, floor-mounted, headrail-braced.
 - 1. Color: To be selected by Architect.
 - 2. Standards: Comply with NFPA 286 Room Corner Test.
- B. Door and Panel Dimensions:
 - 1. Panel Thickness: Not less than 1 inch (25 mm).
 - 2. Door Width: 24 inch (610 mm).
 - 3. Height: 58 inch (1 473 mm).
 - 4. Thickness of Pilasters and Doors: Not less than 1 inch (25 mm).
- C. Urinal Screens: Solid molded high density polyethylene (HDPE) plastic panels, floor mounted, over-head braced.
- D. Provide stainless-steel heat-sink strips applied to bottom edge of all panels & doors.

- E. Reinforce panels as recommended by panel manufacturer for panel mounted toilet accessories as scheduled.

2.2 ACCESSORIES

- A. Pilaster Brackets: Polished stainless steel.
- B. Wall Brackets: Continuous type, polished stainless steel.
- C. Attachments, Screws, and Bolts: Stainless steel, tamper proof type.
 - 1. For attaching panels and pilasters to brackets: Through-bolts and nuts; tamper proof.
- D. Hardware: Polished stainless steel:
 - 1. Pivot hinges, gravity type, adjustable for door close positioning; two per door.
 - 2. Door Latch: Slide type with exterior emergency access feature.
 - 3. Door strike and keeper with rubber bumper; mounted on pilaster in alignment with door latch.
 - 4. Coat hook with rubber bumper; one per compartment, mounted on door.
 - 5. Provide door pull for outswinging doors.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify correct spacing of and between plumbing fixtures.
- C. Verify correct location of built-in framing, anchorage, and bracing.

3.2 INSTALLATION

- A. Install partitions secure, rigid, plumb, and level in accordance with manufacturer's instructions.
- B. Maintain 3/8 to 1/2 inch (9 to 13 mm) space between wall and panels and between wall and end pilasters.
- C. Attach panel brackets securely to walls using anchor devices.
- D. Attach panels and pilasters to brackets. Locate head rail joints at pilaster center lines.
- E. Repair damaged panel, mounting brackets and hardware. If panels cannot be repaired to the satisfaction of the Architect/Engineer, replace damaged items.

3.3 TOLERANCES

- A. Maximum Variation From True Position: 1/4 inch (6 mm).
- B. Maximum Variation From Plumb: 1/8 inch (3 mm).

3.4 ADJUSTING

- A. Adjust and align hardware to uniform clearance at vertical edge of doors, not exceeding 3/16 inch (5 mm).
- B. Adjust hinges to position doors in partial opening position when unlatched.
- C. Adjust adjacent components for consistency of line or plane.

END OF SECTION

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SECTION 10 26 13

CORNER GUARDS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes
 - 1. Corner guards.

1.2 ACTION SUBMITTALS

- A. Product Data: Indicate physical dimensions, features, anchorage details, and rough-in measurements.
- B. Samples: Submit two sections of corner guard, 6 inch (150 mm) long, illustrating component design, configuration, color and finish.

1.3 INFORMATIONAL SUBMITTALS

- A. Manufacturer's Instructions: Indicate special procedures, perimeter conditions requiring special attention.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Wall and Corner Guards:
 - 1. Arden Architectural Specialties, Inc: www.ardenarch.com.
 - 2. Construction Specialties, Inc: www.c-group.com.
 - 3. InPro Corporation: www.inprocorp.com.
 - 4. Koroseal Wall Protection Systems: www.korogard.com.

2.2 COMPONENTS

- A. Corner Guard - Surface Mounted: High impact vinyl direct applied over wall surface.
 - 1. Size: 1.5 inches (38 mm).
 - 2. Thickness: Minimum 0.080 inch (2 mm).
 - 3. Corner: Square.
 - 4. Color: As selected from manufacturer's standard colors.
 - 5. Texture: As selected by Architect.
 - 6. Length: As noted on Drawings.
 - 7. Application: Adhesive.

2.3 FABRICATION

- A. Fabricate components with tight joints, corners and seams.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install components in accordance with manufacturer's instructions, level and plumb, secured rigidly in position to wall or casework component.
- B. Position corner guard to start immediately above vinyl base.
- C. Coordinate with installation of wall finishes and base.

3.2 TOLERANCES

- A. Maximum Variation from Required Height: 1/4 inch (6 mm).
- B. Maximum Variation from Level or Plane for Visible Length: 1/4 inch (6 mm).

END OF SECTION

SECTION 10 28 00
TOILET ROOM ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes
 - 1. Accessories for toilet rooms and showers.

1.2 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate the work with the placement of internal wall reinforcement, concealed ceiling supports, and reinforcement of toilet partitions to receive anchor attachments.

1.3 ACTION SUBMITTALS

- A. Product Data: Provide data on accessories describing size, finish, details of function, attachment methods.

1.4 INFORMATIONAL SUBMITTALS

- A. Manufacturer's Installation Instructions: Indicate special procedures and conditions requiring special attention.

1.5 CLOSEOUT SUBMITTALS

- A. Provide special tools as required to operate and maintain products supplied under this Section.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Toilet Accessories, General: Shop assembled, free of dents and scratches and packaged complete with anchors and fittings, steel anchor plates, adapters, and anchor components for installation.
 - 1. Grind welded joints smooth.
 - 2. Fabricate units made of metal sheet of seamless sheets, with flat surfaces.
- B. Stainless Steel Sheet: ASTM A666, Type 304.
- C. Mirror Glass: Float glass, ASTM C1036 Type I, Class 1, Quality Q2, with silvering, protective and physical characteristics complying with ASTM C1503.

2.2 FINISHES

- A. Stainless Steel: No. 4 satin brushed finish, unless otherwise noted.
- B. Aluminum: Satin finish

- C. Chrome/Nickel Plating: ASTM B456, SC 2, satin finish.

2.3 TOILET ROOM ACCESSORIES

- A. Toilet Paper Dispenser: Compact 4-Roll Rotary Coreless High Capacity, Key Lock, Smoke.
 - 1. Sample Product: Model 56788 by GP Pro (Georgia Pacific) or approved equal.
- B. Paper Towel Dispenser: Automated touchless, stainless steel, surface mounted.
 - 1. Capacity: Unit shall accept 10" x 800' towel rolls.
 - 2. Sample Product: "enMotion" 10" Model 59462A manufactured by Georgia Pacific.
- C. Mirrors: Frameless.
 - 1. ASTM C 1036, Type 1 transparent flat, Class 1 clear, Quality Q1 (mirror select); 6 mm thick.
 - 2. See Drawings for sizes.
 - 3. See Drawings for mounting and trim detail.
- D. Sanitary Napkin Disposal Unit: Stainless steel, surface mounted with self-closing door, locking bottom panel with full-length stainless-steel piano-type hinge, removable receptacle of 1.2 gal..
 - 1. Sample Product: B254 manufactured by Bobrick.
 - 2. Remove tumbler lock and fit with knob and catch or finger grip and catch.
- E. Grab Bars:
 - 1. 1-1/4 inches (32 mm) outside diameter, minimum 0.05 inch (1.3 mm) wall thickness, nonslip grasping surface finish, concealed flange mounting; 1-1/2 inches (38 mm) clearance between wall and inside of grab bar.
 - 2. Length and configuration: As indicated on drawings.
 - 3. Design Basis: B-6806 manufactured by Bobrick
- F. Soap Dispenser: Contractor Provided/Contractor Installed. Spartan Lite & Foamy. Product No. 9756.
- G. Wall-Mounted Coat Rack:
 - 1. Size: 24" Long by 13" Deep
 - 2. Model: U-Line H-2515S
 - 3. Finish: Satin-finish Aluminum

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify exact location of accessories for installation.
- C. Verify reinforcing. Where accessories are to be mounted on toilet partition walls, verify that the partitions are reinforced to receive accessories. Where accessories are to be mounted on framed walls, verify that blocking has been provided. Where accessories are to be mounted on masonry, verify that the cores of the masonry have been filled.

3.2 PREPARATION

- A. Deliver inserts and rough-in frames to site for timely installation.
- B. Provide templates and rough-in measurements as required.

3.3 INSTALLATION

- A. Install accessories in accordance with manufacturers' instructions.
- B. Install plumb and level, securely and rigidly anchored to substrate.
- C. Mounting Heights and Locations: As indicated on drawings

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SECTION 10 44 00
FIRE PROTECTION SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Portable fire extinguishers.
 - 2. Fire extinguisher cabinets.
 - 3. Accessories.

1.2 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate size of fire-protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.
 - 2. Coordinate sizes and locations of fire-protection cabinets with wall depths.
- B. Sequencing
 - 1. Apply [**decals**] [**vinyl lettering**] on field-painted fire-protection cabinets after painting is complete.

1.3 ACTION SUBMITTALS

- A. Shop Drawings: Indicate cabinet physical dimensions and relationship to adjacent materials.
- B. Product Data: Provide extinguisher operational features and data on cabinet.

1.4 QUALITY ASSURANCE SUBMITTALS

- A. Manufacturer's Installation Instructions: Indicate special criteria and wall opening coordination requirements.
- B. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance data: Include test, refill or recharge schedules and re-certification requirements.

1.6 FIELD CONDITIONS

- A. Do not install extinguishers when ambient temperature may cause freezing of extinguisher ingredients.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."
- B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

2.2 FIRE EXTINGUISHERS

- A. Fire Extinguishers - General: Comply with product requirements of NFPA 10 and applicable codes, whichever is more stringent.
- B. Foam Type Fire Extinguishers: Cast steel tank, with pressure gage.
 - 1. Class 4A-80B: C.
 - 2. Finish: Baked enamel, red color.
 - 3. Temperature range: -65 degrees F (-54 degrees C) to 120 degrees F (49 degrees C).
 - 4. Product: Amerex B456, no substitutes.

2.3 FIRE EXTINGUISHER CABINETS

- A. Metal: Formed primed steel sheet; 0.036 inch (0.9 mm) thick base metal.
- B. Cabinet Configuration: Semi-recessed type.
 - 1. Sized to accommodate specified extinguisher.
 - 2. Trim: Rolled-edge, 3-1/2 inch (90 mm) depth.
- C. Door Configuration: Vertical strip window.
 - 1. Material: Aluminum.
 - 2. Glazing: Clear Acrylic.
 - 3. Hardware: Zinc plated handle and roller latch.
- D. Weld, fill, and grind components smooth.
- E. Door and Trim Finish: Clean anodized aluminum
- F. Finish of Cabinet Interior: White enamel.

2.4 ACCESSORIES

- A. Extinguisher Brackets: Formed steel, chrome-plated. (For locations for which no cabinet is indicated)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify rough openings for cabinet are correctly sized and located.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install cabinets plumb and level in wall openings, 36 inches (914 mm) from finished floor to inside bottom of cabinet.
- C. Secure fire-protection cabinets rigidly in place. Fasten cabinets to structure, square and plumb.
- D. Adjust fire-protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.
- E. Place extinguishers and accessories in cabinets.

END OF SECTION

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SECTION 12 21 13
HORIZONTAL LOUVER BLINDS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes
 - 1. Horizontal Slat Louver Blinds.
 - 2. Operating hardware.
- B. Related Requirements
 - 1. Section 06 10 00 - Rough Carpentry: Concealed wood blocking for attachment of headrail brackets.

1.2 ACTION SUBMITTALS

- A. Product Data: Provide data indicating physical and dimensional characteristics.
- B. Shop Drawings: Indicate how blinds will be anchored to the adjacent structure.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Horizontal Louver Blinds:
 - 1. Hunter Douglas: www.hunterdouglas.com.
 - 2. Levolor Contract: www.levolorcontract.com.
 - 3. Graber, division of Springs Window Fashions: www.graberblinds.com.

2.2 BLINDS AND BLIND COMPONENTS

- A. Blinds: Horizontal slat louvers hung from full-width headrail with full-width bottom rail; manual control of raising and lowering by cord with full range locking; blade angle adjustable by control wand; complying with WCMA A100.1.
- B. Metal Slats: Spring tempered pre-finished aluminum; radiused slat corners, with manufacturing burrs removed.
 - 1. Width: 1 inch (25 mm).
 - 2. Thickness: 0.008 inch (0.20 mm).
 - 3. Color: Satin Nickel by Levelor or similar.
- C. Slat Support: Woven polypropylene cord, ladder configuration.
- D. Head Rail: Pre-finished, formed aluminum box, with end caps; internally fitted with hardware, pulleys, and bearings for operation; same depth as width of slats.
 - 1. Color: Same as slats.

- E. Bottom Rail: Pre-finished, formed steel with top side shaped to match slat curvature; with end caps. Color: Same as headrail.
- F. Lift Cord: Braided nylon; continuous loop.
- G. Control Wand: Extruded hollow plastic; hexagonal shape.
 - 1. Color: clear.
- H. Headrail Attachment: Wall brackets, jamb mounting.
- I. Accessory Hardware: Type recommended by blind manufacturer.

2.3 FABRICATION

- A. Fabricate blinds to fit within openings with uniform edge clearance of 1/4 inch (6 mm) each side.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that openings are ready to receive the work.
- B. Ensure structural blocking and supports are correctly placed.

3.2 INSTALLATION

- A. Install blinds in accordance with manufacturer's instructions.
- B. Secure in place with flush countersunk fasteners.

3.3 INSTALLATION TOLERANCES

- A. Maximum Variation of Gap at Window Opening Perimeter: 1/4 inch (6 mm).
- B. Maximum Offset from Level: 1/8 inch (3 mm).

3.4 ADJUSTING

- A. Adjust blinds for smooth operation.

3.5 CLEANING

- A. Clean blind surfaces just prior to occupancy.

END OF SECTION

SECTION 22 05 01

SELECTIVE PLUMBING DEMOLITION AND REMODELING

PART 1 - GENERAL – NOT USED

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify field measurements and piping system arrangements are as shown on Drawings.
- B. Verify that abandoned piping and equipment serve only abandoned facilities.
- C. Demolition Drawings are based on existing record documents and selective field observation. Only items critical to performance of new systems and extensions to existing systems have been verified to extent practicable by field observations. Report discrepancies to Owner and Architect/Engineer before disturbing existing installation.

3.2 PREPARATION

- A. Disconnect piping in walls, floors, and ceiling scheduled for removal.
- B. Coordinate utility service outages with Owner. Notify Owner at 7 days and again at 48 hours prior to service shutdown.

3.3 DEMOLITION AND EXTENSION OF EXISTING PLUMBING WORK

- A. Remove, relocate, and extend existing installations to accommodate new construction.
- B. Remove exposed abandoned piping. Cut piping flush with walls and floors, and patch surfaces per Architectural instructions.
- C. Disconnect and remove abandoned distribution equipment where noted on Drawings.
- D. Disconnect and remove plumbing devices and equipment serving utilization equipment that has been removed.
- E. Repair adjacent construction and finishes damaged during demolition and extension work to match existing conditions.
- F. Maintain access to existing plumbing installations that are to remain active.
- G. Extend existing installations using materials and methods compatible with existing plumbing installations, unless noted otherwise.

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SECTION 22 05 17

SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Sleeves.
 - 2. Sleeve-seal systems.
 - 3. Escutcheons.
 - 4. Grout.

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

2.2 SLEEVE-SEAL SYSTEMS

- A. Sleeve-seal systems in this article are used for piping penetrations in slabs-on-grade and below grade in exterior walls. These systems are available for NPS 1/2 to NPS 48 piping.
- B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
 - 1. Basis of Design: Garlock Link-Seal ®
 - 2. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe materials and size of pipe.
 - 3. Pressure Plates: Carbon steel or glass-reinforced plastic.
 - 4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.3 ESCUTCHEONS

- A. Escutcheon Types:
 - 1. One-Piece, Steel Type: With polished, chrome-plated finish and setscrew fastener.

2.4 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.

- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 1-1/2 inches above finished floor level.
 - 2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- C. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 07 90 00 "Joint Sealers."
- D. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.

3.2 SLEEVE-SEAL SYSTEM INSTALLATION

- A. Install sleeve-seal system in sleeves in exterior concrete walls below grade and slabs-on-grade at service piping into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assembly sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.3 INSTALLATION OF ESCUTCHEONS

- A. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.
- B. Install escutcheons for exposed piping penetrations of walls, ceiling, and finished floors within finished spaces only.

3.4 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
1. Exterior Concrete Walls below Grade:
 - a. All Sizes: Galvanized-steel wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 2. Concrete Slabs on Grade:
 - a. All Sizes: Galvanized-steel wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 3. Concrete Slabs above Grade:
 - a. All Sizes: Galvanized-steel pipe sleeves.
 4. Interior Partitions:
 - a. All Sizes: Galvanized-steel pipe sleeves.

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SECTION 22 05 19

METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Dial Thermometers.
 - 2. Thermometer Supports.
 - 3. Test Plugs.
 - 4. Dial Pressure Gages.
 - 5. Pressure Gage Tapings.

1.2 ACTION SUBMITTALS

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

1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 DIAL THERMOMETERS

- A. Manufacturers:
 - 1. Weksler Glass Thermometer Corp.
 - 2. Weiss Instruments, Inc.
 - 3. Winters Instruments.
 - 4. Trerice.
- B. Thermometer: ASTM E 1, stainless steel case, with front recalibration, bimetallic helix actuated with silicone fluid damping, white with black markings and black pointer hermetically sealed lens, stainless steel stem.
 - 1. Size: 5 inch diameter dial.
 - 2. Lens: Clear glass.
 - 3. Accuracy: 1 percent.
 - 4. Calibration: Degrees F.
 - 5. Temperature Range:
 - a. 0 to 100 degrees F for cold pipes
 - b. 30 to 240 degrees F for hot pipes

2.2 THERMOMETER SUPPORTS

- A. Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.

2.3 DIAL PRESSURE GAGES

- A. Manufacturers:
 - 1. Weksler.
 - 2. Weiss Instruments, Inc.
 - 3. Winters Instruments.
 - 4. Trerice.
- B. Pressure Gages: ASME B40.100, drawn stainless steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.
 - a. 4-1/2 inch dial, cast aluminum case, direct mounting.
 - b. Brass globe needle valve.
 - c. Liquid filled with snubber for pump discharge gages.
- C. Gauge Range to be 1.5 times the normal operating pressuresk.

2.4 PRESSURE GAGE TAPINGS

- A. Gage Cock: Tee or lever handle, brass for maximum 150 psi.
- B. Needle Valve: Brass, 1/4 inch NPT for minimum 150 psi.
- C. Pulsation Damper: Pressure snubber, brass with 1/4 inch connections.
- D. Syphon: Steel, Schedule 40, 1/4 inch angle or straight pattern.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install thermowells with socket extending to center of pipe and in vertical position in piping tees. Enlarge pipes smaller than 2-1/2 inch for installation of thermometer sockets.
- C. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- D. Install thermowells with extension on insulated piping.
- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- F. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- G. Install valve and snubber in piping for each pressure gage for fluids.

3.2 ADJUSTING

- A. Adjust faces of meters and gages to proper angle for best visibility.

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SECTION 22 05 29

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Metal pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Thermal-hanger shield inserts.
 - 4. Fastener systems.
 - 5. Pipe stands.
 - 6. Equipment supports.

1.2 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
 - 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
 - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.3 ACTION SUBMITTALS

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

1.4 QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 - 2. Galvanized Metallic Coatings: Pre-galvanized or hot dipped.
 - 3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
 - 4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 - 5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

6. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
7. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
8. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

B. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.2 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 THERMAL-HANGER SHIELD INSERTS

- A. Insulation-Insert Material for Hot or Cold Piping: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength and vapor barrier.
- B. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- C. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- D. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.4 PIPE STANDS

- A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support piping.
- B. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

2.5 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

- BBS 23067 HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT
Building M-04 Renovation & Addition 22 05 29 - 3
Camp Dodge, Johnston, Iowa

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch
5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.
 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports or metal trapeze pipe hangers and attachments for general service applications.
- F. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.
- G. Use padded hangers for piping that is subject to scratching.
- H. Use thermal-hanger shield inserts for insulated piping and tubing.
- I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
 - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
 - 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
 - 5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 - 6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
 - 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 - 8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 - 9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 - 10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
 - 11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
 - 12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
 - 13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 - 14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
 - 15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
 - 16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
 - 17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.

- BBS 23067 HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT
Building M-04 Renovation & Addition 22 05 29 - 6
Camp Dodge, Johnston, Iowa

- a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
- 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
- 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
- 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 - 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 - 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- N. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

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SECTION 22 05 53

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Pipe labels.
 - 3. Detectable underground warning tape.
 - 4. Valve tags.

1.2 ACTION SUBMITTALS

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

1.3 CLOSEOUT SUBMITTALS

- A. Equipment Label Schedules: For each piece of equipment to include in maintenance manuals.
- B. Valve-Tag Schedules: For each piping system to include in maintenance manuals.
 - 1. Tabulate the following sections:
 - a. Valve Tag Number.
 - b. Location (room name and room number).
 - c. System name.
 - d. Serves (fixture or group of fixtures served).
 - e. Valve manufacturer.
 - f. Valve model number.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Plastic Labels for Equipment:
 - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
 - 2. Letter Color: White.
 - 3. Background Color: Black.
 - 4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
 - 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 - 6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
 - 7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

- B. Label Content: Include equipment's Drawing designation or unique equipment number.

2.2 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: Size letters according to ASME A13.1 for piping.

2.3 DETECTABLE UNDERGROUND WARNING TAPE

- A. Description: Preprinted continuous accident-prevention ribbon tape, bright APWA approved colors, minimum 6-inch wide and 4-mil thick, with detectable aluminum backing, suitable for direct burial over underground utilities.
- B. Nomenclature: Large-size print with a similar or equal description of the following;
 - 1. Water Piping: "CAUTION BURIED WATER LINE BELOW".
 - 2. Sanitary Sewer Piping: "CAUTION BURIED SEWER LINE BELOW".
 - 3. Natural Gas Piping: "CAUTION BURIED GAS LINE BELOW".

2.4 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers. Each valve tag shall identify the piped system on which it is installed, and the branch, area, or device which it serves.
 - 1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Fasteners: Brass wire-link chain or beaded chain.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Label components concealed by insulation, such as valves, strainers, unions, etc. on the outside of the insulation covering.
- C. Coordinate installation of identifying devices with locations of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

- A. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 20 feet along each run.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- B. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- C. Install pipe labels in accordance with manufacturer's instructions.

3.5 DETECTABLE UNDERGROUND WARNING TAPE INSTALLATION

- A. Install underground detectable warning tape between 10 and 12 inches below finished grade, directly above buried piping located exterior of the building.

3.6 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems. List tagged valves in a valve schedule.
- B. Install tags with corrosion resistant chain.

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SECTION 22 07 19

PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Pipe insulation and accessories.
 - 2. Factory-Applied jackets and accessories.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied, if any).

1.3 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.5 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.6 SCHEDULING

- A. Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.

- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- D. Glass-Fiber, Preformed Pipe Insulation:
 - 1. Manufacturers:
 - a. Owens Corning.
 - b. Johns Manville.
 - c. Knauf.
 - 2. Glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 3. ASTM C 411 Minimum Service Temperature: 0 deg. F.
 - 4. ASTM C 411 Maximum Service Temperature: 850 deg. F.
 - 5. ASTM C 209 Water Absorption: <5% by weight.
 - 6. Maximum k-value at 75 deg. F. Mean Temperature: 0.23 BTU.in/ft.²hr.°F.

2.2 INSULATING CEMENTS

- A. Glass-Fiber Insulating Cement: Comply with ASTM C195.

2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Glass-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
- D. ASJ Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

2.4 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

- B. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
 - 1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
 - 2. Service Temperature Range: Minus 20 to plus 180 deg F.
 - 3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
 - 4. Color: White.

2.5 SEALANTS

- A. Joint Sealants:
 - 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 2. Permanently flexible, elastomeric sealant.
 - 3. Service Temperature Range: Minus 100 to plus 300 deg F.
 - 4. Color: White.
 - 5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 6. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- B. ASJ Flashing Sealants:
 - 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 2. Fire- and water-resistant, flexible, elastomeric sealant.
 - 3. Service Temperature Range: Minus 40 to plus 250 deg F.
 - 4. Color: White.
 - 5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.6 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
 - 1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.

2.7 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 1. Install insulation continuously through hangers and around anchor attachments.
 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
 1. Draw jacket tight and smooth.

2. Cover circumferential joints with 3-inch wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
 - a. For below-ambient services, apply vapor-barrier mastic over staples.
 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above-ambient services, do not install insulation to the following:
1. Vibration-control devices.
 2. Testing agency labels and stamps.
 3. Nameplates and data plates.

3.4 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 7. For services not specified to receive a field-applied jacket install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 8. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

3.5 INSTALLATION OF GLASS-FIBER INSULATION

- A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
 4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
- B. Insulation Installation on Pipe Fittings and Elbows:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
- C. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
 2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
 3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 4. Install insulation to flanges as specified for flange insulation application.

3.6 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water:

1. NPS 1 and Smaller: Insulation shall be the following:
 - a. Glass-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.
2. NPS 1-1/4 and Larger: Insulation shall be the following:
 - a. Glass-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

B. Domestic Hot Water:

1. NPS 1-1/2 and Smaller: Insulation shall be the following:
 - a. Glass-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

C. Plumbing Vents Within 10 Feet of the Exterior:

1. NPS 2 and Smaller: Insulation shall be the following:
 - a. Glass-Fiber, Preformed Pipe Insulation, Type 1: 1/2 inch thick.
2. NPS 2-1/2 and Larger: Insulation shall be the following:
 - a. Glass-Fiber, Preformed Pipe Insulation, Type 1: 1 inch thick.

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SECTION 22 11 16
DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Piping materials.
 - 2. Copper tube and fittings.
 - 3. Piping joining materials.

1.2 ACTION SUBMITTALS

- A. Product Data: For pipe materials, fittings, valves, and accessories.
- B. Project Record Documents: Record actual pipe routing and location of valves.

1.3 CLOSEOUT SUBMITTALS

- A. Water Distribution/Service Form A (Flushing and Disinfection).
 - 1. Reference Section 01 78 00 – Project Closeout for “Project Closeout Submittal Checklist”, and Division 01 Appendix for related form.
- B. Water Distribution/Service Form B (Pressure and Leak Test).
 - 1. Reference Section 01 78 00 – Project Closeout for “Project Closeout Submittal Checklist”, and Division 01 Appendix for related form.
- C. Field Quality Control Reports.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.
- B. Potable-water piping and components shall comply with NSF 14 and NSF 61 Annex G. Plastic piping components shall be marked with "NSF-pw."

2.2 COPPTER TUBE AND FITTINGS (BURIED WITHIN 10 FEET OF BUILDING)

- A. Soft Copper Tube: ASTM B88, Type K water tube, annealed temper.
- B. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

2.3 COPPER TUBE AND FITTINGS (ABOVE GRADE)

- A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.
- B. Wrought-Copper, Solder-Joint Fittings:
 - 1. ASME B16.22, wrought-copper pressure fittings.
- C. Copper Pressure-Seal-Joint Fittings:
 - 1. ASME B16.51: Copper and Copper Alloy Press-Connect Pressure Fittings.
 - 2. Fittings for NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber, O-ring seal in each end.
- D. Bronze Flanges:
 - 1. ASME B16.24, Class 150, with solder-joint ends.
- E. Copper Unions:
 - 1. MSS SP-123.
 - 2. Cast-copper-alloy, hexagonal-stock body.
 - 3. Ball-and-socket, metal-to-metal seating surfaces.
 - 4. Solder-joint or threaded ends.

2.4 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials:
 - 1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
 - 2. Full-face or ring type unless otherwise indicated.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys.
- D. Flux: ASTM B 813, water flushable.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install buried copper tubing according to CDA's "Copper Tube Handbook."
- C. Install shutoff valve immediately upstream of each dielectric fitting.
- D. Install domestic water piping level with 0.25 percent slope downward toward drain without pitch and plumb.

- E. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- F. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- G. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- H. Install piping to permit valve servicing.
- I. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.
- J. Install piping free of sags and bends.
- K. Install fittings for changes in direction and branch connections.
- L. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- M. Install pressure gages on suction and discharge piping for each plumbing pump. Comply with requirements for pressure gages in Section 22 05 19 "Meters and Gages for Plumbing Piping."
- N. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."
- O. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."

3.2 JOINT CONSTRUCTION

- A. Copper Piping:
 - 1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
 - 2. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
 - 3. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."
 - 4. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
 - 5. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.
- B. Dissimilar-Material Piping:
 - 1. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.3 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for pipe hanger, support products, and installation in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."
 - 1. Vertical Piping: MSS Type 8 or 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Support vertical piping and tubing at base and at each floor.
- C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.
- D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 3/4 and smaller: 60 inches with 3/8-inch rod.
 - 2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
 - 3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 - 4. NPS 2-1/2: 108 inches with 1/2-inch rod.
 - 5. NPS 3: 10 feet with 1/2-inch rod.
- E. Install supports for vertical copper tubing every 10 feet.

3.4 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.
- C. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
 - 1. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
 - 2. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.5 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification materials and installation in Section 22 05 53 "Identification for Plumbing Piping and Equipment."
- B. Label pressure piping with system operating pressure.

3.6 FIELD QUALITY CONTROL

- A. Conduct Flushing and Disinfection and Pressure Leak Tests in the presence of the Owner prior to Substantial Completion. Submit completed "Water Distribution/Service Form A and B" (Reference Section 01 78 00 – Project Closeout for "Project Closeout Submittal Checklist"). Provide a minimum 48-hours' notice to Owner, prior to start of testing procedures.
- B. Perform the following tests and inspections:
 - 1. Piping Inspections:
 - a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 - b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - 1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
 - 2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
 - c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
 - d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
 - 2. Piping Tests:
 - a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 - b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
 - c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 - e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
 - f. Prepare reports for tests and for corrective action required.
- C. See Section 01 14 00 "General Requirements" for retesting and re-inspecting requirements, and requirements for correcting the Work.
- D. Domestic water piping will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.7 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
 - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
 - b. Adjust calibrated balancing valves to flows indicated.
5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.8 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm (50 mg/L) of chlorine. Isolate with valves and allow to stand for 24 hours.
 - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm (200 mg/L) of chlorine. Isolate and allow to stand for three hours.
 - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d. Repeat procedures if biological examination shows contamination.
 - e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Clean non-potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

- C. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.
- D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.9 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Aboveground domestic cold and hot, NPS 2 and smaller, shall be of the following:
 - 1. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); wrought-copper, solder-joint fittings; and soldered joints.
 - 2. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); copper pressure-seal-joint fittings; and pressure-sealed joints.

3.10 VALVE SCHEDULE

- A. Where specific valve types are not indicated, the following requirements apply:
 - 1. Shutoff Duty: Use ball valves.
 - 2. Throttling Duty: Use ball valves.
 - 3. Drain Duty: Hose-end drain valves.
- B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

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SECTION 22 11 19

DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Backflow Preventers.
 - 2. Ball Valves.
 - 3. Curb Valve.
 - 4. Curb Box.
 - 5. Dielectric Fittings.
 - 6. Pressure Relief Valves.
 - 7. Strainers.
 - 8. Temperature-Actuated, Water Mixing Valves.
 - 9. Water Hammer Arresters.
 - 10. Water Pressure-Reducing Valves.
 - 11. Trap-Seal Primer Valves.

1.2 ACTION SUBMITTALS

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

1.3 CLOSEOUT SUBMITTALS

- A. Backflow Device Test Report
 - 1. Reference Section 01 78 00 – Project Closeout for “Project Closeout Submittal Checklist”, and Division 01 Appendix for related form.
- B. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.
- C. Field quality-control reports.

1.4 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

- A. Potable-water piping and components shall comply with NSF 61 Annex G and NSF 14.

1.5 PERFORMANCE REQUIREMENTS

- A. Maximum working pressure for domestic water piping specialties: 125 psig unless otherwise indicated.

PART 2 - PRODUCTS

2.1 BACKFLOW PREVENTERS

- A. Basis of Design: Watts LF009 Series, 2 Inch.
- B. Manufacturers:
 - 1. Zurn.
- C. Reduced-Pressure-Principle Backflow Preventers:
 - 1. Standard: ASSE 1015.
 - 2. Operation: Continuous-pressure applications.
 - 3. Pressure Loss: 12 psig maximum, through middle third of flow range.
 - 4. Body: Bronze for NPS 2 and smaller; ductile iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
 - 5. End Connections: Threaded for NPS 2 and smaller.
 - 6. Configuration: Designed for horizontal, straight-through flow.
 - 7. Accessories:
 - a. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.
 - b. Epoxy coated wye type strainer.
 - c. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

2.2 WATER PRESSURE-REDUCING VALVES

- A. Basis of Design: Watts LF25AUB-Z3, 2 Inch.
- B. Manufacturers:
 - 1. Watts.
 - 2. Wilkins.
 - 3. Apollo.
- C. Description:
 - 1. Inlet Pressure: 72 psig.
 - 2. Outlet Pressure: 60 psig.
- D. Water Regulators:
 - 1. Standard: ASSE 1003.
 - 2. Pressure Rating: Initial working pressure of 150 psig.
 - 3. Body: Bronze.
 - 4. End Connections: Threaded.

2.3 BALL VALVES

- A. Manufacturers:
 - 1. Conbraco.
 - 2. Nibco.
 - 3. Milwaukee Valve.

B. Description:

1. Standards: MSS SP-110, MSS SP-145, IAPMO/ANSI Z1157.
2. CWP Rating: Minimum 200 psig.
3. Body Design: Two piece.
4. Body Material: Forged brass.
5. Ends: Same as piping.
6. Seats: PTFE or RPTFE.
7. Stem: Brass.
8. Ball: Chrome-plated brass.
9. Port: Full.

2.4 CURB VALVE

A. Manufacturers:

1. Mueller Co.
2. Ford.
3. A.Y. McDonald.

B. Description:

1. Quarter turn check.
2. Threaded inlet and outlet F.I.P. connections.
3. Size: 2 inch.
4. 300 psig maximum working pressure.
5. Stainless steel reinforced seat.
6. Body: Brass ASTM B62 with double O-rings.

2.5 CURB BOX

A. Description

1. Extension type curb box with pattern base.
2. Box: Cast Iron
3. Lid: Cast Iron
4. Plug: Brass pentagon.
5. Upper portion is spring loaded and telescopes into the base for grade adjustment.

B. Features: Cover to fit valve operator with security fastener on cover with word "WATER".

C. Provide cast iron curb box sleeve.

2.6 RELIEF VALVES

A. Pressure Relief: AGA Z21.22 certified, bronze body, teflon seat, steel stem and springs, automatic, direct pressure actuated.

B. Temperature and Pressure Relief: AGA Z21.22 certified, bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, temperature relief maximum 210 degrees F, capacity ASME (BPV IV) certified and labelled.

2.7 STRAINERS

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum unless otherwise indicated.
2. Body: Bronze, Y-pattern.
3. End Connections: Threaded.
4. Screen: Stainless steel with round perforations unless otherwise indicated.
5. Drain: Install ball valve and discharge pipe with threaded cap.

2.8 TEMPERATURE-ACTUATED, WATER MIXING VALVES

A. Basis of Design: As Scheduled on Drawings.

B. Manufacturers:

1. Lawler.
2. Powers.
3. Taco.

C. Tempering Valves:

1. Adjustable temperature selection with locknut.
2. Temperature control per ASSE 1070.
3. Lead free brass body.
4. Integral check valves.

2.9 WATER HAMMER ARRESTERS

A. Basis of Design: Sioux Chief

B. Manufacturers:

1. Jay R. Smith.
2. Watts Regulator Company.
3. Wade

C. Copper construction, piston type sized in accordance with PDI-WH 201, pre-charged suitable for operation in temperature range -100 to 300 degrees F and maximum 250 psi working pressure.

2.10 TRAP-SEAL PRIMER VALVES

A. Drainage-Type, Trap-Seal Primer Device

1. Standard: ASSE 1044, lavatory P-trap with NPS 3/8 minimum, trap makeup connection.
2. Size: NPS 1-1/4 minimum.
3. Material: Chrome-plated, cast brass.

2.11 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Nipples:

1. Source Limitations: Obtain dielectric nipples from single manufacturer.
 2. Standard: IAPMO PS 66.
 3. Electroplated steel nipple complying with ASTM F1545.
- C. Dielectric Flanges:
1. Standard: ASSE 1079
 2. Factory-fabricated, bolted, companion-flange assembly.
 3. Pressure Rating: 150 psig
 4. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install water regulators with shut-off valves at inlet and outlet. Install pressure gages on inlet and outlet. Maximum outlet pressure shall not exceed 80 psig.
- B. Install shut-off valve and balancing valves in locations where they can easily be accessed.
- C. Install supply-type, trap-seal primer valve in vertical position only, following Manufacturer's installation instructions. Pitch trap primer outlet piping down toward drain trap a minimum of 1 percent, and connect to floor-drain body trap primer inlet fitting. Adjust valve for proper flow.
 1. Install shut-off valve immediately upstream of trap-seal primer valve.
- D. Install drainage-type, trap-seal as lavatory P-trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain trap primer inlet fitting.

3.2 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric fittings NPS 2 inch and smaller: Use dielectric NIPPLES.
- C. Dielectric fittings NPS 2-1/2 inch and larger: Use dielectric flange kits.

3.3 FIELD QUALITY CONTROL

- A. All backflow preventers shall be tested in Owner's presence prior to Substantial Completion. Submit completed "Backflow Device Test Report" (Reference Section 01 78 00 – Project Closeout for "Project Closeout Submittal Checklist"). Provide a minimum of 48-hours' notice to Owner, prior to start of testing procedures.
- B. Test each reduced-pressure-principal backflow preventer according to authorities having jurisdiction and the device's reference standard.
- C. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.4 ADJUSTING

- A. Set field-adjustable pressure set points of water pressure-reducing valves.
- B. Set field-adjustable temperature set points of mixing valves as noted on Drawings.

END OF SECTION

SECTION 22 13 16

SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 ACTION SUBMITTALS

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

1.2 CLOSEOUT SUBMITTALS

- A. Field quality-control reports.

1.3 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 74, Service class.
- B. Gaskets: ASTM C 564, rubber.

2.2 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
- B. CISPI, Hubless-Piping Couplings:
 - 1. Standards: ASTM C 1277 and CISPI 310.
 - 2. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.3 COPPER TUBE AND FITTINGS

- A. Soft Copper Tube: ASTM B88, Type K, water tube, annealed temper.
- B. Hard Copper Tube: ASTM B 88, Type L, water tube, drawn temper.
- C. DWV Copper Tube: ASTM B 306, drainage tube, drawn temper.
- D. Copper Pressure Fittings:
 - 1. Wrought Copper, Solder-Joint Fittings: ASME B16.18 or ASME B16.22.
- E. Copper Drainage Fittings:
 - 1. Wrought Copper, Solder-Joint Fittings: ASME B16.23 or ASME B16.29.

- F. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

2.4 DWV PVC PIPE AND FITTINGS

- A. Pipe: Type 1 Grade 1 PVC per ASTM D1784 and D1785, certified by NSF, Schedule 40, DWV.
- B. Fittings: ASTM D1784 and D3311, certified by NSF and conforming to UPC, Schedule 40, DWV.
- C. Adhesive Primer: ASTM F 656.
 - 1. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. Solvent Cement: ASTM D 2564.
 - 1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.5 SPECIALTY PIPE FITTINGS

- A. Transition Couplings:
 - 1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
 - 2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
 - 3. Unshielded, Non-pressure Transition Couplings:
 - a. Standard: ASTM C 1173.
 - b. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - c. Sleeve Materials:
 - 1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
 - 2) For Dissimilar Pipes: ASTM D 5926 or other material compatible with pipe materials being joined.
 - 3) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC
 - 4. Shielded, Non-pressure Transition Couplings:
 - a. Standard: ASTM C 1460.
 - b. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

PART 3 - EXECUTION

3.1 TRENCHING, BEDDING, BACKFILL

- A. Excavate trenches to indicated gradients, lines, depths, and elevations.
- B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated. Clearance: 12 inches each side of pipe.
- C. Trench Bottoms: Excavate trenches 4 inches deeper than bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe.
- D. Bedding: Install minimum four (4) inches aggregate bedding material. Shape bedding material as required at bells and joints of pipe to provide continuous support.
- E. Initial backfill: utilize aggregate bedding material, and encompass the pipe with a minimum of four (4) inches on each side and four (4) inches cover.
- F. Aggregate material for bedding and initial backfill: three-eighths (3/8) inch to three-quarter (3/4) inch washed or unwashed stone.
- G. Final Backfill: Place and compact final backfill of satisfactory soil to final subgrade elevation.

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install piping at slopes as defined by the Uniform Plumbing Code or as noted on Drawings.
- C. Install piping free of sags and bends.
- D. Install fittings for changes in direction and branch connections.
- E. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- F. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- G. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:

1. Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
 2. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- H. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
- I. Install underground PVC piping according to ASTM D 2321.
- J. Plumbing Specialties:
1. Install cleanouts at grade and extend to where building. Comply with requirements for cleanouts specified in Section 22 13 19 "Sanitary Waste Piping Specialties."
 2. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Section 22 13 19 "Sanitary Waste Piping Specialties."
- K. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- L. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."
- M. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."

3.3 TRAP PRIMER PIPING INSTALLATION

- A. Install underfloor trap primer piping continuous, free of couplings, to reduce risk of undetectable leaks.
- B. Install piping at slopes as defined by the Uniform Plumbing code or as noted on Drawings, sloping piping downward toward protected drain trap.
- C. Install copper tubing according to CDA's "Copper Tube Handbook".
1. Install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.

3.4 JOINT CONSTRUCTION

- A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- B. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
- C. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.
- D. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.5 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in OD's.

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger and support devices and installation specified in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
3. Vertical Piping: MSS Type 8 or Type 42, clamps.
4. Install individual, straight, horizontal piping runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
5. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
6. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.

F. Install supports for vertical cast-iron soil piping every 15 feet.

G. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 72 inches with 3/8-inch rod.
2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
3. NPS 2-1/2: 108 inches with 1/2-inch rod.
4. NPS 3 and NPS 5: 10 feet with 1/2-inch rod.
5. NPS 6: 10 feet with 5/8-inch rod.

H. Install supports for vertical copper tubing every 10 feet.

I. Install hangers for DWV PVC piping per manufacturer's installation instructions.

J. Install supports for vertical DWV PVC piping per manufacturer's installation instructions.

3.7 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect drainage and vent piping to the following:
 - 1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
 - 2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
 - 3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
 - 4. Comply with requirements cleanouts and drains specified in Section 22 13 19 "Sanitary Waste Piping Specialties."
- D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

3.8 IDENTIFICATION

- A. Label piping with service type in preparation for future connection. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.9 FIELD QUALITY CONTROL

- A. Conduct Pressure Leak Testing in presence of the Owner prior to Substantial Completion. Provide a minimum of 48-hours' notice to Owner, prior to start of testing procedures.
 - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before

- inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
 5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 6. Prepare reports for tests and required corrective action.

3.10 CLEANING AND PROTECTION

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.11 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Trap-seal primer valve piping NPS 1/2 shall be the following:
 1. Outlet Piping (Above Grade):
 - a. Hard copper tube, ASTM B 88, Type L; wrought copper, solder-joint fittings; and solder joints.
 2. Outlet Piping (Below Grade):
 - a. Soft Copper Tube: ASTM B88, Type K; wrought copper, solder-joint fittings; and solder joints.
 - b. Wrap small-diameter, buried copper piping, with polyethylene encasement film to protect from acidic soil and exposure to concrete.
- C. Aboveground, soil and waste piping NPS 4 and smaller shall be any of the following:
 1. Hub and spigot, cast-iron soil pipe and fittings, service class; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
 3. Dissimilar Pipe-Material Couplings: Unshielded , non-pressure transition couplings.
 4. DWV PVC pipe and fittings, Schedule 40
 - a. Where ceiling plenums do not have ducted return air pathway, DWV PVC piping shall be prohibited.

- D. Aboveground, vent piping NPS 4 and smaller shall be the following:
1. Hub and spigot, cast-iron soil pipe and fittings, service class; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
 3. Copper DWV tube, copper drainage fittings, and soldered joints.
 4. PVC pipe and fittings, Schedule 40.
 - a. Where ceiling plenums do not have ducted return air pathway, DWV PVC piping shall be prohibited.
- E. Underground, soil, waste, and vent piping NPS 4 and smaller shall be any of the following:
1. Hub and spigot, cast-iron soil piping, service class; gaskets; and gasketed joints.
 2. PVC pipe and fittings, Schedule 40.

END OF SECTION

SECTION 22 13 19

SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Cleanouts.
 - 2. Floor drains.

1.2 ACTION SUBMITTALS

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

1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.
- B. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 FLOOR CLEANOUTS

- A. Basis of Design: As Scheduled on Drawings.
- B. Manufacturers:
 - 1. Zurn.
 - 2. Watts.
 - 3. Jay R. Smith
 - 4. Sioux Chief.
 - 5. Josam.
- C. Description:
 - 1. Refer to Schedule on Drawings.

2.2 FLOOR DRAINS

- A. Basis of Design: As Scheduled on Drawings.
- B. Manufacturers:
 - 1. Zurn.
 - 2. Watts.
 - 3. Jay R. Smith.
 - 4. Josam.
- C. Description:
 - 1. Refer to Schedule on Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 - 1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 - 2. Locate at each change in direction of piping greater than 45 degrees.
 - 3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
 - 4. Locate at base of each vertical soil and waste stack.
- B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- D. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
 - 1. Position floor drains for easy access and maintenance.
 - 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
 - a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
 - b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
 - c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
 - 3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
 - 4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- E. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.

- F. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

3.2 CONNECTIONS

- A. Comply with requirements in Section 22 13 16 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

3.3 FLASHING INSTALLATION

- A. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
 - 1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
 - 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
- B. Set flashing on floors and roofs in solid coating of bituminous cement.
- C. Secure flashing into sleeve and specialty clamping ring or device.
- D. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings.
- E. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.
- F. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 FIELD QUALITY CONTROL

- A. Conduct Pressure and Leaks Testing in presence of Owner prior to Substantial Completion. Provide a minimum of 48-hours' notice to Owner, prior to start of testing procedures.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.5 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

END OF SECTION

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SECTION 22 16 00

FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Pipes, tubes, and fittings.
 - 2. Piping and tubing joining materials.
 - 3. Piping specialties.
 - 4. Valves.
 - 5. Gas pressure regulators.

1.2 ACTION SUBMITTALS

- A. Product Data.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For pressure regulators.

1.4 QUALITY ASSURANCE

- A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.
- B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

1.6 PROJECT CONDITIONS

- A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
 - 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
 - 2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
 - 3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
 - 4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - a. Material Group: 1.1.
 - b. End Connections: Threaded to match pipe.
 - c. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
 - d. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.

2.2 JOINING MATERIALS

- A. Joint Compound and Tape: Suitable for natural gas.

2.3 PIPING SPECIALTIES

- A. Appliance Flexible Connectors:
 - 1. Indoor, Moveable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
 - 2. Corrugated stainless-steel tubing with polymer coating.
 - 3. Operating-Pressure Rating: 0.5 psig.
 - 4. End Fittings: Zinc-coated steel.
 - 5. Threaded Ends: Comply with ASME B1.20.1.
 - 6. Maximum Length: 72 inches.
 - 7. Color: Yellow.

2.4 MANUAL GAS SHUTOFF VALVES

- A. General Requirements for Metallic Valves: Comply with ASME B16.33.
 - 1. CWP Rating: 125 psig.
 - 2. Threaded Ends: Comply with ASME B1.20.1 for sizes 2" and smaller.
 - 3. Flanged Ends: Comply with ASME B16.5 for steel flanges for sizes 2-1/2" and larger.
 - 4. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
 - 5. Service Mark: Valves shall have initials "WOG" permanently marked on valve body.
- B. Bronze Plug Valves: MSS SP-78.
 - 1. Body: Bronze, complying with ASTM B 548.
 - 2. Plug: Bronze.

3. Ends: Threaded.
4. Operator: Square head or lug type with tamperproof feature where indicated.
5. Pressure Class: 125 psig.
6. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
7. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

C. Two-Piece, Full Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.

1. Body: Bronze, complying with ASTM B 584.
2. Ball: Chrome-plated bronze.
3. Stem: Bronze; blowout proof.
4. Seats: Reinforced TFE; blowout proof.
5. Packing: Threaded body packnut design with adjustable-stem packing.
6. Ends: Threaded.
7. CWP Rating: 600 psig.
8. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

2.5 GAS PRESSURE REGULATORS

A. Manufacturers for Gas Pressure Regulators:

1. Fisher Co.
2. Elster American Meter.

B. General Requirements for Gas Pressure Regulators:

1. Spring loaded regulator with low pressure shutoff assembly and internal relief valve.
2. Cast iron body, aluminum spring case.
3. Single stage and suitable for natural gas.
4. End Connections: Threaded for gas regulators NPS 2 and smaller.
5. Springs: Interchangeable.
6. Atmospheric vent with stainless steel screen.

C. Designation on Drawing:

1. Basis of Design: Fisher CS400.
2. Description:
 - a. Globe Body Size: 1-1/2 inch.
 - b. Orifice Size: 1/4 inch.
Inlet Pressure: 2 psig.
 - c. Outlet Pressure Set Point: 11 inch water column.
 - d. Variable Outlet Pressure Range: 10 – 14 inches water column.
 - e. Spring Part Number: GE30224X012.
 - f. Spring Color: Unpainted.
 - g. Connected Load: 216 cfh.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Close equipment shutoff valves before turning off natural gas to premises or piping section.
- B. Inspect natural-gas piping according to NFPA 54 to determine that natural-gas utilization devices are turned off in piping section affected.
- C. Comply with NFPA 54 requirements for prevention of accidental ignition.

3.3 INDOOR PIPING INSTALLATION

- A. Comply with NFPA 54 for installation and purging of natural-gas piping.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
- D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- G. Locate valves for easy access.
- H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and branch connections.
- K. Verify final equipment locations for roughing-in.
- L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.
- M. Drips and Sediment Traps: Install drips at points where condensate may collect. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches (75 mm) long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
- N. Extend relief vent connections for indoor service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.
- O. Prohibited Locations:
 1. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
 2. Do not install natural-gas piping in solid walls or partitions.
- P. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- Q. Connect branch piping from top or side of horizontal piping.
- R. Install unions in pipes NPS 2 (DN 50) and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
- S. Do not use natural-gas piping as grounding electrode.
- T. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.
- U. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- V. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping".
- W. Install appliance flexible connectors at each dryer.

3.4 VALVE INSTALLATION

- A. Install manual gas shutoff valve for each gas appliance.
- B. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

3.5 PIPING JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints:

1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
 2. Cut threads full and clean using sharp dies.
 3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
 4. Apply appropriate tape or thread compound to external pipe threads.
 5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- D. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.

3.6 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for pipe hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
 2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
 3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.

3.7 CONNECTIONS

- A. Connect to utility's gas main according to utility's procedures and requirements.
- B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
- C. Install piping adjacent to appliances to allow service and maintenance of appliances.
- D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.
- E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.8 LABELING AND IDENTIFYING

- A. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for piping and valve identification.

3.9 PAINTING

- A. Paint exposed, exterior metal piping, valves, service regulators, service meters, valves, and piping specialties, except components with factory-applied paint or protective coating.
1. Alkyd System: MPI EXT 5.1D.
 - a. Prime Coat: Alkyd anticorrosive metal primer.

- b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
 - c. Topcoat: Exterior alkyd enamel (flat).
 - d. Color: Gray.
- B. Paint exposed, interior metal piping, located within room LAUNDRY 604.
 - 1. Alkyd System: MPI EXT 5.1D.
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Interior alkyd enamel matching topcoat.
 - c. Topcoat: Interior alkyd enamel (flat).
 - d. Color: Sherwin-Williams SW7065 ARGOS.
 - 1) Topcoat to match paint color of finished wall within LAUNDRY 604. See Sheet A100, Room Finish Schedule.
- C. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.10 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Test, inspect, and purge natural gas according to NFPA 54 and authorities having jurisdiction.
- C. Natural-gas piping will be considered defective if it does not pass test and inspections.

3.11 PIPING SCHEDULE

- A. Aboveground, distribution piping shall be the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
 - a. Exception: Aboveground, distribution piping concealed within walls or ceiling bulkheads shall be the following:
 - 1) Steel pipe with wrought-steel welded fittings.

3.12 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Valves, interior, in branch piping for single appliance shall be one of the following:
 - 1. Bronze plug valve.
 - 2. Two-Piece, full-port, bronze ball valve.
- B. Valves, exterior, shall be the following:
 - 1. Bronze plug valve.

END OF SECTION

SECTION 22 30 00

PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Water Heater.
 - 2. Diaphragm-Type Expansion Tank.
 - 3. Water Meter.
 - 4. Gas Meter.

1.2 ACTION SUBMITTALS

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

1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.
- B. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.5 WARRANTY

- A. Domestic Water Heaters: Provide minimum three year manufacturer warranty for tank, and a minimum one year manufacturer warranty for parts.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.
- B. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.
- C. ASME Compliance: Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 and NSF 372.

2.2 WATER HEATER

- A. Basis of Design: As Scheduled on Drawings.
- B. Manufacturers:
 - 1. A.O. Smith.
 - 2. Rheem/Rhuud.
 - 3. Bradford White.
- C. Standard: UL 174.
- D. Storage-Tank Construction: Steel, vertical arrangement.
 - 1. Tappings: ASME B1.20.1 pipe thread.
 - 2. Pressure Rating: 150 psig.
 - 3. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending lining material into tappings.
- E. Factory-Installed, Storage-Tank Appurtenances:
 - 1. Anode Rod: Replaceable magnesium.
 - 2. Dip Tube: Required unless cold-water inlet is near bottom of tank.
 - 3. Drain Valve: Corrosion-resistant metal with hose-end connection.
 - 4. Insulation: Comply with ASHRAE/IES 90.1.
 - 5. Jacket: Steel with enameled finish or high-impact composite material.
 - 6. Heat-Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.
 - 7. Heating Elements: Electric, screw-in immersion type.
 - 8. Temperature Control: Adjustable thermostat.
 - 9. Safety Control: High-temperature-limit cutoff device or system.
 - 10. Relief Valve: ASME rated and stamped for combination temperature-and-pressure relief valves. Include relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select relief valve with sensing element that extends into storage tank.
- F. Domestic-Water Heater Accessories:
 - 1. Drain Pans: Corrosion-resistant metal with raised edge. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than **NPS 3/4** with ASME B1.20.1 pipe threads.
 - 2. Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

2.3 DIAPHRAGM-TYPE EXPANSION TANKS

- A. Basis of Design: As Scheduled on Drawings
- B. Manufacturers:
 - 1. Amtrol.
 - 2. Bell & Gossett.
 - 3. Taco, Inc.
 - 4. Wessels.
 - 5. American Wheatley.

- C. Construction: Welded steel, tested and stamped in accordance with ANSI, NSF61 and ASME (Section VIII, Division 1). Rated for working pressure of 150 psig, with flexible EPDM or Butyl rubber diaphragm sealed into tank.
- D. Accessories: Pressure gauge and air-charging fitting, tank drain.

2.4 WATER METER

- A. Basis of Design: Sensus OMNI Turbo (T²).
- B. Manufacturers:
 - 1. Neptune (Model T-10, with TRECON/E3 Pulse Output Kit).
 - 2. Neptune (Model Mach 10 Standard, with EMP Signalizer and MDR-20-24 power supply).
- C. Certifications:
 - 1. AWWA Standard C701, Class II.
 - 2. NSF/ ANSI Standard 61, Annex F and G.
- D. Ductile-iron construction, with NSF certified epoxy coating.
- E. Electronic Register:
 - 1. LCD screen with adjustable readout.
 - 2. Fully programmable pulse output frequency.
 - 3. Automated meter reading (AMR) and advanced metering infrastructure (AMI) compatible.
 - 4. Pulse output wiring provided with meter from manufacturer.

2.5 GAS METER

- A. Basis of Design: Elster American Meter AC-250.
- B. Manufacturers:
 - 1. Elster American Meter.
 - 2. Honeywell.
- C. Diaphragm meter, die-cast aluminum case with top connections; rated at 250 cfh at 0.5" W.C. differential; with dial index box.
- D. Communications: Elster RVP-FI 52870K161, remote volume pulse kit.
 - 1. Form A pulse. One pulse per revolution of index drive.
 - 2. Odometer style index.
 - 3. Standard 12 foot cable.
 - 4. Factory mount RVP-FI pulse kit to gas meter when ordering.
- E. Power Source: External.
 - 1. Maximum switching voltage: 24 volts AC, 24 volts DC.
- F. Pulse output wiring provided with remote volume pulse kit.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install plumbing equipment in accordance with manufacturer's instructions, as required by code, and complying with conditions of certification, if any.
- B. Coordinate with plumbing piping and related fuel piping work to achieve operating system.
- C. Coordinate with electrical sub-contractor for all required power connections and low voltage communication wiring connections to achieve operating system.
- D. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping.
- E. Domestic-Water Heater Mounting:
 - 1. Maintain manufacturer's recommended clearances.
 - 2. Arrange units so controls and devices that require servicing are accessible.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 5. Install level and plumb, in accordance with layout drawings, original design, and referenced standards.
- F. Domestic Expansion Tanks:
 - 1. Field adjust air pressure of expansion tank to match system operating pressure.
- G. Water Meter:
 - 1. Plumber to coordinate with electrician to install low voltage pulse output meter wiring between water meter and power monitoring unit supplied in Division 26, for remote metering functionality. Electrician to provide additional pulse output meter wiring, matching meter Manufacturer's wiring, as required to reach power monitoring unit location shown on Electrical Drawings.
- H. Gas Meter:
 - 1. Plumber to coordinate with electrician to install low voltage pulse output wiring connection between gas meter and power monitoring unit supplied in Division 26, for remote metering functionality. Electrician to provide additional pulse output meter wiring, matching meter Manufacturer's wiring, as required to reach power monitoring unit location shown on Electrical Drawings.
- I. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for electric, domestic-water heaters that do not have tank drains.
- J. Install dielectric fittings in all locations where piping of dissimilar metals is to be joined. The wetted surface of the dielectric fitting contacted by potable water to contain less than 0.25 percent of lead by weight.

3.2 PIPING CONNECTIONS

- A. Comply with requirements for piping specified in Section 22 11 16 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to electric, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

END OF SECTION

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SECTION 22 40 00
PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Water Closets.
 - 2. Lavatories.
 - 3. Sinks.
 - 4. Mop Basins.
 - 5. Wall Hydrants.
 - 6. Hose Bibbs.

1.2 ACTION SUBMITTALS

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

1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For plumbing fixtures, including faucets, carriers, and related accessories to include in emergency, operation, and operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 WATER CLOSETS

- A. Refer to Schedule on Drawings for description and accessories.
- B. Water Closet Manufacturers:
 - 1. American Standard.
 - 2. Kohler.
 - 3. No Substitutions Allowed.
- C. Flush Valve Manufacturers:
 - 1. Sloan.
 - 2. Zurn.
 - 3. No Substitutions Allowed.
- D. Carrier Manufacturers:
 - 1. Zurn.
 - 2. Watts.

- E. Certifications & Ratings: ASME A112.19.2, suitable for minimum 500lb loads.

2.2 URINALS

- A. Refer to Schedule on Drawings for description and accessories.
- B. Urinal Manufacturers:
 - 1. American Standard.
 - 2. Kohler.
 - 3. No Substitutions Allowed.
- C. Flush Valve Manufacturers:
 - 1. Sloan.
 - 2. Zurn.
 - 3. No Substitutions Allowed.
- D. Carrier Manufacturers:
 - 1. Zurn.
 - 2. Watts.

2.3 LAVATORIES

- A. Refer to Schedule on Drawings for description and accessories.
- B. Lavatory Manufacturers:
 - 1. American Standard.
 - 2. Kohler.
 - 3. No Substitutions Allowed.
- C. Faucet Manufacturers:
 - 1. Delta.
 - 2. American Standard.
 - 3. Moen.
- D. Accessories:
 - 1. Chrome plated 17 gage brass P-trap with clean-out plug, trap primer graywater connection, and arm with escutcheon.
 - 2. Offset waste with perforated round open strainer.
 - 3. Trubro ADA lavguard pipe covers for P-trap, cold, and hot water piping where piping is not otherwise protected by counter apron or casework.
 - 4. Supplies: Chrome plated brass pipe, iron pipe size; chrome plated brass stops equal to Chicago Faucet 441LK, 3/8 inch, loose key.

2.4 SINKS

- A. Refer to Schedule on Drawings for description and accessories.
- B. Sink Manufacturers:

1. Advance Tabco.
2. Just Manufacturing.
3. Elkay.

C. Faucet Manufacturers:

1. Elkay.
2. Kohler.
3. Chicago Faucet.
4. Delta.
5. Moen.

D. Accessories:

1. Chrome plated 17 gage brass P-trap with clean-out plug and arm with escutcheon.
2. Offset waste with perforated round open strainer.
3. Trubro ADA lavguard pipe covers for P-trap, cold, and hot water piping where piping is not otherwise protected by counter apron or casework.
4. Supplies: Chrome plated brass pipe, iron pipe size; chrome plated brass stops equal to Chicago Faucet 441LK, 3/8 inch, loose key.

2.5 MOP BASINS

A. Refer to Schedule on Drawings for description and accessories.

B. Manufacturers:

1. Fiat.
2. Stern-Williams.

C. Service Faucet Manufacturers:

1. Fiat.
2. Chicago Faucet.
3. Zurn.

2.6 WALL HYDRANTS

A. Refer to Schedule on Drawings for description and accessories.

B. Manufacturers:

1. Woodford.
2. Watts.
3. Jay R. Smith.
4. Zurn.

C. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.

D. Description:

1. Pressure Rating: 125 psig.
2. Operation: Loose key.
3. Casing and Operating Rods: Of length required to match wall thickness. Include wall clamps.

4. Outlet: Concealed.
5. Vacuum Breaker:
 - a. Nonremovable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
 - b. Garden-hose thread complying with ASME B1.20.7 on outlet.
6. Operating Key(s): One with each wall hydrant.

2.7 HOSE BIBBS

- A. Refer to Schedule on Drawings for description and accessories.
- B. Manufacturers:
 1. Woodford.
 2. Watts.
 3. Jay R. Smith.
- C. Standard: ASME A112.18.1 for sediment faucets.
- D. Description:
 1. Body Material: Bronze.
 2. Seat: Bronze, replaceable.
 3. Supply Connections: NPS 3/4 threaded joint inlet.
 4. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
 5. Pressure Rating: 125 psig.
 6. Vacuum Breaker: Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
 7. Include integral wall flange.

2.8 MATERIALS

- A. Fixtures: Refer to Plumbing Fixture Schedule for material of construction requirements.
- B. Exposed fittings and trim: Brass, chrome plated.
- C. Tailpieces and extensions to wall: cast brass P-traps with cleanout plugs; chrome plated.
- D. Supplies: Chrome plated brass pipe, iron pipe size; chrome plated brass stops similar and equal to Chicago Faucet 441LK, loose key.
- E. Stainless steel fixtures and accessories: ANSI #4 satin finish; sinks and lavatories sound deadened on underside.
- F. Carriers and drainage specialties shall fit allowed spaces.

PART 3 - EXECUTION

3.1 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 countertop lavatories and sinks.

3.2 PREPARATION

- A. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.3 INSTALLATION

- A. Install each fixture with trap, easily removable for servicing and cleaning.
- B. Provide chrome plated rigid or flexible supplies to fixtures with loose key stops, reducers, and escutcheons.
- C. Install components level and plumb.
- D. Install and secure fixtures in place with wall supports and bolts.
- E. Seal fixtures to wall and floor surfaces with sealant color to match fixture.
- F. Fixture Mounting Heights:
 - 1. Water Closets:
 - a. ADA: 17 inches to top of seat.
 - 2. Lavatory:
 - a. Standard: 31 inches to top of basin rim.
 - 3. Water Closet Flush Valves:
 - a. Standard: 11 inches minimum above bowl rim.
 - 4. Mop Basin Faucet:
 - a. 30 inches to bottom of spout.
 - 5. Wall Hydrant
 - a. 36 inches minimum to bottom of fixture, measured from exterior finished grade.
 - 6. Laundry Boxes
 - a. 48 inches to center of box.

3.4 INTERFACE WITH WORK OF OTHER SECTIONS

- A. Review millwork shop drawings.
- B. Confirm location and size of fixtures and openings before rough-in and installation.
- C. Coordinate and confirm location of power receptacles and laundry boxes.

3.5 ADJUSTING

- A. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

3.6 CLEANING

- A. Clean plumbing fixtures and equipment.

3.7 PROTECTION

- A. Protect installed products from damage due to subsequent construction operations.
- B. Do not permit use of fixtures by construction personnel.
- C. Repair or replace damaged products before Date of Substantial Completion.

END OF SECTION

SECTION 23 05 01

SELECTIVE MECHANICAL DEMOLITION AND REMODELING

PART 1 - GENERAL – NOT APPLICABLE

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Materials and equipment for patching and extending work: As specified in individual Sections.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify field measurements and piping systems arrangements are as shown on Drawings.
- B. Verify that abandoned piping and equipment serve only abandoned facilities.
- C. Demolition Drawings are based on existing record documents and selective field observation. Only items critical to performance of new systems and extensions to existing systems have been verified to extent practicable by field observations. Report discrepancies to Owner and Architect/Engineer before disturbing existing installation.

3.2 PREPARATION

- A. Disconnect piping in walls, floors, and ceilings scheduled for removal.
- B. Coordinate utility service outages with Owner. Notify Owner 7 days and 48 hours prior to service shutdowns.

3.3 DEMOLITION AND EXTENSION OF EXISTING MECHANICAL WORK

- A. Remove, relocate, and extend existing installations to accommodate new construction.
- B. Remove exposed abandoned piping. Cut piping flush with walls and floors, and patch surfaces.
- C. Disconnect and remove abandoned distribution equipment where noted on Drawings.
- D. Disconnect and remove mechanical devices and equipment serving utilization equipment that has been removed.
- E. Repair adjacent construction and finishes damaged during demolition and extension work to match existing.
- F. Maintain access to existing mechanical installations which remain active.
- G. Extend existing installations using materials and methods compatible with existing mechanical installations, unless otherwise specified.

3.4 CLEANING AND REPAIR

- A. Clean and repair existing materials and equipment which remain or are to be reused.

END OF SECTION

SECTION 23 05 19

METERS AND GAGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Bimetallic-actuated thermometers.
 - 2. Thermowells.
 - 3. Dial-type pressure gages.
 - 4. Gage attachments.
 - 5. Test plugs.
 - 6. Test-plug kits.

1.2 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 DIAL THERMOMETERS

- A. Standard: ASME B40.200.
- B. Description:
 - 1. Case: Liquid-filled and sealed type(s); stainless steel.
 - 2. Case Size:
 - a. Within 6'0" above finished floor: 3".
 - b. Above 6'0" above finished floor: 5".
 - 3. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F.
 - 4. Connector Type(s): Union joint, adjustable angle, with unified-inch screw threads.
 - 5. Connector Size: 1/2 inch, with ASME B1.1 screw threads.
 - 6. Stem: 0.25 or 0.375 inch in diameter; stainless steel.
 - 7. Window: Plain glass.
 - 8. Ring: Stainless steel.
 - 9. Element: Bimetal coil.
 - 10. Pointer: Dark-colored metal.
 - 11. Accuracy: Plus or minus 1.5 percent of scale range.

2.2 THERMOWELLS

A. Description:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: CNR or CUNI.
4. Material for Use with Steel Piping: CRES.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.3 DIRECT-MOUNTED, METAL-CASE, DIAL-TYPE PRESSURE GAGES:

A. Description:

1. Standard: ASME B40.100.
2. Case: Sealed type(s); stainless steel.
3. Case Size:
 - a. Within 6'0" above finished floor: 4-1/2"
 - b. Above 6'0" above finished floor: 6".
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Stainless steel.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.4 GAGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.
- B. Siphons: Loop-shaped section of stainless-steel pipe with NPS 1/4 or NPS 1/2 pipe threads.
- C. Valves: Brass ball, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

2.5 TEST PLUGS

- A. Description: Test-station fitting made for insertion into piping tee fitting.

- B. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
- C. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.
- D. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.
- E. Core Inserts: Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- C. Install thermowells with extension on insulated piping.
- D. Fill thermowells with heat-transfer medium.
- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- F. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- G. Install valve and snubber in piping for each pressure gage for fluids (except steam).
- H. Install test plugs in piping tees.
- I. Install flow indicators in piping systems in accessible positions for easy viewing.
- J. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.
- K. Install permanent indicators on walls or brackets in accessible and readable positions.
- L. Install connection fittings in accessible locations for attachment to portable indicators.

3.2 ADJUSTING

- A. After installation, calibrate meters according to manufacturer's written instructions.
- B. Adjust faces of meters and gages to proper angle for best visibility.

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SECTION 23 05 29

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Metal pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Thermal-hanger shield inserts.

1.2 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
 - 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
 - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.3 ACTION SUBMITTALS

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

1.4 QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 - 2. Galvanized Metallic Coatings: Pre-galvanized or hot dipped.
 - 3. Nonmetallic Coatings: Plastic coating, jacket, or liner.

4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.2 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
2. Standard: MFMA-4.
3. Channels: Continuous slotted steel channel with intumed lips.
4. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
6. Metallic Coating: Hot-dipped galvanized PER astm a123 OR a153.

2.4 THERMAL-HANGER SHIELD INSERTS

- A. Insulation-Insert Material for Hot or Cold Piping: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength and vapor barrier.
- B. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- C. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- D. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- D. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- E. Install hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- F. Install lateral bracing with pipe hangers and supports to prevent swaying.
- G. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- H. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- I. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- J. Insulated Piping:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
 - 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
 5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
 6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.
- K. Refer to Section 26 05 26 "Grounding and Bonding for Electrical Systems" for grounding and bonding requirements of hangers.

3.2 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.
 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports and attachments for general service applications.
- F. Use copper-plated pipe hangers and stainless-steel attachments for copper piping and tubing.
- G. Use padded hangers for piping that is subject to scratching.
- H. Use thermal-hanger shield inserts for insulated piping and tubing.
- I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
 - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
 - 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
 - 5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 - 6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
 - 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 - 8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 - 9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 - 10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
 - 11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
 - 12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
 - 13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 - 14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
 - 15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.

16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
 17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
 18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
 19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
 20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
 21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.

11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- N. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- O. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION

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SECTION 23 05 48

VIBRATION CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Elastomeric isolation pads.

1.2 ACTION SUBMITTALS

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

1.3 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 - PRODUCTS

2.1 ELASTOMERIC ISOLATION PADS

- A. Elastomeric Isolation Pads:
 - 1. Manufacturers:
 - a. Kinetics Noise Control.
 - b. Mason Industries.
 - c. Vibro-Acoustics.
 - 2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
 - 3. Size: Factory or field cut to match requirements of supported equipment.
 - 4. Pad Material: Oil and water resistant with elastomeric properties.
 - 5. Surface Pattern: Ribbed pattern.
 - 6. Infused nonwoven cotton or synthetic fibers.
 - 7. Load-bearing metal plates adhered to pads.
 - 8. Sandwich-Core Material: Resilient and elastomeric, ribbed pattern.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 VIBRATION CONTROL DEVICE INSTALLATION

- A. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.
- B. Install elastomeric isolation pads on all floor-mounted equipment.

END OF SECTION

SECTION 23 05 53

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Pipe labels.
 - 3. Valve tags.

1.2 ACTION SUBMITTALS

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

1.3 CLOSEOUT SUBMITTALS

- A. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- B. Valve Schedules: For each piping system to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Plastic Labels for Equipment:
 - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, having predrilled holes for attachment hardware.
 - 2. Letter Color: White.
 - 3. Background Color: Black.
 - 4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
 - 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 - 6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
 - 7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

- C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction according to ASME A13.1.
- B. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: Size letters according to ASME A13.1 for piping.

2.3 VALVE TAGS

- A. Description: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
 - 1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Fasteners: Brass wire-link chain or beaded chain.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 - 1. Valve-tag schedule shall be included in operation and maintenance data.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

- A. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- B. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- C. Pipe Label Color Schedule:
 - 1. Loop-Water Piping: White letters on a safety-green background.

3.5 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

END OF SECTION

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SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Balancing Air Systems:
 - a. Variable-volume air systems.
 - 2. Balancing Hydronic Piping Systems:
 - a. Constant-flow hydronic systems.
 - 3. Testing, Adjusting, and Balancing Equipment:
 - a. Heat-transfer coils.
- B. This specification section is for informational purposes only and to aid those engaged in the construction of heating, ventilating, air conditioning, exhaust and appurtenant systems included in this project.
- C. The testing and balancing agency engaged to complete all required work for this project will be secured by and under direct contract with the owner. The contractor shall provide all labor and materials to assist the TAB agency in the execution of their work including correction of any deficiencies identified by the TAB agency

1.2 INFORMATIONAL SUBMITTALS

- A. TAB Plan:
 - 1. Qualification Data: Submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
 - 2. Strategies and Procedures Plan: TAB strategies and step-by-step procedures as specified in "Preparation" Article.
 - 3. System Readiness Checklists: Submit system readiness checklists as specified in "Preparation" Article.
 - 4. Examination Report: Submit a summary report of the examination review required in "Examination" Article.
 - 5. Sample report forms.

1.3 CLOSEOUT SUBMITTALS

- A. Certified TAB reports including instrument calibration reports, to include the following:
 - 1. Instrument type and make.
 - 2. Serial number.
 - 3. Application.
 - 4. Dates of use.
 - 5. Dates of calibration.

1.4 QUALITY ASSURANCE

- A. TAB Specialists Qualifications: Certified by AABC.
- B. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.
- B. Examine installed systems for balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.
- F. Examine equipment performance data including fan and pump curves.
 - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
 - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

- G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- H. Examine test reports specified in individual system and equipment Sections.
- I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.
- J. Examine strainers. Verify that startup screens have been replaced by permanent screens with indicated perforations.
- K. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- L. Examine system pumps to ensure absence of entrained air in the suction piping.
- M. Examine operating safety interlocks and controls on HVAC equipment.
- N. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

- A. Prepare a TAB plan that includes the following:
 - 1. Equipment and systems to be tested.
 - 2. Strategies and step-by-step procedures for balancing the systems.
 - 3. Instrumentation to be used.
 - 4. Sample forms with specific identification for all equipment.
- B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
 - 1. Airside:
 - a. Duct systems are complete with terminals installed.
 - b. Volume, smoke, and fire dampers are open and functional.
 - c. Clean filters are installed.
 - d. Fans are operating, free of vibration, and rotating in correct direction.
 - e. Variable-frequency controllers' startup is complete and safeties are verified.
 - f. Automatic temperature-control systems are operational.
 - g. Ceilings are installed.
 - h. Windows and doors are installed.
 - i. Suitable access to balancing devices and equipment is provided.
 - 2. Hydronics:
 - a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.
 - b. Piping is complete with terminals installed.
 - c. Water treatment is complete.
 - d. Systems are flushed, filled, and air purged.
 - e. Strainers are pulled and cleaned.
 - f. Control valves are functioning per the sequence of operation.

- g. Shutoff and balance valves have been verified to be 100 percent open.
- h. Pumps are started and proper rotation is verified.
- i. Pump gage connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
- j. Suitable access to balancing devices and equipment is provided.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" and in this Section.
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
 - 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
 - 2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 23 07 13 "Duct Insulation" and Section 23 07 19 "HVAC Piping Insulation."
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- D. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- F. Verify that motor starters are equipped with properly sized thermal protection.
- G. Check dampers for proper position to achieve desired airflow path.
- H. Check for airflow blockages.
- I. Check condensate drains for proper connections and functioning.
- J. Check for proper sealing of air-handling-unit components.
- K. Verify that air duct system is sealed as specified in Section 23 31 13 "Metal Ducts."

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure total airflow.
 - a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
 - b. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
 - c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
 - d. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
 - 2. Measure fan static pressures as follows:
 - a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the air-handling system.
 - d. Report artificial loading of filters at the time static pressures are measured.
 - 3. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
 - 4. Obtain approval from Engineer for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
 - 5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.
 - 1. Measure airflow of submain and branch ducts.
 - 2. Adjust submain and branch duct volume dampers for specified airflow.
 - 3. Re-measure each submain and branch duct after all have been adjusted.
- C. Adjust air inlets and outlets for each space to indicated airflows.
 - 1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
 - 2. Measure inlets and outlets airflow.
 - 3. Adjust each inlet and outlet for specified airflow.
 - 4. Re-measure each inlet and outlet after they have been adjusted.
- D. Verify final system conditions.
 - 1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
 - 2. Re-measure and confirm that total airflow is within design.

3. Re-measure all final fan operating data, rpms, volts, amps, and static profile.
4. Mark all final settings.
5. Test system in economizer mode. Verify proper operation and adjust if necessary.
6. Measure and record all operating data.
7. Record final fan-performance data.

3.6 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports for pumps, coils, and heat exchangers. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required coil and heat exchanger flow rates with pump design flow rate.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts.
- C. In addition to requirements in "Preparation" Article, prepare hydronic systems for testing and balancing as follows:
 1. Check liquid level in expansion tank.
 2. Check highest vent for adequate pressure.
 3. Check flow-control valves for proper position.
 4. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
 5. Verify that motor starters are equipped with properly sized thermal protection.
 6. Check that air has been purged from the system.

3.7 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

- A. Adjust pumps to deliver total design gpm.
 1. Measure total water flow.
 - a. Position valves for full flow through coils.
 - b. Measure flow by main flow meter.
 2. Measure pump TDH as follows:
 - a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
 - b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
 - c. Convert pressure to head and correct for differences in gage heights.
 - d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
 - e. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.
 3. Monitor motor performance during procedures and do not operate motor in an overloaded condition.
- B. Adjust flow-measuring devices installed in mains and branches to design water flows.
 1. Measure flow in main and branch pipes.
 2. Adjust main and branch balance valves for design flow.

3. Re-measure each main and branch after all have been adjusted.
- C. Adjust flow-measuring devices installed at terminals for each space to design water flows.
1. Measure flow at terminals.
 2. Adjust each terminal to design flow.
 3. Re-measure each terminal after it is adjusted.
 4. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
 5. Perform temperature tests after flows have been balanced.
- D. Verify final system conditions as follows:
1. Re-measure and confirm that total water flow is within design.
 2. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
 3. Mark final settings.
- E. Verify that memory stops have been set.

3.8 PROCEDURES FOR MOTORS

- A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:
1. Manufacturer's name, model number, and serial number.
 2. Motor horsepower rating.
 3. Motor rpm.
 4. Phase and hertz.
 5. Nameplate and measured voltage, each phase.
 6. Nameplate and measured amperage, each phase.
 7. Starter size and thermal-protection-element rating.
 8. Service factor and frame size.
- B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

3.9 TOLERANCES

- A. Set HVAC system's airflow rates and water flow rates within the following tolerances:
1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
 2. Air Outlets and Inlets: Plus or minus 10 percent.
 3. Loop-Water Flow Rate: Plus or minus 10 percent.
- B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.10 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 2. Include a list of instruments used for procedures, along with proof of calibration.
 3. Certify validity and accuracy of field data.
- B. Final Report Contents: In addition to certified field-report data, include the following:
1. Pump curves.
 2. Fan curves.
 3. Manufacturers' test data.
 4. Field test reports prepared by system and equipment installers.
 5. Other information relative to equipment performance; do not include Shop Drawings and Product Data.
- C. General Report Data: In addition to form titles and entries, include the following data:
1. Title page.
 2. Name and address of the TAB specialist.
 3. Project name.
 4. Project location.
 5. Architect's name and address.
 6. Engineer's name and address.
 7. Contractor's name and address.
 8. Report date.
 9. Signature of TAB supervisor who certifies the report.
 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 11. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 12. Nomenclature sheets for each item of equipment.
 13. Data for terminal units, including manufacturer's name, type, size, and fittings.
 14. Notes to explain why certain final data in the body of reports vary from indicated values.
 15. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outdoor-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Face and bypass damper settings at coils.
 - e. Fan drive settings including settings and percentage of maximum pitch diameter.
 - f. Inlet vane settings for variable-air-volume systems.
 - g. Settings for supply-air, static-pressure controller.
 - h. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
 2. Water flow rates.
 3. Duct, outlet, and inlet sizes.
 4. Pipe and valve sizes and locations.

5. Terminal units.
6. Balancing stations.
7. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Unit arrangement and class.
 - g. Discharge arrangement.
 - h. Sheave make, size in inches, and bore.
 - i. Center-to-center dimensions of sheave and amount of adjustments in inches.
 - j. Number, make, and size of belts.
 - k. Number, type, and size of filters.
2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave and amount of adjustments in inches.
3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Filter static-pressure differential in inches wg.
 - f. Preheat-coil static-pressure differential in inches wg.
 - g. Cooling-coil static-pressure differential in inches wg.
 - h. Heating-coil static-pressure differential in inches wg.
 - i. Outdoor airflow in cfm.
 - j. Return airflow in cfm.
 - k. Outdoor-air damper position.
 - l. Return-air damper position.
 - m. Vortex damper position.

F. Apparatus-Coil Test Reports:

1. Coil Data:
 - a. System identification.
 - b. Location.
 - c. Coil type.
 - d. Number of rows.
 - e. Fin spacing in fins per inch o.c.
 - f. Make and model number.

- g. Face area in sq. ft..
- h. Tube size in NPS.
- i. Tube and fin materials.
- j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

- a. Airflow rate in cfm.
- b. Average face velocity in fpm.
- c. Air pressure drop in inches wg.
- d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
- e. Return-air, wet- and dry-bulb temperatures in deg F.
- f. Entering-air, wet- and dry-bulb temperatures in deg F.
- g. Leaving-air, wet- and dry-bulb temperatures in deg F.
- h. Water flow rate in gpm.
- i. Water pressure differential in feet of head or psig.
- j. Entering-water temperature in deg F.
- k. Leaving-water temperature in deg F.
- l. Refrigerant expansion valve and refrigerant types.
- m. Refrigerant suction pressure in psig.
- n. Refrigerant suction temperature in deg F.

G. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

- a. System and air-handling-unit number.
- b. Location and zone.
- c. Traverse air temperature in deg F.
- d. Duct static pressure in inches wg.
- e. Duct size in inches.
- f. Duct area in sq. ft..
- g. Indicated airflow rate in cfm.
- h. Indicated velocity in fpm.
- i. Actual airflow rate in cfm.
- j. Actual average velocity in fpm.
- k. Barometric pressure in psig.

H. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

1. Unit Data:

- a. Unit identification.

- b. Location.
- c. Service.
- d. Make and size.
- e. Model number and serial number.
- f. Water flow rate in gpm.
- g. Water pressure differential in feet of head or psig.
- h. Required net positive suction head in feet of head or psig.
- i. Pump rpm.
- j. Impeller diameter in inches.
- k. Motor make and frame size.
- l. Motor horsepower and rpm.
- m. Voltage at each connection.
- n. Amperage for each phase.
- o. Full-load amperage and service factor.
- p. Seal type.

2. Test Data (Indicated and Actual Values):

- a. Static head in feet of head or psig.
- b. Pump shutoff pressure in feet of head or psig.
- c. Actual impeller size in inches.
- d. Full-open flow rate in gpm.
- e. Full-open pressure in feet of head or psig.
- f. Final discharge pressure in feet of head or psig.
- g. Final suction pressure in feet of head or psig.
- h. Final total pressure in feet of head or psig.
- i. Final water flow rate in gpm.
- j. Voltage at each connection.
- k. Amperage for each phase.

I. Instrument Calibration Reports:

1. Report Data:

- a. Instrument type and make.
- b. Serial number.
- c. Application.
- d. Dates of use.
- e. Dates of calibration.

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SECTION 23 07 13

DUCT INSULATION

PART 1 - GENERAL

1.1 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

1.2 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.
- C. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work.
 - 1. Ductwork Mockups:
 - a. One 10-foot section each of rectangular and round straight duct.
 - b. One each of a 90-degree mitered round and rectangular elbow, and one each of a 90-degree radius round and rectangular elbow.
 - c. One rectangular branch takeoff and one round branch takeoff from a rectangular duct. One round tee fitting.
 - d. One rectangular and round transition fitting.
 - e. Four support hangers for round and rectangular ductwork.
 - f. Each type of damper and specialty.
 - 2. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
 - 3. Notify Architect seven days in advance of dates and times when mockups will be constructed.
 - 4. Obtain Architect's approval of mockups before starting insulation application.
 - 5. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
7. Demolish and remove mockups when directed.

1.3 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.4 COORDINATION

- A. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.5 SCHEDULING

- A. Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- B. Manufacturers:
 1. Certain Teed.
 2. Johns Manville.
 3. Knauf.
 4. Owens Corning.
- C. Glass-Fiber Blanket Insulation: Glass-Fiber Blanket: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature up to 450 deg F in accordance with ASTM C411. Comply with ASTM C553, Type II, and ASTM C1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

- D. Glass-Fiber Board Insulation: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature between 35 deg F and 250 deg F for jacketed in accordance with ASTM C411. Comply with ASTM C612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied ASJ or FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Glass-Fiber and Mineral Wool Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
- C. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

2.3 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.

2.4 SEALANTS

- A. FSK and Metal Jacket Flashing Sealants:
 - 1. Materials are compatible with insulation materials, jackets, and substrates.
 - 2. Fire- and water-resistant, flexible, elastomeric sealant.
 - 3. Service Temperature Range: Minus 40 to plus 250 deg F.
 - 4. Color: Aluminum.
- B. ASJ Flashing Sealants:
 - 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 2. Fire- and water-resistant, flexible, elastomeric sealant.
 - 3. Service Temperature Range: Minus 40 to plus 250 deg F.
 - 4. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.5 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
 - 1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
 - 2. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.

2.6 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.

2.7 SECUREMENTS

- A. Bands:
 - 1. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal or closed seal.
 - 2. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.
- B. Insulation Pins and Hangers:
 - 1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, length to suit depth of insulation indicated.
 - 2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
 - 3. Insulation-Retaining Washers: Self-locking washers with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.
- D. Wire: 0.062-inch soft-annealed, stainless steel.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 - 1. Verify that systems to be insulated have been tested and are free of defects.
 - 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.
- B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Keep insulation materials dry during application and finishing.
- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- H. Install insulation with least number of joints practical.
- I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.
- L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 - 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 - 4. Seal jacket to wall flashing with flashing sealant.
- C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

3.5 INSTALLATION OF GLASS-FIBER INSULATION

- A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
 - 1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
 - 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 - 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.

- b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Impale insulation over pins and attach speed washers.
 - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
- 4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
- 5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
- 6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
- 7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.6 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.
- B. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.7 DUCT INSULATION SCHEDULE, GENERAL

- A. Items Not Insulated:
1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
 2. Double-wall ductwork.
 3. Fabric ductwork.
 4. Factory-insulated flexible ducts.
 5. Factory-insulated plenums and casings.
 6. Flexible connectors.
 7. Factory-insulated access panels and doors.
 8. Pre-insulated exterior ductwork.
- B. Unconditioned Spaces are defined as plenums and air spaces without conditioned airflow. These spaces include but are not limited to:
1. Wall cavities.
 2. Ceiling plenums not used for return air pathways.
 3. Attics.
 4. Unconditioned rooms.

3.8 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

- A. Round, supply-, fresh-, and outdoor-air duct insulation in unconditioned spaces shall be the following:
1. Glass-Fiber Blanket: 2 inches thick or a minimum installed R-value of 6.0.
- B. Round, supply-, fresh-, and outdoor-air duct insulation in conditioned spaces shall be the following:
1. Glass-Fiber Blanket: 1-1/2 inches thick or a minimum installed R-value of 4.0.
- C. Rectangular supply-, fresh-, and outdoor-air duct insulation in unconditioned spaces shall be one of the following:
1. Glass-Fiber Blanket: 2 inches thick or a minimum installed R-value of 6.0.
 2. Glass-Fiber Board: 2 inches thick or a minimum installed R-value of 6.0.
- D. Rectangular supply-, fresh-, and outdoor-air duct insulation in conditioned spaces shall be one of the following:
1. Glass-Fiber Blanket: 1-1/2 inches thick or a minimum installed R-value of 4.0.
 2. Glass-Fiber Board: 1-1/2 inches thick or a minimum installed R-value of 4.0.
 3. Within 8'0" of mechanical room floor:
 - a. Glass-Fiber Board: 1-1/2 inches thick or a minimum installed R-value of 4.0.
- E. Rectangular return-air duct insulation shall be the following:
1. Glass-Fiber Board: 1-1/2 inches thick or a minimum installed R-value of 4.0.
 2. Within 8'0" of mechanical room floor:

- a. Glass-Fiber Board: 1-1/2 inches thick or a minimum installed R-value of 4.0.
- F. Round, exhaust-air duct insulation in conditioned and unconditioned spaces shall be the following:
 - 1. Glass-Fiber Blanket: 1-1/2 inches thick or a minimum R-value of 4.0.
- G. Rectangular, exhaust-air duct insulation in conditioned and unconditioned spaces shall be one of the following:
 - 1. Glass-Fiber Blanket: 1-1/2 inches thick or a minimum R-value of 4.0.

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SECTION 23 07 19

HVAC PIPING AND EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 ACTION SUBMITTALS

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

1.2 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

1.3 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.4 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.5 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- B. Glass-Fiber, Preformed Pipe: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature up to 850 deg F in accordance with ASTM C411. Comply with ASTM C547.
 - 1. Manufacturers:
 - a. Certain Teed.
 - b. Johns Manville.
 - c. Knauf.
 - d. Owens Corning.
 - 2. Preformed Pipe Insulation with Factory-Applied ASJ and ASJ-SSL: Comply with ASTM C 547, Type I.
 - 3. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
- C. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Grade 1, Type I for tubular materials.
 - 1. Manufacturers:
 - a. Armaflex.
 - b. K-flex.
- D. Removable Valve Covers:
 - 1. Basis of Design: Fit Tight Covers.
 - 2. Manufacturers:
 - a. No Sweat.
 - b. Thermaxx.
 - 3. Jacket and Liner: Silicone-coated Fiberglass.
 - 4. Fastening: Velcro with stainless steel d-rings.
 - 5. Rated Temperature Range: 30 deg. F. to 350 deg. F.

2.2 INSULATING CEMENTS

- A. Glass-Fiber Insulating Cement: Comply with ASTM C 195.

2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Glass-Fiber and Mineral Wool Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

- C. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
- D. ASJ Adhesive: Comply with MIL-A-3316C, Class 2, Grade A, for bonding insulation jacket lap seams and joints.
- E. PVC Jacket Adhesive: Compatible with PVC jacket.

2.4 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
 - 1. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
 - 2. Service Temperature Range: Minus 20 to plus 180 deg F.
 - 3. Color: White.

2.5 SEALANTS

- A. Verify sealant has a VOC content of 420 g/L or less.
- B. Joint Sealants:
 - 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 2. Permanently flexible, elastomeric sealant.
 - 3. Service Temperature Range: Minus 100 to plus 300 deg F.
 - 4. Color: White.
- C. FSK and Metal Jacket Flashing Sealants:
 - 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 2. Fire- and water-resistant, flexible, elastomeric sealant.
 - 3. Service Temperature Range: Minus 40 to plus 250 deg F.
 - 4. Color: Aluminum.
- D. ASJ Flashing Sealants and PVC Jacket Flashing Sealants:
 - 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 2. Fire- and water-resistant, flexible, elastomeric sealant.
 - 3. Service Temperature Range: Minus 40 to plus 250 deg F.
 - 4. Color: White.

2.6 FIELD-APPLIED JACKETS

- A. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM E 84 and ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
 - 1. Adhesive: As recommended by jacket material manufacturer.
 - 2. Color: White.

3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
 - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

2.7 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

2.8 SECUREMENTS

- A. Bands:
 1. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal.
- B. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel.
- C. Wire: 0.062-inch soft-annealed, stainless steel.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 1. Verify that systems to be insulated have been tested and are free of defects.
 2. Verify that surfaces to be insulated are clean and dry.
 3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
 - a. For below-ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above-ambient services, do not install insulation to the following:
 - 1. Vibration-control devices.
 - 2. Testing agency labels and stamps.
 - 3. Nameplates and data plates.
 - 4. Manholes.
 - 5. Handholes.
 - 6. Cleanouts.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 - 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 - 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Floor Penetrations:
 - 1. Pipe: Install insulation continuously through floor penetrations.

3.5 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
 - 1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 - 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 - 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 - 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 - 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
 - 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 - 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 - 8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 - 9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

3.6 INSTALLATION OF GLASS-FIBER AND MINERAL WOOL INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install prefabricated pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with glass-fiber or mineral-wool blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install prefabricated sections of same material as that of straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install prefabricated sections of same material as that of straight segments of pipe insulation when available.
2. When prefabricated sections are not available, install fabricated sections of pipe insulation to valve body.

3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.7 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
 1. Install pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
 4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
 1. Install mitered sections of pipe insulation.
 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Isolation Valves:
 1. Install preformed valve covers manufactured of same material as pipe insulation when available.
 2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 3. Install insulation to flanges as specified for flange insulation application.
 4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- E. Insulation Installation on Strainers, Balancing Valves, and Control Valves:
 1. Install removable valve covers.

3.8 FIELD-APPLIED JACKET INSTALLATION

- A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.
 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

3.9 INDOOR PIPING INSULATION SCHEDULE

- A. Loop Water Supply and Return Piping:
 - 1. NPS 1-1/4 and Smaller: Insulation shall be one the following:
 - a. Flexible Elastomeric: 3/4 inch thick.
 - b. Glass Fiber: 1 inch thick.
 - 2. NPS 1-1/2 and Larger: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 1 inch thick.
 - b. Glass Fiber: 1-1/2 inch thick.
 - 3. Exterior Piping: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 1-1/2 inch thick.
 - b. Glass Fiber: 2 inch thick.
- B. Boiler Water Supply and Return Piping
 - 1. NPS 1-1/4 and Smaller: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I: 1 inch thick.
 - 2. NPS 1-1/2 and Larger: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I: 1-1/2 inches thick.
- C. Indoor Condensate and Equipment Drain Water below 60 Deg F:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Cellular Glass: 1 inches thick.
 - b. Flexible Elastomeric: 1/2 inch thick.

3.10 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, in Mechanical Room:
 - 1. PVC: 30 mils thick.

END OF SECTION

SECTION 23 09 23

DIRECT DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Complete System of Automatic Controls.
- B. Control Devices, Components, Wiring and Material.
- C. Instructions for Owners.
- D. Remodeling.

1.2 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

- A. Control Valves.
- B. Temperature Sensor Sockets.
- C. Gauge Taps.
- D. Automatic Dampers.

1.3 REFERENCES

- A. AMCA 500 - Test Methods for Louvers, Dampers and Shutters.
- B. ANSI/ASHRAE Standard 135-2001: BACnet® – A Data Communication Protocol for Building Automation and Control Networks, including all amendments.
- C. ANSI/NEMA 250 - Enclosures for Electrical Equipment (1000 volts Maximum).
- D. ANSI/NFPA 70 - National Electrical Code.
- E. ANSI/NFPA 90A - Installation of Air-Conditioning and Ventilation Systems.
- F. ASHRAE 85 - Automatic Control Terminology for Heating, Ventilating, Air Conditioning.
- G. ASHRAE 90.1 – Energy Standard for Buildings Except Low-Rise Residential Buildings.

1.4 AGENCY AND CODE APPROVALS

- A. All products shall have the following agency approvals. Provide verification that the approvals exist for all submitted products with the submittal package.
 - 1. UL-916; Energy Management Systems.
 - 2. C-UL listed to Canadian Standards Association C22.2 No. 205-M1983 "Signal Equipment."
 - 3. EMC Directive 89/336/EEC (European CE Mark).
 - 4. FCC, Part 15, Subpart J, Class A Computing Devices.

1.5 ACRONYMS

A. Acronyms used in this specification are as follows:

1. BACnet Building Automation and Control Networks
2. B-AAC BACnet Advanced Application Controller
3. B-ASC BACnet Application Specific Controller
4. BTL BACnet Testing Laboratories
5. DDC Direct Digital Controls
6. FMCS Facility Management and Control System
7. GUI Graphic User Interface
8. IBC Interoperable BACnet Controller
9. IDC Interoperable Digital Controller
10. LAN Local Area Network
11. LCU Local Control Unit
12. MS/TP Master-Slave/Token-Passing
13. NCU Network Control Unit
14. ODBC Open DataBase Connectivity
15. OOT Object Oriented Technology
16. OPC Open Connectivity via Open Standards
17. PICS Product Interoperability Compliance Statement
18. TCC Temperature Control Contractor
19. TCS Temperature Control System
20. TCU Terminal Control Unit
21. WAN Wide Area Network
22. WBI Web Browser Interface

1.6 SUMMARY

- A. Provide new standalone FMCS for this project.
- B. The Installer, otherwise identified as the Temperature Controls Contractor (TCC), who is furnishing the Direct Digital Control (DDC) network shall meet with the Installers of the heating, ventilating and air-conditioning (HVAC) equipment and related products which are specified to be equipped with factory furnished unitary controllers to coordinate details between their HVAC equipment's unitary controllers and the DDC network. The Owner or his designated representative shall be present at this meeting. The purpose of this meeting shall be to insure there are no unresolved issues regarding the specified integration of the proposed HVAC equipment into the DDC network and overall control system performance. Each HVAC equipment Installer shall furnish to the Owner and all other Installers the details of their proposed control interfaces including but not limited to the hardware and software identifiers for interface points, control point mapping requirements, wiring requirements, communication speeds and network accessories. Required coordination efforts shall extend to any 3rd party integral control systems which are furnished with a BACnet interface for integration into the DDC system described within. Equipment and DDC controls submittals, including but not limited to those required under Part 3 section – "Sequences of Operation for HVAC" shall not be approved prior to the satisfactory completion of this coordination meeting.

1.7 SYSTEM DESCRIPTION

- A. The entire TCS shall be comprised of a network of interoperable, standalone digital controllers communicating via BACnet MS/TP protocol to an NCU. Temperature Control System products shall be as specified below.

B. The FMCS shall include NCUs within each facility. The NCU shall connect to the Owner's local

BBS 23067 DIRECT DIGITAL CONTROL SYSTEM FOR HAC
Building M-04 Renovation & Addition 23 09 23 - 2
Camp Dodge, Johnston, Iowa

or wide area network, depending on configuration. Provide access to the system, locally in each building through standard Web browsers and/or via local area network. Coordinate all requirements for network access with the Owner.

- C. Provide materials and labor necessary to connect factory supplied control components.
- D. Provide central and remote hardware, software, and interconnecting wire and conduit. New, manufacturer approved wire shall be used for communication network. Coordinate with Iowa Army National Guard wire and cabling standards.
- E. The FMCS shall include automated alarming software capable of calling e-mail compatible cellular telephones and pagers. The e-mail alarm paging system shall be able to segregate users, time schedules, and equipment and be capable of being programmed by the Owner.
- F. For the dedicated configuration tool provided, it is preferable that it be launched from within the applicable Network Management Software. If not, include any software required for controller configuration as a leave-behind tool with enough license capability to support the installation.
- G. All licenses shall be open and turned over to the Owner. The front end controller shall be fully unlocked to allow programming, scheduling, and set point adjustments by the Owner and to allow the Owner the option to solicit alternate service contractors at the Owner's discretion.
- H. Furnish one legal copy of all software tools, configuration tools, management tools, and utilities used during system commissioning and installation. All tools shall be readily available in the market. Contractor shall convey to the Owner all software tools and their legal licenses at project closeout.
- I. TCC to extend CAT5 cable from NCUs to existing server. Coordinate all requirements with Owner.
- J. All inputs and outputs (I/O) shall come from field-level controllers. Extended I/O from NCUs will not be allowed. Satellite points (unused I/O re-purposed through network programming) will not be allowed.
- K. Field-level communication system shall utilize daisy-chained topography; no tees or star configuration. Communication layout shall be pre-approved by Owner prior to construction.
- L. This FMCS will communicate back the Niagara N4 Web Supervisor located at the Joint Forces Headquarters building in Johnston Iowa. The connection to the Web Supervisor will be performed by the Owner. This contractor shall assist the owner in this process and be responsible for any additional software or licenses necessary for that connection to take place.
- M. Niagara version shall be revision 4.7.109. JACE platform user name and password shall be provided to Owner's HVAC Specialist. Embedded WorkBench shall be loaded and enabled on the system JACE(s).
- N. Operating system shall be open ANSI/ASHRAE Standard 135-(current version): BACnet-A Data Communication Protocol for Building Automation and Control Networks (ANSI Approved).
- O. There is an existing BAS server which resides at JFHQ Camp Dodge. Network topographies that provide a local BAS server will not be allowed. BAS shall be connected to the Camp Dodge server.
- P. To prevent a confusing array of GUIs, standardization of graphics packages is mandatory and shall be DG-lux or PX files.

- Q. Graphics shall reside in the local JACE unless directed to save trend data in a separate SQL database. For Owner records JACE MAC address shall be provided. JACE primary port will be for the secure network (Guard network), the secondary port shall be enabled and its IP shall be set to 192.168.100.100. All graphics shall be pre-approved by Owner and must be complete prior to award of substantial completion.
- R. Graphics shall include a time/date stamp for the JACE on the system home page. Graphics shall also include pages for sequence of operation for the equipment, Network topography with device address and location, and on systems with ductwork, a ductwork layout page shall also be included.
- S. All installations shall include a point to point checkout with the results signed "verified" by the contractor and the results provided to the Owner."
- T. JACE will have a surge protection device installed to protect the hardware in power quality events.

1.8 SUBMITTALS

A. Shop Drawings:

1. Submit in accordance with Section 01 33 00 - Submittal Procedures and Section 01 33 05 – Electronic Submittal Procedures.
2. Cross-reference all control components and point names in a single table located at the beginning of the submittal with the identical nomenclature used in this section.
3. Submittal shall also include a trunk cable schematic diagram depicting control panel locations and a description of the communication type, media and protocol.
4. System Architecture: Provide riser diagrams of wiring between central control unit and all control panels. This shall include specific protocols associated with each level within the architecture. Identify all interface equipment between CPU and control panels.
5. Diagrams shall include:
 - a. Wiring diagrams and layouts for each control panel showing all termination numbers.
 - b. Schematic diagrams for all control, communication, and power wiring. Provide a schematic drawing of the central system installation. Label all cables and ports with computer manufacturers' model numbers and functions. Show all interface wiring to the control system.
 - c. Schematic diagrams for all field sensors and controllers.
 - d. A schematic diagram of each controlled system. The schematics shall have all control points labeled. The schematics shall graphically show the location of all control elements in the system.
 - e. A schematic wiring diagram for each controlled system. Each schematic shall have all elements labeled. Where a control element is the same as that shown on the control system schematic, label it with the same name. Label all terminals.
 - f. A tabular instrumentation list for each controlled system. The table shall show element name, type of device, manufacturer, model number and product data sheet number.
 - g. All installation details and any other details required to demonstrate that the system will function properly.
 - h. All interface requirements with other systems.
 - i. BAS subnet communication wiring routing.
6. The network infrastructure shall conform to the published guidelines for wire type, length, number of nodes per channel, termination, and other relevant wiring and infrastructure criteria as published. The number of nodes per channel shall be no more than 80% of the defined segment (logical or physical) limit in order to provide future system enhancement with minimal infrastructure modifications.

7. Sequences: Submit a complete description of the operation of the control system, including sequences of operation. The description shall include and reference a schematic diagram of the controlled system. The wording of the control sequences in the submittal shall match verbatim that included in the construction documents to ensure there are no sequence deviations from that intended by the Engineer. Clearly highlight any deviations from the specified sequences on the submittals.
8. Points List Schedule:
 - a. Submit a complete points list of all points to be connected to the TCS and FMCS. The points list for each system controller shall include both inputs and outputs (I/O), point number, the controlled device associated with the I/O point, the location of the I/O device, and reference drawings. Where a control point is the same as that shown on the control system schematic, label it with the same name. Points list shall specifically identify alarms, trends, event history, archive, totalization, graphic points, and all mapped points from other systems. Provide point lists, point naming convention, and factory support information for systems provided and integrated into the FMCS.
9. Submit a description of the proposed processes and timelines along with proposed report formats and detailed checklists to be used in Part 3 subsection: "Control System Commissioning, Demonstration and Acceptance."
10. Damper Schedule: Schedule shall include a separate line for each damper and a column for each of the damper attributes:
 - a. Damper Identification Tag.
 - b. Location.
 - c. Damper Type.
 - d. Damper Size.
 - e. Duct Size.
 - f. Arrangement.
 - g. Blade Type.
 - h. Velocity.
 - i. Pressure Drop.
 - j. Fail Position.
 - k. Actuator Identification Tag.
 - l. Actuator Type.
 - m. Mounting.
11. Valve Schedule: Valve manufacturer shall size valves and create a valve schedule. Schedule shall include a separate line for each valve and a column for each of the valve attributes:
 - a. Valve Identification Tag.
 - b. Location.
 - c. Valve Type.
 - d. Valve Size.
 - e. Pipe Size.
 - f. Configuration.
 - g. Flow Characteristics.
 - h. Capacity.
 - i. Valve CV.
 - j. Design Pressure Drop.
 - k. Pressure Drop at Design Flow.
 - l. Fail Position.
 - m. Close-off Pressure.
 - n. Valve and Actuator Model Number and Type.

1.9 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Manual:

1. Submit in accordance with Section 01 33 05 – Electronic Submittal Procedures and Section 01 77 00 - Closeout Procedures.
2. Each O&M manual shall include:
 - a. Table of contents with indexed tabs dividing information as outlined below.
 - b. Definitions: List of all abbreviations and technical terms with definitions.
 - c. Warranty Contacts: Names, addresses, and 24-hour telephone numbers of contractors installing equipment and controls and service representatives of each.
 - d. Licenses, Guarantees, and Warranties: Provide documentation for all equipment and systems.
 - e. System Components: Alphabetical list of all system components, with the name, address, and telephone number of the vendor.
 - f. Operating Procedures: Include procedures for operating the control systems; logging on/off; enabling, assigning, and reporting alarms; generating reports; collection, displaying, and archiving of trended data; overriding computer control; event scheduling; backing up software and data files; and changing setpoints and other variables.
 - g. Programming: Description of the programming language (including syntax), statement descriptions (including algorithms and calculations used), point database creation and modification, program creation and modification, and use of the editor.
 - h. Engineering, Installation, and Maintenance: Explain how to design and install new points, panels, and other hardware; recommended preventive maintenance procedures for all system components, including a schedule of tasks (inspection, cleaning, calibration, etc.), time between tasks, and task descriptions; how to debug hardware problems; and how to repair or replace hardware. A list of recommended spare parts.
 - i. Original Software: Complete original issue CDs for all software provided, including operating systems, programming language, and graphics software.
 - j. Software: One set of CDs containing an executable copy of all custom software created using the programming language, including the setpoints, tuning parameters, and object database.
 - k. Graphics: A glossary or icon symbol library detailing the function of each graphic icon and graphics creation and modification. One set of CDs containing files of all color graphic screens created for the project.

B. Training Manual:

1. Provide a course outline and training manuals for each training class.
2. Contractor shall submit to Engineer for review and comment, course outlines and training materials for controls training classes at least four weeks before scheduling said training classes. Engineer shall review and return course outlines and training materials at least two weeks prior to respective training class scheduled date after modifying, if necessary, to best meet the Owner's staff needs.

C. Record Documents:

1. Provide a complete set of "as-built" drawings and application software on CDs. Provide drawings as AutoCAD™ or Visio™ compatible files. Provide two copies of the "as-built" drawings with revisions clearly indicated in addition to the documents on compact disk. All as-built drawings shall also be installed on the FMCS server in a dedicated directory. Provide all product data sheets in PDF format.

2. Submit two hard copies and one electronic copy of as-built versions of the shop drawings, including product data and record drawings with revisions clearly indicated. Provide floor plans showing actual locations of control components including panels, thermostats, sensors, and hardware.
3. Testing and Commissioning Reports and Checklists: Provide completed versions of Testing and Commissioning Reports and Checklists, along with trend logs for each system identified in the points list and which are used to satisfy requirements of Part 3 subsection: "Control System Testing, Commissioning, Demonstration and Acceptance."
4. Submit printouts of all graphic screens with current values (temperatures, pressures, etc.) to the A/E verifying completion and proper operation of all points.
5. Installation Operation and Maintenance Manual (IOM):
 - a. Operation section of manual shall include detailed procedures for operating control systems such as: logging on and off, handling alarms, adding and modifying schedules, establishing data trending, producing point reports and trend logs, overriding computer controls, and revising set-points and adjustable system variables.
 - b. Programming section of manual shall include detailed descriptions of programming languages and syntax for algorithms and calculations used, point database creation and modification, programming subroutines creation and modification and editor usage.
 - c. Maintenance and Engineering section of manual shall show instructions on how to design, install, program and implement new points, panels and hardware; how to calibrate sensors, plan and accomplish preventative maintenance; how to diagnose and if needed repair or replace hardware. Preventative maintenance procedures shall include recommended schedules of required tasks such as inspections, cleanings and calibrations.
6. Listings of all initial set-points including allowable ranges of adjustments, initial time of day schedules, and notes for each controlled device.
7. Listing of Names, addresses, phone numbers of installing contractors and service technician representatives for equipment and control systems.

1.10 INFORMATION SUBMITTALS

- A. Qualification Data: Submit documentation that the TCC and this Project's TCC team members meet the qualifications specified in "Quality Assurance" Article.

1.11 SOFTWARE LICENSE AGREEMENT

- A. The Owner shall be the named license holder of all software associated with any and all incremental work on the project(s). In addition, the Owner shall receive ownership of all job-specific configuration documentation, data files, configuration tools, and application-level software developed for the project. This shall include, but is not limited to, all custom, job-specific software code and documentation for all configuration and programming that is generated for a given project and/or configured for use with the NCU, FMCS Server(s), and any related LAN/WAN/intranet and/or Internet connected routers and devices. Provide the Owner with all required IDs and passwords for access to any component or software program. The Owner shall determine which organizations shall be named in the System Integrator organization ID ("orgid") of all software licenses. Owner shall be free to direct the modification of the "orgid" in any software license, regardless of supplier. ALL LICENSES OF THE ACTUAL HARDWARE BEING INSTALLED SHALL BE SUBMITTED TO THE OWNER FOR APPROVAL BEFORE ANY CONTROL SYSTEM HARDWARE IS INSTALLED

1.12 DELIVERY, STORAGE AND HANDLING

- A. Provide factory-shipping cartons for each piece of equipment and control device. Maintain

cartons through shipping, storage, and handling as required to prevent equipment damage. Store equipment and materials inside and protected from weather.

- B. Factory-Mounted Components: Where control devices specified in this section are indicated to be factory mounted on equipment, arrange for shipping control devices to unit manufacturer.

1.13 JOB CONDITIONS

- A. Cooperation with Other Trades: Coordinate the Work of this section with that of other sections to ensure that the Work will be carried out in an orderly fashion. It is this Contractor's responsibility to check the Contract Documents for possible conflicts between the Work of this section and that of other crafts in equipment location; pipe, duct and conduit runs; electrical outlets and fixtures; air diffusers; and structural and architectural features.
- B. Equipment Coordination:
 - 1. The Controls Contractor shall obtain approved equipment submittals from other contractors to determine equipment wiring connections, to choose appropriate controllers, and to provide programming.
 - 2. Control valve selections shall be based on flow rates shown in approved shop drawings.
 - 3. Coordinate the control interface of all equipment with the equipment manufacturers prior to submittal submission.

1.14 QUALITY ASSURANCE

- A. All new building automation system products on this project shall be provided by a firm that is a registered ISO 9001:2000 manufacturer at time of bid.
 - 1. The manufacturer of the Building Automation System digital controllers shall provide documentation supporting compliance with ISO 9001:2000 (Model for Quality Assurance in Design/Development, Production, Installation and Servicing).
 - 2. Provide a copy of the registration certificate that contains the ISO 9001:2000 Certification bearing the name of the registered auditor.
- B. Control products such as direct digital controllers, control valves, actuators, sensors and transmitters shall be provided from a single manufacturer.
- C. Provide product literature that bears the name of the manufacturer on all direct digital controllers, control valves, actuators, sensors and transmitters.
- D. The Building Automation System shall be furnished, engineered, installed, tested and calibrated by factory certified technicians qualified for this work. The contractor shall have in place a support facility located within 70 miles, further with approval, of the project site with technical staff, spare parts inventory and all necessary test and diagnostic equipment. The contractor shall be a Factory Authorized System Integrator in good standing with the Manufacturer Factory trained technicians shall provide instruction, routine maintenance, and emergency service within 24 hours upon receipt of request.
- E. Upon request, installer shall present records of successful completion of factory training courses including course outlines.
- F. Upon request the installer shall provide a letter from the manufacturer that they are a Factory Authorized System Integrator in good standing.

- G. The system integrator must employ a field staff of no less than 5 factory certified trained technicians, where their primary daily duties are working on Building Automation Systems. These technicians must reside in the state of Iowa. Upon request names and addresses of these technicians will be provided before work begins.
- H. Provide satisfactory operation without damage at 110% above and 85% below rated voltage and at 3 hertz variation in line frequency. Provide static, transient, and short circuit protection on all inputs and outputs. Communication lines shall be protected against incorrect wiring, static transients and induced magnetic interference. Bus connected devices shall be AC coupled, or equivalent so that any single device failure will not disrupt or halt bus communication.
- I. TCC: Company specializing in the work of this section with minimum five years temperature control experience.
- J. Technician: Minimum five years' experience installing commercial temperature control systems.

1.15 WARRANTY

- A. Within the warranty period, any defects in the work provided under this section due to faulty materials, methods of installation or workmanship shall be promptly (within 48 hours after receipt of notice) repaired or replaced by this Contractor at no expense to the Owner.
 - 1. Warranty requirements include furnishing and installing all FMCS software upgrades issued by the manufacturer during the one-year warranty period.
 - 2. Update all software and back-ups during warranty period and all user documentation on the Owner's archived software disks.

1.16 WARRANTY ACCESS

- A. The Owner shall grant to this Contractor reasonable access to the TCS and FMCS during the warranty period.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Provide a building automation system consisting of Tridium Niagara N4 platform with Honeywell CIPer line of field controllers supplied by a company regularly engaged in the manufacturing and distribution of building automation systems. The BAS Manufacturer shall meet the following qualifications as a minimum:
 - 1. The manufacturer of the hardware and software components must be primarily engaged in the manufacture of building automation systems as specified herein, and must have been so for a minimum of five (5) years.
 - 2. The manufacturer of the hardware and software components as well as its subsidiaries must be a member in good standing of BACnet International.
 - 3. At least 75% of the manufacture product line shall be produced under their own direction, including R&D and assembly. Rebranding of another manufacture product shall not qualify.
 - 4. The manufacturer of the hardware and software components shall have a technical support group accessible via a toll free number that is staffed with qualified personnel, capable of providing instruction and technical support service for networked control systems.

2.2 SYSTEM ARCHITECTURE

- A. The Building Automation System (BAS) shall be comprised of Network Control Units (NCU) connected to the Building Automation System local area network (BAS LAN). Access to the BAS, either through a Workstation on the BAS LAN, within the building or remotely through the Internet, shall be accomplished through a standard Web browser. Each NCU shall communicate to BTL Listed BACnet controllers provided under the Programmable Controllers section. The system includes Network Control Unit(s) (NCU), software and programming of the NCU, development of all graphical screens, setup of schedules, trends, logs and alarms, network management and connection of the NCU to the local area network.
- B. The system shall consist of a network of Network Control Units (NCUs), interoperable Local Control Units (LCUs) and Terminal Control Units (TCUs) (VAV Box Controllers, Fan Coil Unit Controllers, etc.). All controllers for terminal units, air handling units (AHU) and controllers shall communicate and share data, utilizing BACnet MS/TP or BACnet IP communications protocol only and be provided by the DDC contractor.
- C. The intent of this specification is to provide a distributed and networked open Building Automation System, the capability to integrate ANSI/ASHRAE Standard 135, BACnet and ISO/IEC 14908-1: Open Data Communication in Building Automation, Controls and Building Management – Control Network Protocol into a unified system in order to provide flexibility for expansion, maintenance, and service of the system.
- D. BACnet system must be tested and listed on BACnet Testing Laboratory (BTL) web site. Systems based on vendor specific proprietary hardware or software will not be considered for this project.
- E. Systems utilizing gateways will not be considered for this project. A gateway is considered to be a device or controller where the sole function is mapping of data points from one protocol to another.
- F. The BAS shall utilize BACnet/IP (ASHRAE Standard 135, Annex J) for communication between NCUs. Manufacturer specific proprietary protocols, gateways, or protocol converters are not acceptable for this project. The Server shall communicate to the NCUs utilizing standard Ethernet to IEEE 802.3 Standards. Any break in the BAS LAN between NCU and Server shall result in an alarm notification at the Server.
- G. The supplied system software shall employ object-oriented technology (OOT) for representation of all data and control devices within the system. In addition, adherence to industry standards including ANSI/ASHRAE™ Standard 135, BACnet to assure interoperability between all system components is required.
- H. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer's internal Intranet network. Systems employing a flat single tiered architecture shall not be acceptable. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 10 seconds for network connected user interfaces. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 60 seconds for remote or dial-up connected user interfaces.
- I. User Access - The supplied system must incorporate the ability to access all data using standard Web browsers without requiring proprietary operator interface and configuration programs.
- J. An Open DataBase Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage. This data shall reside on a supplier-installed server for all database access. Systems requiring proprietary database and user interface programs shall not be acceptable.

- K. Software Tools - All software tools needed for full functional use, including programming of controllers, network management and expansion, and graphical user interface use and development, of the BAS described within these specifications shall be provided to the owner or his designated agent. Any licensing required by the manufacturer now and to the completion of the warranty period, including changes to the licensee of the software tools and the addition of hardware corresponding to the licenses, to allow for a complete and operational system for both normal day to day operation and servicing shall be provided. Any such changes to the designated license holders shall be made by the manufacturer upon written request by the owner or his agent. Any cost associated with the license changes shall be identified within the BAS submittals.

2.3 DYNAMIC DATA ACCESS

- A. All operator devices shall have the ability to access all point status and application report data, or execute control functions for any and all other devices via the local area network. Access to data shall be based upon logical identification of building equipment.

2.4 NETWORKS

- A. Design for the Network LAN (NCU LAN) shall include the following provisions:

1. The network LAN shall utilize BACnet/IP (ASHRAE Standard 135, Annex J) for communication between NCUs. Manufacturer specific proprietary protocols, gateways, or protocol converters are not acceptable for this project. The Server shall communicate to the NCUs utilizing standard Ethernet to IEEE 802.3 Standards. Products utilizing BACnet over ARCnet technology are not acceptable for this project.
2. High-speed data transfer rates for alarm reporting, quick report generation from multiple controllers and upload/download efficiency between network devices.
3. Support of any combination of controllers directly connected to the local area network. A minimum of 50 devices shall be supported on a single local area network.
4. Detection and accommodation of single or multiple failures of workstations, controller panels and the network media. The network shall include provisions for automatically reconfiguring itself to allow all operational equipment to perform their designated functions as effectively as possible in the event of single or multiple failures.
5. Message and alarm buffering to prevent information from being lost.
6. Error detection, correction, and retransmission to guarantee data integrity.
7. Default device definition to prevent loss of alarms or data, and ensure alarms are reported as quickly as possible in the event an operator device does not respond.
8. Commonly available, multiple sourced, networking components shall be used to allow the system to coexist with other networking applications such as office automation. ETHERNET to IEEE 802.3 standard is the only acceptable technology.
9. Synchronization of the real-time clocks in all NCU panels shall be provided.
10. The NCU LAN shall be a 100 Megabits/sec Ethernet network supporting BACnet for maximum flexibility for integration of building data with enterprise information systems and providing support for multiple Network Control Units (NCUs), user workstations and where specified, a local server. Local area network minimum physical and media access requirements:
 - a. Ethernet; IEEE standard 802.3
 - b. Cable; 100 Base-T, UTP-8 wire, category 5
 - c. Minimum throughput; 100 Mbps
11. Provide access to the NCU LAN from a remote location, via the Intranet or Internet. The owner shall provide (in future) a connection to the Internet to enable access via high-speed cable modem, asynchronous digital subscriber line (ADSL) modem, ISDN line, T1 Line or access to an Internet Service Provider (ISP). If required, the owner will provide a

switch/firewall between the building LAN and the NCU LAN. Through this connection the NCU LAN will provide authorized staff with the ability to monitor and control the BAS from a remote location through a web browser, cellular phone, pager, web-enabled media players, or PDA. (Pocket Computer).

- B. Design for the Building Automation System LAN (LCU and TCU LAN) shall include either or both of the following BACnet architecture provisions:
 - 1. The BAS must be based on Open Systems. BAS shall employ the BACnet protocol for communication between controllers. BACnet protocol implementation shall adhere to the ANSI/ASHRAE Standard 135. Communications between BACnet devices shall be 38.4 kbps over approved twisted shielded pair cabling utilizing Master/Slave Token Passing BACnet protocol. BACnet defines a comprehensive set of object types and application services for communication requirements among all levels of control in a distributed, hierarchical Building Automation System. BACnet is intended to provide a single, uniform standard for the BAS to provide the required interoperability.

2.5 UNINTERRUPTABLE POWER SUPPLIES

- A. Provide each NCU with individual UPS to provide clean, reliable, noise-filtered power at all times and to protect and maintain systems operation throughout short term power interruptions of up to 15 minutes duration. Approved UPS manufacturer: APC.

2.6 UTILITY SOFTWARE

- A. Supply and install software products to allow the owner to access and manipulate the control schematic diagrams, and to access product data sheets in an electronic format.
- B. Enter all soft copy submissions; including "Record" drawings as specified herein [Shop Drawings, Product Data and Review Process] in OWS.

2.7 GRAPHICAL USER INTERFACE (GUI) SOFTWARE AND WEB BROWSER CLIENTS

- A. A software tool that provides for the development and management of the end user's Graphical User Interface (GUI) and as the primary point of access to the BAS for the end user. All Tridium Niagara N4 JACE products installed must incorporate the embedded workbench toolset and open licenses.
- B. The GUI shall employ browser-like functionality for ease of control system navigation and operation. It shall include a tree view (similar to Windows Explorer) for quick viewing of, and access to, the hierarchical structure of the database. In addition, menu-pull downs, and toolbars shall employ buttons, commands and navigation to permit the operator to perform tasks with a minimum knowledge of the HVAC Control System and basic computing skills. These shall include, but are not limited to, forward/backward buttons, home button, and a context sensitive locator line (similar to a URL line), that displays the location and the selected object identification. The GUI shall allow configuration of system-wide controllers, including management and display of the controller programming. This GUI software system shall provide the capability to configure controller binary and analog inputs/outputs.
- C. The GUI shall be capable of using third-party Windows-based programs for such things as spreadsheet analysis, graphing, charting, custom report generation, and graphics design packages. Provide software features which enables the non-programmer skill level operator to easily perform tasks which are likely to be part of his daily routine.

D. Real-Time Displays. The GUI, shall at a minimum, support the following graphical features and functions:

1. Graphic screens shall be developed using any Windows-based drawing package capable of generating or assembling objects from a GIF, JPG, PNG or ICO file formats. Use of proprietary graphic file formats shall not be acceptable. In addition to, or in lieu of a graphic background, the GUI shall support the use of scanned pictures.
2. Graphic screens shall have the capability to contain objects for text, real-time values, animation, color spectrum objects, logs, graphs, HTML or XML document links, schedule objects, hyperlinks to other URL's, and links to and from other graphic screens.
3. The GUI software shall provide facilities for manual entries and visual displays enabling an operator to enter information into the system and obtain displays and logs of system information. All requests for status, analog, graphic displays, logs, and control shall be selected from the GUI. The operator interface shall minimize the use of typewriter style keyboard by implementing a mouse or similar pointing device and "point and click" approach to command selection. A robust full-featured GUI shall be provided to permit the system Operator to perform the following tasks:
 - a. Automatic logging of digital alarms and change of status message.
 - b. Automatic logging of all analog alarms.
 - c. System changes (alarm limits, set-points, alarm lock-outs, etc.).
 - d. Display specific points as requested by the operator.
 - e. Provide reports as requested by the operator and on Scheduled basis where so required.
 - f. Display graphics as requested by the system Operator.
 - g. Display help information.
 - h. Provide trend logs as required by the system Operator.
 - i. Provide manual control of digital and analog outputs as required by the system Operator.
 - j. Direct the hard copy output of information to the device selected by the system user operator.
 - k. Data displayed on monitor must cyclically update as appropriate.
 - l. Operator shall be able to revise or override via the GUI:
 - 1) Alarm limits
 - 2) Set-points
 - 3) Dead-bands
 - 4) Deletions/additions of analog or digital points.
 - 5) Times of day, day, month, year.
 - 6) Control loop tuning through the adjustment of control loop parameters.
 - 7) Additions/deletions to system graphics
 - 8) Schedules, times of day, day, month, year
4. Modifying common application objects, such as schedules, calendars, and set points shall be accomplished in a graphical manner.
 - a. Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
 - b. Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.
5. Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.
6. Adjustments to analog objects, such as set points, shall be done by right-clicking the selected object and using a graphical slider to adjust the value. No entry of text shall be required.

7. It shall be possible for the Operator to initiate analog and digital output commands via the GUI. Where the BAS software normally originates these outputs, the provision shall exist for the Operator to terminate automatic BAS control of any particular output and to originate a manual analog or digital output command. The provision shall exist for the Operator to return analog or digital output command functions back to automatic BAS software control.
 - 8.
- E. System Configuration. At a minimum, the GUI shall permit the operator to perform the following tasks, with proper password access:
1. Create, delete or modify control strategies.
 2. Add/delete objects to the system.
 3. Enable or disable control strategies.
 4. Control loop tuning through the adjustment of control loop parameters.
 5. Generate hard copy records or control strategies on a printer.
 6. Select points to be alarm-able and define the alarm state.
 7. Select points to be trended over a period of time and initiate the recording of values automatically.
- F. Password Protection:
1. Provide security system that prevents unauthorized use unless Operator is logged on. Access shall be limited to Operator's terminal functions unless user is logged on. This includes displays as outlined above.
 2. GUI software shall provide security for 100 users minimum. Each user shall have an individual User ID, User Name and Password. Entries are alphanumeric characters only and are case sensitive (except for User ID). User ID shall be 8 characters, User Name shall be 29 characters, and Password shall be 8 characters long. Each system user shall be allowed individual assignment of only those control functions and menu items to which that user requires access. All passwords, user names, and access assignments shall be adjustable online at the operator's terminal. Each user shall also have a set security level, which defines access to displays and individual objects the user may control. System shall include 10 separate and distinct security levels for assignment to users.
 3. All above functions shall operate under the password protection system.
- G. Security. Each operator shall be required to log on to that system with a user name and password in order to view, edit, add, or delete data. System security shall be selectable for each operator. The system administrator shall have the ability to set passwords and security levels for all other operators. Each operator password shall be able to restrict the operators' access for viewing and/or changing each system application, full screen editor, and object. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected. This auto log-off time shall be set per operator password. All system security data shall be stored in an encrypted format.
- H. Trend Data:
1. System shall periodically gather historically recorded selected samples of object data stored in the field equipment (global controllers, field controllers) and archive the information where specified. Archived files shall be appended with new sample data, allowing samples to be accumulated over several years. Systems that write over archived data shall not be allowed, unless limited file size is specified. Samples may be viewed at the GUI in a trend log. Logged data shall be stored in spreadsheet format. Operator shall be able to scroll through all trend log data. System shall automatically open archive files as needed to display archived data when Operator scrolls through the data vertically. All trend log information shall be displayed in standard engineering units.

2. Secondary software shall be included that is capable of graphing the trend logged object data. Software shall be capable of creating two-axis (x, y) graphs that display up to six object types at the same time in different colors. Graphs shall show object type value relative to time.
3. Operator shall be able to change trend log setup information as needed. This includes the information to be logged as well as the interval at which it is to be logged. All input, output, and value object types in the system shall be able to be logged. Setup and viewing may be accessed directly from any and all graphics object is displayed on.
4. Trend Reports: To permit the trending of points selected by the Operator, including as a minimum digital input and output, analog input and output, set points, and calculated values.
5. Historical Data Collection: Provision shall be made to ensure historical data is not lost. The ability to off-load historical data to removable media, and to later load data previously backed-up, will be provided. Historical data values, for an Operator specified time range and for Operator specified points, may be output the same as for trend data.
6. Disable Point Summary: Provide a summary of all points in the disabled state and include as a minimum point acronym and point description.
7. Run Time Summary: Provide a summary of the accumulated running time of selected pieces of equipment with point acronym and description, run time to date, alarm limit setting. The run time shall continue to accumulate until reset individually by means of suitable Operator selection.
8. User Record Summary: Provide a summary of all user records to include as a minimum; user name, password, initials, command access level and point groups assigned.

I. Reports:

1. Provide a report facility to generate and format for display, printing, or permanent storage, as selected by the Operator, the reports as specified in this section. If display output is requested, it shall be scrollable; scroll bars will be used to allow easy and flexible movement within the report. Output to be sorted by area, system point.
2. Periodic/Automatic Report: Provide the software to automatically generate any report specified, the User/Operator will be able to specify the type of report, start time and date, interval between reports (hourly, daily, weekly, monthly) and output device. The software will allow the operator to modify the periodic/automatic reporting profile at any time.

J. Archiving:

1. Store backup copies of all controller databases in at least one OWS and the server.
2. Provide continuous supervision of integrity of all controller databases. If controller loses database, system to automatically download new copy of database to restore proper operation.
3. Data base back up and downloading to occur over LAN without operator intervention. Operator to be able to manually download entire controller database or parts thereof.

K. On-Line Help. Provide a context sensitive, on-line help system to assist the Operator in operation and editing of the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext. All system documentation and help files shall be in HTML format.

L. System Diagnostics. The system shall automatically monitor the operation of all workstations, printers, modems, network connections, building management panels, and controllers. The failure of any device shall be annunciated to the Operator.

M. Alarm Console and Alarms:

1. Operator's terminal shall provide audible, visual, and printed means of alarm indication. The alarm dialog box shall always become the top dialog box regardless of the application(s),

- currently running (such as a word processor). Printout of alarms shall be sent to the assigned terminal and port.
2. System shall provide log of alarm messages. Alarm log shall be archived to the hard disk of the system operator's terminal. Each entry shall include a description of the event-initiating object generating the alarm, time and date of alarm occurrence, time and date of object state return to normal, and time and date of alarm acknowledgement.
 3. Alarm messages shall be in user-definable text English or other specified language) and shall be entered either at the operator's terminal or via remote communication.
 4. The system will be provided with a dedicated alarm window or console. This window will notify the Operator(s) of an alarm condition, and allow the operator to view details of the alarm and acknowledge the alarm. The use of the Alarm Console can be enabled or disabled by the system administrator.
 5. When the Alarm Console is enabled, a separate alarm notification window will supersede all other windows on the desktop and shall not be capable of being minimized or closed by the operator. This window will notify the operator of new alarms and un-acknowledged alarms. Alarm notification windows or banners that can be minimized or closed by the operator shall not be acceptable.
 6. Critical Alarm Summary: Provide a summary of those points in the critical alarm state and include as a minimum; point acronym, point description, alarm type, limit exceed, current value, alarm type, time and date of occurrence.
 7. Alarm Summary: Provide a summary of all points in alarm and include as a minimum; point acronym, point description, current value, alarm type, limit exceeded, and time and date of occurrence.
 8. Maintenance Alarm Summary: Provide a summary of those points in maintenance alarm and include as a minimum; point acronym, point description, current value, alarm type, limit exceed, time and date of occurrence.

2.8 WEB BROWSER CLIENTS

- A. The primary means of access to the BAS for day to day operation from any PC connected to the LAN (and or remote via the Internet if so required) without the need for any proprietary software.
 1. The system shall be capable of supporting an unlimited number of clients using a standard Web browser such as Internet Explorer™ or Mozilla Firefox™. Systems requiring additional software (to enable a standard Web browser) to be resident on the client machine, or manufacture-specific browsers shall not be acceptable. As a minimum provide the capability of 32 web browser clients that can simultaneously access the system.
 2. The Web browser software shall run on any operating system and system configuration that is supported by the Web browser. Systems that require specific machine requirements in terms of processor speed, memory, etc., in order to allow the Web browser to function with the Building Automation System (BAS), shall not be acceptable.
 3. The Web browser shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the Graphical User Interface. Systems that require different views or that require different means of interacting with objects such as schedules, or logs, shall not be permitted.
 4. The Web browser client shall support at a minimum, the following functions:
 - a. User log-on identification and password shall be required. If an unauthorized user attempts access, a blank web page shall be displayed. Security using Java authentication and encryption techniques to prevent unauthorized access shall be implemented.
 - b. Graphical screens developed for the GUI shall be the same screens used for the Web browser client. Any animated graphical objects supported by the GUI shall be supported by the Web browser interface.
 - c. HTML programming shall not be required to display system graphics or data on a Web page

- d. Storage of the graphical screens shall be in the Network Control Unit (NCU), without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.
- e. Real-time values displayed on a Web page shall update automatically without requiring a manual "refresh" of the Web page.
- f. Users shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:
 - 1) Modify common application objects, such as schedules, calendars, and set points in a graphical manner.
 - 2) Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
 - 3) Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.
 - 4) Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.
 - 5) View logs and charts
 - 6) View and acknowledge alarms
- g. The system shall provide the capability to specify a user's (as determined by the log-on user identification) home page. Provide the ability to limit a specific user to just their defined home page. From the home page, links to other views, or pages in the system shall be possible, if allowed by the system administrator.
- h. Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.

2.9 BUILDING AUTOMATION SYSTEM CONTROLLERS - NETWORK CONTROL UNIT (NCU)

- A. The Network Control Unit (NCU) shall provide the interface between the LAN or WAN and the field control devices, and provide global supervisory control functions over the control devices connected to the NCU.
- B. The NCU shall be capable of executing application control programs to provide:
 - 1. Calendar functions
 - 2. Scheduling
 - 3. Trending
 - 4. Alarm monitoring and routing
 - 5. Time synchronization
 - 6. Integration of BACnet MS/TP and BACnet/IP controllers as well as their BACnet objects
 - 7. Network Management functions for all BACnet MS/TP and BACnet/IP based devices
 - 8. Host graphics
- C. The Network Control Unit must provide the following hardware features as a minimum:
 - 1. One Ethernet Port -10 / 100 Mbps
 - 2. One RS-485 port
 - 3. Battery Backup
 - 4. Flash memory for long term data backup (If battery backup or flash memory is not supplied, the controller must contain a Type SSD (Solid State Drive) hard disk with at least 1 terabyte (TB) storage capacity)
 - 5. The NCU must be capable of operation over a temperature range of 32 to 122°F

6. The NCU must be capable of withstanding storage temperatures of between 32 to 140°F and a humidity range of 5 to 95% RH, non-condensing
 7. A modem port and 56K modem. Exempt if remote access is provided via the Internet
- D. The NCU shall provide multiple user access to the system and support for ODBC or SQL. A database resident on the NCU shall be an ODBC-compliant database or must provide an ODBC data access mechanism to read and write data stored within it.
- E. Provide multiple Network Control Units as necessary. The NCU shall support a minimum of 128 BACnet controllers. In order to maintain peak performance of the network, no more than 110 BACnet controllers may be connected to a single NCU. In any event no more than 80% of the available resources of the NCU (as indicated by the resource meter of the programming tools for the NCU) shall be committed. In the event that the available resources are less than 20%, the number of nodes connected to the NCU shall be reduced in order to maintain a 20% or greater buffer of resources within the NCU.
- F. The NCU shall support standard Web browser access via the Intranet/Internet. It shall support a minimum of 32 simultaneous users.
- G. Event Alarm Notification and actions - The NCU shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers. The NCU shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via dial-up, telephone connection, or wide-area network.
1. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including but limited to:
 - a. To alarm
 - b. Return to normal
 - c. To fault
 2. Provide for the creation of a minimum of eight of alarm classes for the purpose of routing types and or classes of alarms, i.e.: security, HVAC, Fire, etc.
 3. Provide timed (schedule) routing of alarms by class, object, group, or node.
 4. Provide alarm generation from binary object "runtime" and /or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control. Control equipment and network failures shall be treated as alarms and annunciated.
 5. Alarms shall be annunciated in any of the following manners as defined by the user:
 - a. Screen message text
 - b. Email of the complete alarm message to multiple recipients. Provide the ability to route and email alarms based on:
 - 1) Day of week
 - 2) Time of day
 - 3) Recipient
 - c. Pagers via paging services that initiate a page on receipt of email message
 - d. Graphic with flashing alarm object(s)
 - e. Printed message, routed directly to a dedicated alarm printer
 6. The following shall be recorded by the NCU for each alarm (at a minimum):

- a. Time and date
 - b. Location (building, floor, zone, office number, etc.)
 - c. Equipment (air handler #, access way, etc.)
 - d. Acknowledge time, date, and user who issued acknowledgement.
 - e. Number of occurrences since last acknowledgement.
- 7. Alarm actions may be initiated by user defined programmable objects created for that purpose.
 - 8. Defined users shall be given proper access to acknowledge any alarm, or specific types or classes of alarms defined by the user.
 - 9. A log of all alarms shall be maintained by the NCU and/or a server (if configured in the system) and shall be available for review by the user.
 - 10. Provide a "query" feature to allow review of specific alarms by user defined parameters.
 - 11. A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.
 - 12. An Error Log to record invalid property changes or commands shall be provided and available for review by the user.

2.10 DATA COLLECTION AND STORAGE

- A. The NCU shall have the ability to collect data for any property of any object and store this data for future use.
- B. The data collection shall be performed by log objects, resident in the NCU that shall have, at a minimum, the following configurable properties:
 - 1. Designating the log as interval or deviation.
 - 2. For interval logs, the object shall be configured for time of day, day of week and the sample collection interval.
 - 3. For deviation logs, the object shall be configured for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.
 - 4. For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full, or rollover the data on a first-in, first-out basis.
 - 5. Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.
- C. All log data shall be stored in a relational database in the NCU and the data shall be accessed from a server (if the system is so configured) or a standard Web Browser. All log data, when accessed from a server, shall be capable of being manipulated using standard SQL statements. All log data shall be available to the user in the following data formats:
 - 1. HTML
 - 2. XML
 - 3. Plain Text
 - 4. Comma or tab separated values
- D. Systems that do not provide log data in HTML and XML formats at a minimum shall not be acceptable.
- E. The NCU shall have the ability to archive its log data either locally (to itself), or remotely to a server or other NCU on the network. Provide the ability to configure the following archiving properties, at a minimum:
 - 1. Archive when the log has reached its user-defined capacity of data stores

2. Archive on time of day
 3. Archive on user-defined number of data stores in the log (buffer size)
 4. Provide ability to clear logs once archived
- F. Audit Log - Provide and maintain an Audit Log that tracks all activities performed on the NCU. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached its user-defined buffer size. Provide the ability to archive the log locally (to the NCU), to another NCU on the network, or to a server. For each log entry, provide the following data:
1. Time and date
 2. User ID
 3. Change or activity: i.e., Change setpoint, add or delete objects, commands, etc.

2.11 DATABASE BACKUP AND STORAGE

- A. The NCU shall have the ability to automatically backup its database. The database shall be backed up based on a user-defined time interval. Copies of the current database and, at the most recently saved database shall be stored in the NCU. The age of the most recently saved database is dependent on the user-defined database save interval. The NCU database shall be stored, at a minimum, in XML format to allow for user viewing and editing, if desired. Other formats are acceptable as well, as long as XML format is supported.
- B. Provide three (3) copies of all tools necessary for the development, maintenance, expansion and use of the BAS described within these specifications. All software tools shall be compatible with Microsoft Windows 7 or XP Professional. For the purpose of this specification software tools shall be divided into the following categories and meet these specified requirements.

2.12 NCU PROGRAMMING WIZARDS FOR LCU/TCU CONTROLLERS

- A. Provide Wizards or objects that facilitate the programming and configuration of the Local Control Unit (LCU) and Terminal Control Unit (TCU) Controllers sequence of operation through a menu driven wizard. The programming and configuration tools shall perform the following functions:
1. LCU Controllers programming shall be accomplished by Graphical Programming Language (GPL) where objects are used to define different portions of the control sequence. All control sequences programmed into the controller shall be stored in non-volatile memory. Systems that only allow selection of sequences from a library or table are not acceptable. All code must be exportable to a library for future use.
 2. TCU Controllers – Provide for the programming of the required sequence of operation through an intuitive menu driven selection process. The configuration tools menu shall define items such as I/O configurations, set point, delays, PID loops, optimum start stops, and network variables settings. The configuration tool must indicate the device status and allow system override. Or, provide for the programming of the required sequence of operation through Graphical Programming Language (GPL) where objects are used to define different portions of the control sequence. All control sequences programmed into the controller shall be stored in non-volatile memory. Systems that only allow selection of sequences from a library or table are not acceptable. All code must be exportable to a library for future use.
 3. Wizards shall be openly available and be compatible with the current published versions of the network management tool that is provided as part of this project. The wizard software shall be available for public access from the manufacturer's web site. These wizard programming or configuration tools shall be compatible with at least 3 other manufactures Building Automation System (BAS). The System Integrator shall demonstrate as part of their prequalification as to how they intend to comply with these requirements. Should wizards as specified herein not be available then the System Integrator shall provide the following:

4. Provide three copies of the programming or configuration tools along with any manufacture specific software tools required to operate the programming or configuration tools. Such tools shall be provided with a permanent and operating system transferable license.
5. Provided free of charge to the owner or his designated agent for a period of 10 years the latest manufacturer's updates to the software described herein.

2.13 NCU NETWORK MANAGEMENT SOFTWARE TOOLS

- A. Provide a complete set of Network Management tools that provides for the development and management of BACnet networks.
- B. Provide a complete set of integrated BACnet network management tools for working with these networks. These tools shall manage a database for all BACnet devices by type and revision, and shall provide a software mechanism for identifying each device on the network. Systems requiring the use of third party BACnet network management tools shall not be accepted.
- C. Network management shall include the following services: device identification, device installation, device configuration, device diagnostics, device maintenance and network variable binding.
- D. The network configuration tool shall also provide diagnostics to identify devices on the network, to reset devices, and to view health and status counters within devices.
- E. These tools shall provide the ability to "discover" existing BACnet networks, regardless of what network management tool(s) were used to install the existing network, so that existing BACnet devices and newly added devices are part of a single network management database.
- F. The network management database shall be resident in the NCU with proper authorization has access to the network management database at all times. Systems employing network management databases that are not resident, at all times, within the control system, shall not be accepted.
- G. Provide for the ability to access all of the Network Management tool functions including controller programming from a Web Browser.

2.14 NCU PROGRAMMING SOFTWARE

- A. Provide programming software for the Network Control Unit that allows for the development of the NCU control logic, point management, global properties such as alarm, trend and scheduling.
- B. A library of control, application, and graphic objects shall be provided to enable the creation of all applications and user interface screens. Access to these functions shall be provided through Graphical User Interface software (GUI). Applications are to be created by selecting the desired control objects from the library, dragging or pasting them on the screen, and linking them together using a built in graphical connection tool. Completed applications may be stored in the library for future use. Graphical User Interface screens shall be created in the same fashion. Data for the user displays is obtained by graphically linking the user display objects to the application objects to provide "real-time" data updates. Any real-time data value or object property may be connected to display its current value on a user display. Systems requiring separate software tools or processes to create applications and user interface displays shall not be acceptable.
- C. Programming Methods - Provide the capability to copy objects from the supplied libraries, or from a user-defined library to the user's application. Objects shall be linked by a graphical linking scheme by dragging a link from one object to another. Object links will support one-to-one, many-

to-one, or one-to-many relationships. Linked objects shall maintain their connections to other objects regardless of where they are positioned on the page and shall show link identification for links to objects on other pages for easy identification. Links will vary in color depending on the type of link; i.e., internal, external, hardware, etc.

1. Configuration of each object will be done through the object's property sheet using fill-in the blank fields, list boxes, and selection buttons. Use of custom programming, scripting language, or a manufacturer-specific procedural language for configuration will not be accepted.
2. The software shall provide the ability to view the logic in an off-line (debug), the monitor mode shall allow the user to set values to inputs and monitor the logic for diagnosing execution before it is applied to the system.
3. All programming shall be done in real-time. Systems requiring the uploading, editing, and downloading of database objects shall not be allowed.
4. The system shall support object duplication within a customer's database. An application, once configured, can be copied and pasted for easy re-use and duplication. All links, other than to the hardware, shall be maintained during duplication.

D. NCU Object Library:

1. A standard library of software objects that represent functions and applications for the development and setup of application logic, user interface displays, system services, and communication networks.
2. The objects in this library shall be capable of being copied and pasted into the user's database and shall be organized according to their function. In addition, the user shall have the capability to group objects created in their application and store the new instances of these objects in a user-defined library.
3. In addition to the standard libraries specified here, the supplier of the system shall maintain an on-line accessible (over the Internet) library, available to all registered users to provide new or updated objects and applications as they are developed.
 - a. All control objects shall conform to the control objects specified in the ANSI/ASHRAE Standard 135-2008 BACnet specification.
 - b. The library shall include applications or objects for the following functions, at a minimum:
 - 1) Scheduling Object. The schedule must conform to the schedule object as defined in the BACnet specification, providing 7-day plus holiday & temporary scheduling features and a minimum of 10 on/off events per day. Data entry to be by graphical sliders to speed creation and selection of on-off events.
 - 2) Calendar Object. The calendar must conform to the calendar object as defined in the BACnet specification, providing 12-month calendar features to allow for holiday or special event data entry. Data entry to be by graphical "point-and-click" selection. This object must be "linkable" to any or all scheduling objects for effective event control.
 - 3) Duty Cycling Object. Provide a universal duty cycle object to allow repetitive on/off time control of equipment as an energy conserving measure. Any number of these objects may be created to control equipment at varying intervals
 - 4) Temperature Override Object. Provide a temperature override object that is capable of overriding equipment turned off by other energy saving programs (scheduling, duty cycling etc.) to maintain occupant comfort or for equipment freeze protection.
 - 5) Start-Stop Time Optimization Object. Provide a start-stop time optimization object to provide the capability of starting equipment just early enough to bring space conditions

to desired conditions by the scheduled occupancy time. Also, allow equipment to be stopped before the scheduled un-occupancy time just far enough ahead to take advantage of the building's "flywheel" effect for energy savings. Provide automatic tuning of all start / stop time object properties based on the previous day's performance.

- c. The library shall include control objects for the following functions. All control objects shall conform to the objects as specified in the BACnet specification.
- 1) Analog Input Object - Minimum requirement is to comply with the BACnet standard for data sharing. Allow high, low and failure limits to be assigned for alarming. Also, provide a time delay filter property to prevent nuisance alarms caused by temporary excursions above or below the user defined alarm limits.
 - 2) Analog Output Object - Minimum requirement is to comply with the BACnet standard for data sharing. The BACnet Command Prioritization priority scheme shall be incorporated to allow multiple control applications to execute commands on this object with the highest priority command being invoked. Provide sixteen levels of priority as a minimum. Systems not employing the BACnet method of contention resolution shall not be acceptable.
 - 3) Binary Input Object - Minimum requirement is to comply with the BACnet standard for data sharing. The user must be able to specify either input condition for alarming.
 - 4) Binary Output Object - Minimum requirement is to comply with the BACnet standard for data sharing. Properties to enable minimum on and off times for equipment protection as well as inter-start delay must be provided. The BACnet Command Prioritization priority scheme shall be incorporated to allow multiple control applications to execute commands on this object with the highest priority command being invoked. Provide sixteen levels of priority as a minimum. Systems not employing the BACnet method of contention resolution shall not be acceptable.
 - 5) Multi-State Input Object - Minimum requirement is to comply with the BACnet standard for data sharing.
 - 6) Multi-State Output Object - Minimum requirement is to comply with the BACnet standard for data sharing. The BACnet Command Prioritization priority scheme shall be incorporated to allow multiple control applications to execute commands on this object with the highest priority command being invoked. Provide sixteen levels of priority as a minimum. Systems not employing the BACnet method of contention resolution shall not be acceptable.
 - 7) PID Control Loop Object - Minimum requirement is to comply with the BACnet standard for data sharing. Each individual property must be adjustable as well as to be disabled to allow proportional control only, or proportional with integral control, as well as proportional, integral and derivative control.
 - 8) Comparison Object - Allow a minimum of two analog objects to be compared to select either the highest, lowest, or equality between the two linked inputs. Allow a minimum of two analog objects to be compared using comparators and return a True/False value. The following comparators shall be supported as a minimum: equal, not equal, greater than, less than, greater or equal, less or equal. Also, allow limits to be applied to the output value for alarm generation.
 - 9) Math Object - Allow a minimum of four analog objects to be tested for the minimum or maximum, or the sum, difference, or average of linked objects. Also, allow limits to be applied to the output value for alarm generation. Allow mathematical operation on a minimum of two analog objects. The following mathematical operators shall be supported as a minimum: add, subtract, multiply, divide, sine, cosine, tangent, logarithm, natural logarithm, square root, power and absolute value.
 - 10) Logic Object - Allow a minimum of two binary objects to be compared using Boolean comparator. The following comparators shall be supported as a minimum: And, Or, X or and Not.

- 11) Custom Programming Objects - Provide a blank object template for the creation of new custom objects to meet specific user application requirements. This object must provide a standard programming language that is used to define object behavior. Provide a library of functions including math and logic functions, string manipulation, and e-mail as a minimum. Also, provide a comprehensive on-line debug tool to allow complete testing of the new object. Allow new objects to be stored in the library for re-use.
- 12) Interlock Object - Provide an interlock object that provides a means of coordination of objects within a piece of equipment such as an Air Handler or other similar types of equipment. An example is to link the return fan to the supply fan such that when the supply fan is started, the return fan object is also started automatically without the user having to issue separate commands or to link each object to a schedule object. In addition, the control loops, damper objects, and alarm monitoring (such as return air, supply air, and mixed air temperature objects) will be inhibited from alarming during a user-defined period after startup to allow for stabilization. When the air handler is stopped, the interlocked return fan is also stopped, the outside air damper is closed, and other related objects within the air handler unit are inhibited from alarming thereby eliminating nuisance alarms during the off period.
- 13) The object library shall include objects to support the integration of devices connected to the Network Control Unit (NCU). At a minimum, provide the following as part of the standard library included with the programming software:
 - a) For BACnet devices, provide the following objects at a minimum:
 - (1) Analog Input
 - (2) Analog Output
 - (3) Analog Value
 - (4) Binary Input
 - (5) Binary Output
 - (6) Binary Value
 - (7) Multi-State Input
 - (8) Multi-State Output
 - (9) Multi-State Value
 - (10) Schedule Export
 - (11) Calendar Export
 - (12) Trend Export
 - (13) Device
 - (14) Loop
 - b) For each BACnet object, provide the ability to assign the object a BACnet device and object instance number.
 - c) For BACnet devices, provide the following services at a minimum:
 - (1) Segmentation
 - (2) Segmented Request
 - (3) Segmented Response
 - (4) Application Services
 - (5) Read Property
 - (6) Read Property Multiple
 - (7) Write Property
 - (8) Write Property Multiple
 - (9) Confirmed Event Notification
 - (10) Unconfirmed Event Notification
 - (11) Acknowledge Alarm
 - (12) Get Alarm Summary

- (13) Who-has
- (14) I-have
- (15) Who-is
- (16) I-am
- (17) Subscribe COV
- (18) Confirmed COV notification
- (19) Unconfirmed COV notification
- (20) Media Types
- (21) Ethernet
- (22) BACnet IP Annex J
- (23) MSTP
- (24) BACnet Broadcast Management Device (BBMD) function Routing

2.15 BUILDING AUTOMATION SYSTEM CONTROLLERS - LOCAL CONTROL UNITS (LCU), TERMINAL CONTROL UNITS (TCU)

A. General

1. Refer to Building Automation System PART 1 – GENERAL REQUIREMENTS with the following clarifications and additions.
2. Performance requirements of the Programmable Controllers are specified in this section.
3. All controllers provided as part of this system and used for indoor applications shall operate under ambient environmental conditions of 32°F to 122°F dry bulb and 5% to 90% relative humidity, non-condensing as a minimum.
4. All controllers provided as part of this system and used for outdoor applications shall operate under ambient environmental conditions of -40°F to 158°F dry bulb and 5% to 90% relative humidity, non-condensing as a minimum.

B. System Design

1. Local Control Units (LCU) shall be utilized for primary mechanical and electrical systems such as Air handling equipment, Make-up Air Unit, Boiler System Control, and Chiller System Control type of applications.
2. Terminal Control Units (TCU) shall be utilized for terminal equipment, such as Variable Air Volume, Fan Coil, and Rooftop Units, etc.
3. Each LCU and TCU controller shall have a minimum of 10% spare capacity of each point type for future points. As a minimum, each controller shall have one spare of each point type available on the controller.
4. Each NCU and each LAN shall have the capability of accepting 20% additional LCU/TCU(s) without the necessity of adding additional LAN controllers or LAN wiring.
5. The LCU and TCU controller programming or configuration tools shall be fully accessible through the Web Browser Client through the use of Wizards.
 - a. Provide Wizards or objects as specified in NCU section, which facilitate the programming and configuration of the LCU and TCU through a menu driven wizard.

2.16 CONTROLLER LOCAL AREA NETWORK (BAS SUB LAN)

- A. Provide a network of stand-alone, distributed direct digital controllers that operate on the following protocol using the specified physical layers:
 1. ANSI/ASHRAE Standard 135 BACnet Master/Slave Token Passing (MS/TP) at 76.8 kbps.
 2. BACnet IP devices will be allowed.
- B. Strict adherence to industry standards including ANSI/ASHRAE Standard 135, BACnet, certified by BACnet Testing Laboratory (BTL listed) to assure interoperability between all system

components. Controllers that are not BTL listed are unacceptable.

- C. Provide BAS Controllers that conform to ANSI/ASHRAE Standard 135, BACnet. Controllers using proprietary protocols or protocols other than the two listed herein are unacceptable.
- D. The design of the BAS sub LAN shall network Local Control Unit (LCU) and Terminal Control Unit (TCU) to a Network Control Unit (NCU).
- E. This level of communication shall support a family of application specific controllers and shall communicate bi-directionally with the network through DDC Controllers for transmission of global data.
- F. Terminal Control Unit (TCU) shall be arranged on the BAS sub LAN's in a functional relationship manner with Local Control Unit (LCU). Ensure that a Variable Air Volume (VAV) Terminal Control Unit (TCU) is logically on the same LAN or segment as the Local Control Unit (LCU) that is controlling its corresponding Air Handling Unit (AHU).

2.17 LOCAL CONTROL UNITS (LCU) (PRIMARY SYSTEMS SUCH AS AHU, MAU, DOAS, BOILER, WATER SYSTEM)

- A. The Local Control Units (LCU) shall be 32 bits microprocessor-based. They shall also be multi-tasking, real-time digital control processors consisting of modular hardware with plug-in enclosed processors, communication controllers, power supplies and input/output point modules. Controller size shall be sufficient to fully meet the requirements of this specification and the attached point list.
- B. Each LCU shall have sufficient memory, to support its own operating system and databases, including:
 - 1. Control processes
 - 2. Energy management applications
 - 3. Alarm management applications
 - 4. Historical/trend data for points specified
 - 5. Maintenance support applications
 - 6. Custom processes
 - 7. Manual override monitoring
- C. Each LCU shall support:
 - 1. Monitoring of the following types of inputs, without the addition of equipment outside the DDC Controller cabinet:
 - a. Analog inputs of 4-20 mA, 0-10 Vdc, 10,000 ohm thermistor or 1000 ohm RTD.
 - b. Digital inputs from dry contact closure, pulse accumulators, voltage sensing.
 - 2. Each LCU shall be capable of providing the following control outputs without the addition of equipment outside the DDC controller cabinet:
 - a. Digital outputs (contact closure for motor starters up to size 4).
 - b. Analog outputs of 4-20 mA or 0-10 Vdc.
- D. The LCU analog or universal input shall use a 16 bit A/D converter.
- E. The LCU analog or universal output shall use a 10 bit D/A converter. Each output shall have

supervised manual override switch and a potentiometer.

- F. Each LCU shall have a minimum of 10% spare capacity for each point type for future point connection. Provide all processors, power supplies and communication controllers complete so that the implementation of a point only requires the addition of the appropriate point input/output termination module and wiring. As a minimum, provide one of each type of point available on the controller.
- G. Provide sufficient internal memory for the specified control sequences and have at least 25% of the memory available for future use.
- H. The LCU shall provide local LED status indication for each output for constant, up-to-date verification of all point conditions without the need for an operator output device. Graduated intensity LEDs or analog indication of value shall also be provided for each analog output. Status indication shall be visible without opening the panel door.
- I. The LCU shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all panel components. The controller shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication.
- J. Should the LCU memory be lost for any reason, the user shall have the capability of reloading the controller software via the BAS LAN or Server. Controller requiring a local port to reload the controller software is not acceptable.
- K. Provide an onboard network communication jack for connection to the BACnet Network.

2.18 LCU PROGRAMMING SOFTWARE

- A. Provide programming software for the Local Control Unit (LCU) that allows for the development of the LCU control logic and point management.
- B. A library of control, application, and graphic objects shall be provided to enable the creation of all applications and user interface screens. Access to these functions shall be provided through Graphical User Interface software (GUI). Applications are to be created by selecting the desired control objects from the library, dragging or pasting them on the screen, and linking them together using a built in graphical connection tool. Completed applications may be stored in the library for future use. Graphical User Interface screens shall be created in the same fashion. Data for the user displays is obtained by graphically linking the user display objects to the application objects to provide "real-time" data updates. Any real-time data value or object property may be connected to display its current value on a user display. Systems requiring separate software tools or processes to create applications and user interface displays shall not be acceptable.
- C. Programming Methods - Provide the capability to copy objects from the supplied libraries, or from a user-defined library to the user's application. Objects shall be linked by a graphical linking scheme by dragging a link from one object to another. Object links will support one-to-one, many-to-one, or one-to-many relationships. Linked objects shall maintain their connections to other objects regardless of where they are positioned on the page and shall show link identification for links to objects on other pages for easy identification.
 - 1. Configuration of each object will be done through the object's property sheet using fill-in the blank fields, list boxes, and selection buttons. Use of custom programming, scripting language, or a manufacturer-specific procedural language for configuration will not be accepted.
 - 2. The software shall provide the ability to view the logic with value being inputted/outputted of

- the graphical blocks (debug mode),
- 3. The system shall support object duplication within a customer's database. An application, once configured, can be copied and pasted for easy re-use and duplication. All links, other than to the hardware, shall be maintained during duplication.
- D. Provides function to compare and calculate from multiple values from networked controllers (NCU, TCU and/or LCU). As a minimum, the function shall calculate and compared the values and return the average, sum, highest, lowest, 3 highest and 3 lowest values.

2.19 TERMINAL CONTROL UNITS (TCU) (SECONDARY SYSTEMS SUCH AS HEAT PUMPS AND VARIABLE-AIR-VOLUME TERMINAL UNITS)

- A. Provide Terminal Control Units (TCU) for control of each piece of terminal equipment.
- B. The Terminal Control Units (TCU) shall be 8 bits microprocessor-based. They shall also be multi-tasking, real-time digital control processors consisting of modular hardware with plug-in enclosed processors, communication controllers, power supplies and input/output point modules. Controller size shall be sufficient to fully meet the requirements of this specification and the attached point list.
- C. Each TCU shall have sufficient memory, to support its own operating system and databases, including:
 - 1. Control processes
 - 2. Maintenance support applications
 - 3. Custom processes
 - 4. Manual override monitoring
- D. Each TCU shall support:
 - 1. Monitoring of the following types of inputs, without the addition of equipment:
 - a. Analog inputs of 4-20 mA, 0-10 Vdc, 10,000 ohm thermistor or 1000 ohm RTD.
 - b. Digital inputs from dry contact closure, pulse accumulators, voltage sensing.
 - 2. Each TCU shall be capable of providing the following control outputs without the addition of equipment:
 - a. Digital outputs (contact closure for motor starters up to size 4).
 - b. Analog outputs of 4-20 mA or 0-10 Vdc.
- E. The TCU analog or universal input shall use a 16 bit A/D converter.
- F. The TCU analog or universal output shall use a 10 bit D/A converter.
- G. Controllers shall include all point inputs and outputs necessary to perform the specific control sequences. As a minimum, 25% of the point outputs shall be of the universal type; that is, the outputs may be utilized either as modulating or two-state, allowing for additional system flexibility. Analog outputs shall be industry standard signals such as 24V floating control, allowing for interface to a variety of modulating actuators.
- H. Each TCU controller performing space temperature control shall be provided with a matching room temperature sensor. Each room temperature sensor shall include a terminal jack integral to the sensor assembly. The terminal jack shall be used to connect a portable operator's terminal

to control and monitor all hardware and software points associated with all controllers on the Network.

- I. Each controller shall perform its primary control function independent of other NCU controller LAN communication, or if LAN communication is interrupted. Reversion to a fail-safe mode of operation during LAN interruption is not acceptable. The controller shall receive its real-time data from the NCU controller time clock to insure LAN continuity. Each controller shall include algorithms incorporating proportional, integral, and derivative (PID) gains for all applications. All PID gains and biases shall be field-adjustable by the user via terminals as specified herein. This functionality shall allow for tighter control of space conditions and shall facilitate optimal occupant comfort and energy savings.
- J. Provide each TCU with sufficient memory to accommodate point databases, operating programs, local alarming and local trending. All databases and programs shall be stored in non-volatile EEPROM, EPROM and PROM. The controllers shall be able to return to full normal operation without user intervention after a power failure of unlimited duration. Operating programs shall be field selectable for specific applications. In addition, specific applications may be modified to meet the user's exact control strategy requirements, allowing for additional system flexibility. Controllers that require factory changes of all applications are not acceptable.

2.20 TCU PROGRAMMING SOFTWARE

- A. Provide programming software for the Terminal Control Unit (TCU) that allows for the development of the TCU control logic and point management.
- B. A library of control, application, and graphic objects shall be provided to enable the creation of all applications and user interface screens. Access to these functions shall be provided through Graphical User Interface software (GUI). Applications are to be created by selecting the desired control objects from the library, dragging or pasting them on the screen, and linking them together using a built in graphical connection tool. Completed applications may be stored in the library for future use. Graphical User Interface screens shall be created in the same fashion. Data for the user displays is obtained by graphically linking the user display objects to the application objects to provide "real-time" data updates. Any real-time data value or object property may be connected to display its current value on a user display. Systems requiring separate software tools or processes to create applications and user interface displays shall not be acceptable.
- C. Programming Methods - Provide the capability to copy objects from the supplied libraries, or from a user-defined library to the user's application. Objects shall be linked by a graphical linking scheme by dragging a link from one object to another. Object links will support one-to-one, many-to-one, or one-to-many relationships. Linked objects shall maintain their connections to other objects regardless of where they are positioned on the page and shall show link identification for links to objects on other pages for easy identification.
 - 1. Configuration of each object will be done through the object's property sheet using fill-in the blank fields, list boxes, and selection buttons. Use of custom programming, scripting language, or a manufacturer-specific procedural language for configuration will not be accepted.
 - 2. The software shall provide the ability to view the logic with value being inputted/outputted of the graphical blocks (debug mode),
 - 3. The system shall support object duplication within a customer's database. An application, once configured, can be copied and pasted for easy re-use and duplication. All links, other than to the hardware, shall be maintained during duplication.

- D. Provides function to compare and calculate from multiple values from networked controllers

(NCU, TCU and/or LCU). As a minimum, the function shall calculate and compared the values and return the average, sum, highest and lowest values.

2.21 TCU CONFIGURATION SOFTWARE

- A. Configuration of the TCU controller shall be done through the configuration tool using fill-in the blank fields, list boxes, and selection buttons.
- B. The configuration tool menu shall define items such as I/O configurations, set point, delays, PID loops, optimum start stops, and network variables/object settings. The configuration tool shall indicate the device status and allows system override.
- C. The Configurable Controller shall allow the use of its spare I/O as dumb I/O to be shared over the network to other Controllers such as Programmable Controllers, where a sequence of operation can be applied to the I/O. Such applications shall include but not be limited to exhaust fan control, heaters, etc.

2.22 CONTROLLERS – BACNET PROTOCOL

- A. Provide BACnet Controllers that BACnet Testing Laboratory listed as specified herein:
 - 1. BACnet Building Controller (B-BC)
 - 2. BACnet Advanced Application Controller (B-AAC)
 - 3. BACnet Application Specific Controller (B-ASC)
- B. All BACnet Controllers shall use the following communication specifications and achieve performance as specified herein:
 - 1. All controllers shall be able to communicate peer-to-peer without the need for a Network Control Unit (NCU). Any controller on the MS/TP Data Link/Physical layer shall be able to act as a Master to allow for the exchange and sharing of data variables and messages with any other controller connected on the same communication cabling. Slave controllers are not acceptable.
 - 2. Performance – Each BACnet controller shall have a minimum of 64Kb of RAM and 384Kb of non-volatile flash memory. Each controller shall have a 32-bit microprocessor operating at 68 MHz and support a BACnet protocol stack in accordance with the ANSI/ASHRAE Standard 135-2008 and the BACnet Device Profile supported. Each BACnet controller shall provide a loading characteristic of minimum 1/4th Load on the BACnet MS/TP communications trunk. Manufacturers, who wish to supply LCU and TCU controllers with less than a 32-bit microprocessor and/or a MS/TP loading characteristic of greater than 1/4th Load, may do so as long as only they provide a maximum of 32 controllers on a single bus segment per NCU.
 - 3. BACnet Controllers shall be provided for Fan Coils, Variable Air Volume (VAV) Terminals and other applications as shown on the drawings. The application control program shall be resident within the same enclosure as the input/output circuitry, which translates the sensor signals.
 - 4. All Local Control Unit (LCU) and Terminal Control Units (TCUs) shall be fully programmable and the programming software shall have a library of pre-built, tested, and user re-definable control sequences for a wide range of typical HVAC applications. LCU and TCU controllers that are not fully programmable are not acceptable.
 - 5. BACnet Controllers shall communicate with the Network Control Unit (NCU) via a BACnet/IP connection at a baud rate of not less than 100 Mbps or via the RS485 MS/TP connection at a baud rate of not less than 76.8 kbps.
 - 6. BACnet TCU matching room temperature and/or humidity sensor shall connect directly to the TCU and shall not utilize any of the I/O points of the Controller. The TCU matching room temperature sensor shall provide a communications jack for connection to the BACnet

communication trunk to which the TCU is connected. The TCU matching room temperature sensor, the connected TCU, and all other devices on the BACnet bus shall be accessible from this communications jack.

- C. All BACNET LCU AND TCU SHALL BE FULLY APPLICATION PROGRAMMABLE. ALL CONTROL SEQUENCES PROGRAMMED INTO THE LCU AND TCU SHALL BE STORED IN NON-VOLATILE MEMORY, WHICH IS NOT DEPENDENT UPON THE PRESENCE OF A BATTERY, TO BE RETAINED.
- D. The network router shall be used to route messages from a segment, sub-net, or domain in full duplex communication mode. Routers shall utilize BACnet protocol transport, network, and session layers to transparently route messages bound for a device instance in another network. The routers, shall be capable of DIN rail or panel mounting and be equipped with status LED lights for Network traffic and power. A router may not manage more than 60 nodes on any single channel so as to allow for future expansion. Equip each router with a network transceiver on each network port (inbound and outbound) as dictated by the network type
- E. A repeater or signal booster may only be used to increase the signal strength of the communications. Under no circumstances may it be used in the place of a router.
- F. The System Integrator supplying the BACnet Controllers shall provide documentation for each device, with the following information at a minimum:
 - 1. BACnet Device; MAC address, name, type and instance number
 - 2. BACnet Objects; name, type and instance number
- G. It is the responsibility of the System Integrator to ensure that the proper BACnet objects are provided in each BACnet controller, as required by the Point List located in the POINTS LIST section of this specification.

2.23 CONTROL PANELS, ENCLOSURES & SUB-PANELS

- A. Provide wall or base mounted enclosures to house all controllers, transformers, relays, etc. associated with system, mechanical room or area. Enclosures shall conform to the following requirements:
 - 1. Minimum 16 gauge steel or aluminum, totally enclosed on all sides and painted with a baked enamel finish.
 - 2. Enclosures located outdoors shall meet NEMA 4X.
 - 3. Enclosures located in all other locations including but not limited to mechanical or electrical rooms not requiring NEMA 2, occupied spaces, above ceilings and plenums shall be the same NEMA classification as all other enclosures located in the same environment, except if location requires additional protection due to potential vandalism or environmental conditions and shall at a minimum meet NEMA 1 requirements.
 - 4. Provide a hinged door, keyed locking latch and removable sub-panel. A single key shall be common to all control enclosures.
 - 5. Provide each DDC panel with on/off control, 120VAC convenience outlet, high/low voltage separation, control fuse(s), control transformer(s), terminal blocks and DC power supplies as necessary.
 - 6. **Size panels for a minimum of two (2) future expansion modules, LCUs, or TCUs.**

2.24 FIELD DEVICES

- A. Control Dampers

1. Rectangular Control Dampers - Insulated:

- a. Basis of Design: TAMCO Series 9000.
- b. Shall be licensed to bear the AMCA Certified Rating Seal.
- c. Test leakage and pressure drop per AMCA 500.
- d. Frame: Hat-shaped channel, minimum 12 gauge aluminum, and minimum 4" deep. Zinc-plated steel fasteners or weld seams.
- e. Blades: Minimum 14 gauge extruded aluminum airfoil design, minimum 6" wide, and overlapping blades and blade seals (overlapping blade seals only is unacceptable). Thermally broken and insulated with foam insulation for a minimum R-2.29 insulating factor.
- f. Shaft: Non-cylindrical, solid aluminum shaft with opening in blade to match profile of shaft. Shaft shall be securely fastened to the blade and of sufficient length to mount direct-coupled actuator. Damper manufacturer shall provide drive pin extensions and outboard bearing support brackets as required.
- g. Bearings: Acetal (Delrin/Celcon) inner bearing fixed to an aluminum shaft, rotating within a polycarbonate outer bearing inserted in the frame. Provide thrust bearings for vertical damper applications.
- h. Blade Seals: Silicone or EPDM gaskets secured in an integral slot within the blade.
- i. Frame Seals: Silicone gasket secured in an integral slot within the frame.
- j. Linkage: Shall be concealed in the frame, constructed of aluminum or corrosion-resistant zinc plated steel, and securely fastened to shaft. Blades linked for opposed operation, unless noted otherwise on the drawings. Blades shall close evenly. Use one direct-coupled actuator per damper section. Jack-shafting is not acceptable.
- k. Operating Temperature: 40 deg. F to 212 deg. F.
- l. Size Limits: 48" maximum horizontal blade length, 24 square foot maximum area per damper. Total cross-sectional area of dampers in ducts shall be at least as large as the duct without the use of blank-off sections.
- m. Maximum Leakage: Class IA at 1 in. w.c. static pressure.
- n. Maximum Pressure Drop for Opposed Blade Damper: 0.15" for 8,000 cfm through a 24"x24" damper (2000 fpm).
- o. Maximum Pressure Drop for Parallel Blade Damper: 0.08" for 8,000 cfm through a 24"x24" damper (2000 fpm).

2. Rectangular Control Dampers - Uninsulated:

- a. Basis of Design: TAMCO Series 1000.
- b. Shall be licensed to bear the AMCA Certified Rating Seal.
- c. Test leakage and pressure drop per AMCA 500.
- d. Frame: Hat-shaped channel, minimum 12 gauge aluminum, and minimum 4" deep. Caulk or weld seams to prevent leakage.
- e. Blades: Minimum 12 gauge extruded aluminum airfoil design, minimum 6" wide, and overlapping blades and blade seals (overlapping blade seals only is unacceptable).
- f. Shaft: Non-cylindrical, solid aluminum shaft with opening in blade to match profile of shaft. Shaft shall be securely fastened to the blade and of sufficient length to mount direct-coupled actuator. Damper manufacturer shall provide drive pin extensions and outboard bearing support brackets as required.
- g. Bearings: Acetal (Delrin/Celcon) inner bearing fixed to an aluminum shaft, rotating within a polycarbonate outer bearing inserted in the frame. Provide thrust bearings for vertical damper applications.
- h. Blade Seals: Extruded silicone gaskets secured in an integral slot within the blade.
- i. Side Seals: Stainless steel compression type or extruded silicone gasket secured in an integral slot within the frame.
- j. Linkage: Shall be concealed in the frame, constructed of aluminum or corrosion-resistant zinc plated steel, and securely fastened to shaft. Blades linked for opposed operation,

unless noted otherwise on the drawings. Blades shall close evenly. Use one direct-coupled actuator per damper section. Jack-shafting is not acceptable.

- k. Size Limits: 48" maximum horizontal blade length, 24 square foot maximum area per damper. Total cross-sectional area of dampers in ducts shall be at least as large as the duct without the use of blank-off sections.
- l. Maximum Leakage: 9 cfm at 1" w.c. pressure differential for a 24"x 24" damper.
- m. Maximum Pressure Drop for Opposed Blade Damper: 0.15" for 8,000 cfm through a 24"x24" damper (2000 fpm).
- n. Maximum Pressure Drop for Parallel Blade Damper: 0.08" for 8,000 cfm through a 24"x24" damper (2000 fpm).

B. Damper Actuators

1. Damper Actuators - Electronic - Spring Return:

- a. Damper actuators shall be UL listed, electronic direct coupled with spring return to normal position for modulating or two-position control as noted in the sequence of control. Actuator shall be 24 VAC with proportional control, electronic overload protection to prevent actuator damage due to over-rotation and "V" bolt clamp with matching "V" toothed cradle (single bolt or setscrew fasteners not acceptable).
- b. Following power interruption, spring return mechanism shall close the damper. Mechanical spring shall be rated for a minimum of 60,000 full cycles. Provide breathable membrane in actuator housing to compensate for pressure differential and allow for 95% non-condensing relative humidity in the airstream.
- c. Mount actuators with motor outside of airstream whenever possible. Unit casings shall have housing with proper weather, corrosive, or explosion-proof construction as required by application.
- d. Actuators shall be rated for 60,000 full cycles at rated torque with 2-year unconditional warranty. Size actuators per damper manufacturer's recommendations.

C. Hydronic Control Valves

1. General:

- a. Two-position valves shall be a minimum of line size with a maximum allowable pressure drop of 2 psi.
- b. Size two-way and three-way modulating valves to provide a pressure drop at full flow of 1 to 4 psig.
- c. Two-way valves shall be 100% tight-closing. Three-way valves shall be 100% tight-closing in both extreme positions.
- d. Modulating two-way valves shall have equal percentage flow characteristics.
- e. Modulating three-way valves shall have linear flow characteristics.
- f. Piping geometry correction factors for Cv ratings shall be used and stated for ball valves, butterfly valves, or non-characterized valves.

2. Two-Position:

a. Ball 2" and Under:

- 1) Design Pressure: 400 psig.
- 2) Design Temperature: 212°F.
- 3) Bronze or brass body, stainless steel stem, stainless steel full port ball, PTFE or RTFE seats and seals, screwed ends (solder ends are acceptable only if rated for soldering in line with 470°F melting point of 95-5 solder).

D. Valve Actuators

1. General:

- a. Actuators shall be sized to operate the valve through its full range of motion and shall close against pump shutoff pressure without producing audible noise at any valve position.
- b. Provide visual position indication.
- c. Mount actuator directly on valve or provide linear motion assembly as required for valve type.

2. Valve Actuators - Electronic:

- a. Actuator shall be UL listed and provided with NEMA housing for applicable environment, electronic overload protection to prevent actuator damage due to over-rotation, and "V" bolt clamp with matching "V" toothed cradle (single bolt or setscrew fasteners not acceptable).
- b. Actuators shall be rated for 60,000 full stroke cycles at rated torque. Stall motor not acceptable.
- c. Tri-state/floating actuators shall have auto-zeroing function for realigning valve position.
- d. Proportional actuator position shall be proportional to analog or pulse width modulating signal from electronic control system.
- e. Spring return actuators shall have an internal spring return mechanism. Non-mechanical forms of fail-safe operation are not acceptable.
- f. Provide analog feedback signal for positive position indication. Refer to Valve Schedule and FMCS points list.

2.25 CONTROL INSTRUMENTATION

A. Electromagnetic Flow Meters:

1. Manufacturers:

- a. Badger Meter.
- b. Dwyer.
- c. Ebtron
- d. Omicron Controls Inc.

2. Basis of Design: Badger Meter M2000.
3. Description: Electromagnetic flow meter with integral amplifier.
4. Amplifier Housing: Powder coated cast aluminum.
5. Detector Housing: Carbon Steel.
6. Pipe Spool: 316 stainless steel.
7. Flanges: ANSI B16.5 Class 150 cast steel.
8. Electrode: Alloy C.
9. Flow Range: 0.1 to 39.4 ft/s
10. Accuracy for Velocities Greater Than 1.64 ft/s: $\pm 0.25\%$
11. Accuracy for Velocities Less Than 1.64 ft/s: ± 0.004 ft/s
12. Repeatability: $\pm 0.1\%$

B. Makeup Water Flow Meters:

1. Basis of Design: Dwyer WMT2
2. Body Material: Brass.
3. Flow Range: 0.25 to 30 gpm.
4. Accuracy:

- a. Transitional Flow: $\pm 5\%$.
 - b. Nominal Flow: $\pm 2\%$.
- 5. Maximum Pressure: 232 psi.
 - 6. Output Signal: Pulse output.
 - 7. Pulse Rate: 0.1 gal/pulse.

C. Zone Thermostats:

- 1. Shall be constructed for either surface or wallbox mounting.
- 2. Shall have the following options:
 - a. Ambient Conditions: 32 deg. F. to 122 deg. F. and 10% to 90% RH.
 - b. Temperature Sensor: Digital.
 - c. Humidity Sensor: Thin film capacitive.
 - d. Temperature Resolution: plus or minus 0.5 deg. F.
 - e. Temperature Accuracy: plus or minus 1 deg. F.
 - f. Humidity Accuracy: plus or minus 2 percent RH for ranges between 20% to 80% RH.
 - g. Color: White.
 - h. Fixed segment display.
 - i. BACnet MS/TP or IP protocol.
 - j. Sensors: As indicated on drawings.
 - k. Unless noted otherwise, sensor shall be connected via modular jack and communicate via the controller's SA buss.

D. Temperature Sensors

- 1. Sensors and transmitters shall be provided, as outlined in the input/output summary and sequence of operations.
- 2. The temperature sensor shall be of the resistance type, and shall be either two-wire 1000 ohm nickel RTD, or two-wire 1000 ohm platinum RTD.
- 3. The following point types (and the accuracy of each) are required, and their associated accuracy values include errors associated with the sensor, lead wire, and A to D conversion:

Point Type	Accuracy
Chilled Water	$\pm .5^{\circ}\text{F.}$
Room Temperature	$\pm .5^{\circ}\text{F.}$
Duct Temperature (Averaging)	$\pm .5^{\circ}\text{F.}$
All Others	$\pm .75^{\circ}\text{F}$

a. Thermowells

- 1) When thermowells are required, the sensor and well shall be supplied as a complete assembly, including well head and greenfield fitting.
- 2) Thermowells shall be pressure rated and constructed in accordance with the system working pressure.
- 3) Thermowells and sensors shall be mounted in a threadolet or 1/2" NPT saddle and allow easy access to the sensor for repair or replacement.
- 4) Thermowells shall be constructed of brass.
- 5) Provide bushings as necessary to accommodate thread size differences between thermowell and threadolet.

4. Thermowells

- a. When thermowells are required, the sensor and well shall be supplied as a complete assembly, including well head and greenfield fitting.
- b. Thermowells shall be pressure rated and constructed in accordance with the system working pressure.
- c. Thermowells and sensors shall be mounted in a threadolet or 1/2" NPT saddle and allow easy access to the sensor for repair or replacement.
- d. Thermowells shall be constructed of brass.
- e. Provide bushings as necessary to accommodate thread size differences between thermowell and threadolet.

5. Duct Mount Sensors

- a. Duct mount sensors shall mount in an electrical box through a hole in the duct, and be positioned so as to be easily accessible for repair or replacement.
- b. Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.
- c. For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used.

E. Outdoor Air Measuring Devices:

- 1. Basis of Design: Vaisala HMS80
- 2. Combination humidity and temperature transmitters with integrated radiation shield.
- 3. Operating Environment:

- a. Temperature: -40 to +140 deg F.
- b. Humidity: 0 to 100% RH.
- c. Maximum wind speed: 67 mph..

4. Relative Humidity:

- a. Range: 0 to 100% RH.
- b. Accuracy at 86 to 140 deg F. and below 90% RH: $\pm 5\%$.
- c. Accuracy at 86 to 140 deg F. and above 90% RH: $\pm 7\%$.
- d. Accuracy at 50 to 86 deg F. and below 90% RH: $\pm 3\%$.
- e. Accuracy at 50 to 86 deg F. and above 90% RH: $\pm 5\%$.
- f. Accuracy at minus 4 to 50 deg F. and below 90% RH: $\pm 5\%$.
- g. Accuracy at minus 4 to 50 deg F. and above 90% RH: $\pm 7\%$.
- h. Accuracy at minus 40 to minus 4 deg. F. and 0 to 100% RH: $\pm 7\%$.

5. Temperature:

- a. Range: minus 40 to 140 deg. F.
- b. Accuracy at 68 deg. F.: ± 0.54 deg. F.

6. Dew Point Temperature:

- a. Range: minus 40 to 140 deg. F.
- b. Accuracy at 68 deg. F.: ± 1.6 deg. F.

7. Wet Bulb Temperature:

- a. Range: minus 40 to 140 deg. F.

- b. Accuracy at 68 deg. F.: ± 1.3 deg. F.
- 8. Enthalpy:
 - a. Range: minus 10 to 190 BTU/lb.
 - b. Accuracy at 68 deg. F.: ± 0.9 BTU/lb.
- 9. Housing Material: Polycarbonate with 10% glass fiber.
- 10. Housing Finish: White.

F. Pressure Measuring Devices

- 1. Differential Pressure Switches:
 - a. Standard Pressure Switches:
 - 1) Diaphragm-activated gauge with 4-3/4" dial, cast aluminum case, sealed interior, designed to resist shock and vibration, and rated for 15 psig.
 - 2) Accuracy shall be $\pm 3\%$ of full scale maximum throughout entire range at 70°F.
 - 3) Provide mounting brackets, probes, and shut-off valves required for proper installation.
 - 4) The range and service shall be as required for application or as noted on the drawings.
 - 5) Provide two (2) photo-transistor-activated circuits and two (2) DPDT relays for both high or low limit alarms or controls.
 - 6) Provide latching relays that require manual reset once activated.
 - 7) Acceptable Manufacturer: Dwyer Photohelic Series 3000.
- 2. Pressure Transmitters/Transducer:
 - a. Select device suitable for intended application; water or air, static or differential.
 - b. Select for appropriate range, including negative if applicable.
 - c. 100% solid state device, temperature compensated, suitable for pressures of 200% rated range with averaging to stabilize output, accuracy of $\pm 1\%$ full scale, and a 4-20 mA output.
 - d. Provide a NEMA 4 enclosure unless panel mounted.
 - e. Air service shall have a minimum of three field selectable ranges.
 - f. When used for room pressure control, the transducer shall be bidirectional with a range of ± 0.1 " W.C.
 - g. Provide pressure line outlet cover on both sides of the wall when used for room pressure control.
 - h. Furnish with integral LED's to indicate Zero Pressure, Pressure In Range, and Pressure Out Of Range as a diagnostic aid.

G. Current Measuring Devices:

- 1. Current Switches for Constant Speed Motors:
 - a. Digital device rated for amperage load of motor or device with split core design, adjustable high and low trip points, 600 VAC rms isolation, induced power from the monitored load, LED indicator lamps for output status and sensor power. The device shall sense overloading, belt-loss, and power failure with a single signal.
- 2. Current Switches for Motors Controlled by VFD:
 - a. Digital device rated for amperage load of motor or device with split core design, factory programmed to detect motor under current conditions on variable or constant volume

loads, self-calibrating, positive status indication, LED indicator lamps, 600 VAC rms isolation, and induced power from the monitored load with N.O. output. The current sensor shall store the motor current operating parameters in non-volatile memory and have a pushbutton reset to clear the memory if the operating parameters change or the sensor is moved to another load. The device shall sense overloading, belt-loss, and power failure with a single signal. The sensor shall be mounted on the load side of variable frequency drives.

2.26 MISCELLANEOUS DEVICES:

A. Control Relays:

1. Form "C" contacts rated for the application with "push-to-test" contact transfer feature and an integral LED to indicate coil energization.
2. Mount all relays and power supplies in a NEMA 1 enclosure beside the FMCS panel or controlled device and clearly label their functions.

B. Occupancy Counting

1. Basis of Design: Ebtron Census C100
2. Description: Automatic detection and counting of occupants entering or exiting the space.
3. Sensor shall utilize dual-sensor differential thermal imaging technology with two thermopile sensors.
4. Sensor shall provide occupancy count accuracy typically within ± 5 percent of actual population or 3 people, whichever is greater, for openings 42 inches or less in width.
5. Sensor shall be suitable for installation at door openings and shall be mounted on the overhead door jamb or above the door opening with an optional manufacturer-provided stand-off bracket.
6. Sensor shall operate within an ambient temperature range of 65 to 85°F and relative humidity range of 5 to 95 percent.
7. Provide integral transmitter with 24 VAC power.
 - a. Provide individual 24 VAC transformers for each sensor where required for isolated RS-485 communications.
8. Control Signal: 0–10 VDC scalable and protected analog output proportional to occupancy count.
9. Provide all mounting hardware, stand-off brackets, power supplies, transformers, wiring, communications wiring, and accessories required for a complete and operational installation.

2.27 WIRING, CABLE, AND RACEWAYS

A. Conduit Types:

1. Electrical Metallic Tubing (EMT) and Fittings: ANSI C80.3
 - a. Fittings and conduit bodies: Compression or steel set screw type of steel or malleable iron design for their specific application.
2. Flexible Metallic Conduit (FMC) and Fittings: FS-WW-C-566
 - a. Construction: Flexible steel, approved for conduit ground, zinc coated, threadless type formed from a continuous length of spirally wound, interlocked zinc coated strip steel.

- b. Fittings and conduit bodies: Threadless hinged clamp type, galvanized zinc coated cadmium plated malleable cast iron that shall include plastic or cast metal inserts supplied by the manufacturer to protect conductors from sharp edges.
- c. Maximum allowable length 6'-0".

B. Wire and Cable Types:

1. Building Wire:

- a. Control Circuits: Copper, stranded conductor 600 volt insulation, THHN/THWN.

2. Remote Control and Signal Cable:

- a. Control Cable for Class 1 Remote Control and Signal Circuits: Copper conductor, 600 volt insulation, rated 60°C, individual conductors twisted together, shielded, and covered with a PVC jacket.
- b. Control Cable for Class 2 or Class 3 Remote Control and Signal Circuits: Copper conductor, 300 volt insulation, rated 60°C, individual conductors twisted together, shielded, and covered with a PVC jacket; UL listed.
- c. Plenum Cable for Class 2 or Class 3 Remote Control and Signal Circuits: Copper conductor, 300 volt insulation, rated 60°C, individual conductors twisted together, shielded, and covered with a nonmetallic jacket; UL listed for use in air handling ducts, hollow spaces used as ducts, and plenums.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

- A. Verify that systems are ready to receive work. Beginning of installation means installer accepts existing conditions.
- B. Install system and materials in accordance with manufacturer's instructions.
- C. Drawings of the TCS and FMCS network are diagrammatic only. Any apparatus not shown but required to meet the intent of the project documents shall be furnished and installed without additional cost.
- D. Install all operators, sensors, and control devices where accessible for service, adjustment, calibration, and repair. Do not install devices where blocked by piping or ductwork. Devices with manual reset or limit adjustments shall be installed below 6'-0" if practical to allow inspection without using a ladder.
- E. Verify locations of wall-mounted devices (such as thermostats, temperature and humidity sensors, and other exposed sensors) with drawings and room details before installation. Coordinate mounting heights to be consistent with other wall-mounted devices. Maximum height above finished floor shall not exceed 48".
- F. Provide valves over 3/4" size with position indicators and pilot positioners where sequenced with other controls.
- G. Mount control panels adjacent to associated equipment on vibration-free walls or freestanding angle iron supports. One cabinet may accommodate more than one system in same equipment room.
- H. After completion of installation, test, calibrate and adjust as required all control equipment

including sensors. This includes but is not limited to factory installed sensors which may be part of any HVAC equipment served by factory furnished unitary controllers.

- I. Check calibration of instruments. Recalibrate or replace.
- J. Furnish and install conduit, wire, and cable per the National Electric Code, unless noted otherwise in this section.
- K. All controls associated with the proper operation of air handling units, pumps, or other mechanical equipment served by emergency power shall be connected to the emergency power system. Control components shall not be powered from the life safety branch of the emergency power system. Coordinate emergency power source connections with the Engineer.
- L. All hardware, software, equipment, accessories, wiring (power and sensor), piping, relays, sensors, power supplies, transformers, and instrumentation required for a complete and operational FMCS system, but not shown on the electrical drawings, are the responsibility of the TCC.
- M. Remodeling:
 - 1. All room devices as indicated on the drawings shall be removed by this Contractor. The Contractor shall also prepare the wall for finishes. Preparing the wall shall include patching old anchor holes (after the anchoring device has been removed) and sanding the wall to remove old paint outlines remaining from original devices. The wall shall be painted to match the existing wall prior to the installation of the new room device. In the event that wall covering requires patching, the Contractor shall furnish new wall covering to match existing. If new wall covering is not available to match existing, the Contractor shall furnish a white acrylic or Plexiglas plate, 1/4" thick and sized to cover the void.
- N. Labels For Control Devices:
 - 1. Provide labels indicating service of all control devices in panels and other locations.
 - 2. Labels may be made with permanent marking pen in the control panels if clearly legible.
 - 3. Use engraved labels for items outside panel such as outside air thermostats.
 - 4. Labels are not required for room thermostats, damper actuators and other items where their function is obvious.
- O. VFD's:
 - 1. This project includes several variable frequency drives to control the flow of fans and/or pumps based on a control variable.
 - 2. Verify output signal required, 4-20 mA or 0-10V dc, with the EC.
 - 3. If VFD has a bypass feature, auxiliary contacts on the drive may not be used for motor status. A separate relay must be used to indicate motor rotation in either hand or auto positions.
 - 4. If a separate current transmitter or switch is indicated for status, install this device between the VFD and the motor. In this case, the drive status may be connected to the auxiliary contacts in the VFD.
 - 5. Some devices, such as low limits and fire alarm shutdown relays, must be hardwired to the fan motor. Make connections such that fan will shut down whether in hand or auto position if the unit has a bypass feature.

3.2 GRAPHIC DISPLAY

- A. Create a customized graphic for each piece of equipment indicated on the itemized points list.

- B. Components shall be arranged on graphic as installed in the field.
- C. Include each graphic point listed in the itemized points list using real time data.
- D. Provide a graphic representation of the following:
 - 1. Where there are multiple buildings, color code the campus map by the systems serving that building. The building graphic shall be linked to the graphic for that building's systems.
 - 2. Where there are multiple floors, provide color codes/designations for the areas served by each AHU and TAB by floor.
 - 3. Where multiple AHUs serve one floor, color code the areas served by each AHU. The area shall be linked to the graphic for that area's AHU.
 - 4. Provide an overall floor plan of each floor of the building color coded by zone linked to the TAB for that zone. The zone shall be linked to the graphic for that zone's TAB graphic.
 - 5. Show the location of each thermostat on the floor plan.
 - 6. Provide separate graphics showing the chilled and heating water system flow diagram. Show temperatures and flows on the flow diagram. Each piece of equipment shown on the flow diagram shall be linked to the graphic for that piece of equipment.
 - 7. Provide a graphic showing the steam system flow diagram. Show pressures and flows on the flow diagram. Each piece of equipment shown on the flow diagram shall be linked to the graphic for that piece of equipment.
- E. The FMCS shall include full graphic operator interface to display the following graphics as a minimum:
 - 1. Home page to include a minimum of six critical points: Outside Air Temperature, Outside Air Relative Humidity, Enthalpy, KWH, KW, etc.
 - 2. Graphic floor plans accurately depicting rooms, walls, hallways, and showing accurate locations of space sensors and major mechanical equipment.
 - 3. Detailed graphics for each mechanical system including AHUs, ERUs, EFs, chillers, and boilers, as a minimum.
 - 4. Access corresponding system drawings, technical literature, and sequences of operations directly from each system graphic.
- F. The FMCS shall include individual graphical buttons to access the following data stored in PDF format:
 - 1. Project control as-built documentation including all TCS drawings, diagrams and sequences of operation.
 - 2. TCS Bill of Material for each system, e.g. AHU, RTU, FCU, boiler, etc.
 - 3. Technical literature specification data sheets for all components listed in the TCS Bill of Material.
- G. The operator's workstation shall display all data associated with the project. The operator's terminal software shall accept, GIF, PNG, JPG and ICO format graphic files for display purposes. Graphic files shall be created using scanned, full color photographs of system installation, AutoCAD or Visio drawing files of field installation drawings and wiring diagrams from as-built drawings. Operator's terminal shall display all data using 3-D graphic representations of all mechanical equipment.
- H. System shall be capable of displaying graphic file, text, and dynamic object data together on each display. Information shall be labelled with descriptors and shall be shown with the appropriate engineering units. All information on any display shall be dynamically updated without any action by the user. Terminal shall allow user to change all field-resident BAS functions associated with the project, such as setpoints, weekly schedules, exception schedules, etc. from any screen no

matter if that screen shows all text or a complete graphic display. This shall be done without any reference to object addresses or other numeric/mnemonic indications.

- I. All displays shall be generated and customized in such a manner by the local DDC system supplier that they fit the project as specified. Canned displays shall not be acceptable. Displays shall use standard English for labelling and readout. Systems requiring factory programming for graphics or DDC logic are specifically prohibited. The installing contractor without factory dependency or assistance shall support all graphics and DDC programming locally.
- J. Binary objects shall be displayed as ON/OFF/NULL or with customized text. Text shall be justified left, right or center as selected by the user. Also, allow binary objects to be displayed as individual change-of-state bitmap objects on the display screen such that they overlay the system graphic. Each binary object displayed in this manner shall be assigned up to three bitmap files for display when the point is ON, OFF or in alarm. For binary outputs, toggle the objects commanded status when the bitmap is selected with the system digitizer (mouse). Similarly, allow the terminal operator to toggle the object's status by selecting (with the mouse) a picture of a switch or light, for example, which then displays a different picture (such as an ON switch or lighted lamp). Additionally, allow binary objects to be displayed as an animated graphic.
- K. Animated graphic objects shall be displayed as a sequence of multiple bitmaps to simulate motion. For example: when a pump is in the OFF condition, display a stationary picture of the pump. When the operator selects the pump picture with the mouse, the represented objects status is toggled and the picture of the pumps impeller rotates in a time-based animation. The operator shall be able to click on an animated graphical object or switch it from the OFF position to ON, or ON to OFF. Allow operator to change bitmap file assignment and also create new and original bitmaps online. System shall be supplied with a library of standard bitmaps, which may be used unaltered or modified by the operator. Systems that do not allow customization or creation of new bitmap objects by the operator (or with third-party software) shall not be allowed.
- L. Analog objects shall be displayed with operator modifiable units. Analog input objects may also be displayed as individual bitmap items on the display screen as an overlay to the system graphic. Each analog input object may be assigned to a minimum of five bitmap files, each with high/low limits for automatic selection and display of the bitmaps. As an example, a graphic representation of a thermometer would rise and fall in response to either the room temperature or its deviation from the controlling setpoint. Analog output objects, when selected with the mouse, shall be displayed as a prompted dialog (text only) box. Selection for display type shall be individual for each object. Analog object values may be changed by selecting either the increase or decrease arrow in the analog object spinner box without using the keypad. Pressing the button on the right side of the analog object spinner box allows direct entry of an analog value and accesses various menus where the analog value may be used, such as trend logs.
- M. Analog objects may also be assigned to an area of a system graphic, where the color of the defined area would change based on the analog objects value. For example, an area of a floor-plan graphic served by a single control zone would change color with respect to the temperature of the zone or its deviation from setpoint. All editing and area assignment shall be created or modified online using simple icon tools.
- N. A customized menu label (push-button) shall be used for display selection. Menu items on a display shall allow penetration to lower level displays or additional menus. Dynamic point information and menu label push buttons may be mixed on the same display to allow sub-displays to exist for each item. Each display may be protected from viewing unless operator has appropriate security level. A separate security level may be assigned to each display and system object.

- O. A mouse, or other form of digitizer, shall be used to move the pointer arrow to the desired item

for selection of new display or to allow the operator to make changes to object data.

P. Displays may be modified on site or via remote communications.

Q. Entire system shall operate without dependency on the operator's terminal. Provide graphic generation software at each workstation.

3.3 CONDUIT, WIRING, AND CABLE INSTALLATION

A. Conduit Sizing and Installation:

1. Conduit and conductor sizing shall be coordinated to limit conductor fill to less than 40%. Maintain conductor ampere capacity as required by the National Electrical Code (to include enlarged conductors due to temperature and quantity derating values) and to prevent excessive voltage drop and pulling tension due to long conduit/conductor lengths.
2. Minimum conduit size shall be 1/2" above grade, 3/4" below grade less than 5 feet from building foundation, and 1-1/4" below grade more than 5 feet from building foundation, unless noted otherwise.
3. Supports for metallic conduit shall be as near to 5 feet intervals as possible. A greater interval may be used if convenient because of building construction, but in no event shall support spans exceed the National Electric Code requirements.
4. Conduit runs installed above ceilings shall be properly supported. In no case shall conduit rest on the ceiling construction or the ceiling support system be used for conduit support.
5. Conduit shall not be supported from ductwork, water or sprinkler piping, etc., unless approved by the Engineer. All supports shall be from the building structure, unless noted otherwise and coordinated with all other applicable contractors.
6. Install expansion/deflection joints where conduit crosses structure expansion/seismic joints.
7. Conduit shall be mechanically continuous from source of current to all outlets. Conduit shall be electrically continuous from source of current to all outlets, unless a properly sized bonding conductor is routed within the conduit. All metallic conduit shall be grounded per the National Electrical Code.
8. Thermostats/temperature sensors shall be installed in junction boxes, flush with the wall, and shall be coordinated for orientation with Engineer.
9. All conduit shall be concealed in walls and above ceilings unless noted otherwise.

B. Wire Installation Methods:

1. Use no wire smaller than 14 AWG for line voltage (120V) wiring.
2. Use no wire smaller than 18 AWG for low voltage (24V) control wiring.
3. Splice and tap only in accessible junction or outlet boxes.
4. Neatly train and lace wiring inside boxes, equipment, and panelboards.
5. All conductors shall be continuous from device to their termination.
6. Install wire in conduit after interior of building has been physically protected from the weather and all mechanical work likely to damage conductors has been completed.
7. Thoroughly clean wires before installing lugs and connectors.
8. Make splices, taps and terminations to carry full ampacity of conductors without perceptible temperature rise.
9. Terminate spare conductors with electrical tape, unless otherwise indicated on the drawings.

C. Cable Installation Methods:

1. Provide protection for exposed cables where subject to damage.
2. Use suitable cable fittings and connectors.
3. Run all open cable in a neat and symmetrical manner.

4. Open cable shall be supported by the appropriate size bridle rings. Wire and cable from different systems shall not be installed in the same bridle rings.
5. Open cable installed above suspended ceilings shall not rest on the suspended ceiling construction or use the ceiling support system for wire and cable support.
6. Where open cables are grouped, they shall be neatly bundled and held together with nylon tie wraps placed every 2.5 feet on the bundle. Where tie bundle passes through a bridle ring, it shall be fastened to the ring with a tie wrap.
7. Bridle ring supports shall be installed at five-foot intervals. All rings shall be installed where completely accessible and not blocked by piping, ductwork, inaccessible ceilings, etc.
8. Open cable shall only be installed where specifically identified in these specifications.

D. Wire and Cable Installation in Conduit:

1. Pulling shall be continuous without unnecessary stops and starts with wire or cable only partially through conduit.
2. Reels of cable or wire shall be set up close to the point where the wire or cable enters the conduit so that the cable or wire may be unreeling and run into the conduit with a minimum of change in the direction of the bend.
3. Cables or wires shall not be laid out on the ground before pulling.
4. Cables or wires shall not be dragged over earth or paving.
5. Care shall be taken so as not to subject the cable or wire to high mechanical stresses that would cause damage to the wire and cable.
6. Conductors shall not be pulled through conduits until plastering or masonry work is completed and conduits are free from moisture. Care shall be taken so that long pulls of wire or pulls around several bends are not made where the wire may be permanently stretched and the insulation damaged.
7. At least six (6) inch loops or ends shall be left at each device for installation connection.
8. Completely and thoroughly swab conduit system before installing conductors.

E. Field Quality Control:

1. Inspect wire and cable for physical damage and proper connection.
2. Torque test conductor connections and terminations to manufacturer's recommended values.
3. Perform continuity test on all conductors.
4. Protection of cable from foreign materials:
 - a. It is the Contractor's responsibility to provide adequate physical protection to prevent foreign material application or contact with any cable type. Foreign material is defined as any material that would negatively impact the validity of the manufacturer's performance warranty. This includes, but is not limited to, overspray of paint (accidental or otherwise), drywall compound, or any other surface chemical, liquid or compound that could come in contact with the cable, cable jacket or cable termination components.
 - b. Overspray of paint on any cable, cable jacket or cable termination component will not be accepted. It shall be the Contractor's responsibility to replace any component containing overspray, in its entirety, at no additional cost to the project. Cleaning of the cables with harsh chemicals is not allowed. This requirement is regardless of the PASS/FAIL test results of the cable containing overspray. Should the manufacturer and warrantor of the structured cabling system desire to physically inspect the installed condition and certify the validity of the structured cabling system (via a signed and dated statement by an authorized representative of the structured cabling manufacturer), the Owner may, at their sole discretion, agree to accept said warranty in lieu of having the affected cables replaced. In the case of plenum cabling, in addition to the statement from the manufacturer, the Contractor shall also present to the Owner a letter from the local Authority Having Jurisdiction stating that they consider the plenum rating of the cable to be intact and acceptable.

F. Installation Schedule:

1. Conduit terminations to all devices installed in applications with rotating equipment, expansion/contraction or vibration shall be made with flexible metallic conduit, unless noted otherwise. Final terminations to exterior devices installed in damp or wet locations shall be made with liquid tight flexible metallic conduit. Terminations in hazardous areas, as defined in the National Electrical Code, shall be connected using flexible conduit rated for the environment.

<u>Location</u>	<u>Conduit Type Required for Building Wire and Cable</u>
Dry Mechanical Spaces	EMT, FMC, or Cable Tray
Wet or Damp Locations	RGS or LFMC
Interior Locations Below Accessible Ceilings	EMT
Above Non-Accessible Ceilings	EMT
Above Accessible Ceilings	None, Plenum Cable Required
Exterior Locations	RGS or LFMC
Below Accessible Floor	EMT
Hazardous Locations as Defined by the National Electric Code	RGS conduit complete with screwed fittings and conduit seals
In Walls, Bulkheads, Soffits, or other enclosed areas	EMT

3.4 FMCS INSTALLATION

- A. Coordinate voltage and ampacity of all contacts, relays, and terminal connections of equipment being monitored or controlled. Voltage and ampacity shall be compatible with equipment voltage and be rated for full ampacity of wiring or overcurrent protection of circuit controlled.
- B. Naming Conventions: Coordinate all point naming conventions with Owner standards. In the absence of Owner standards, naming conventions shall use equipment designations shown on plans.

3.5 CONTROL SYSTEM TESTING, COMMISSIONING, DEMONSTRATION AND ACCEPTANCE

- A. The Contractor shall furnish all labor, tooling and test equipment as needed to fully test, calibrate and commission all controls, sensors, instruments, hardware, wiring, software, equipment and related accessories. Testing and Commissioning including furnish required documentation thereof shall be completed prior to Demonstration and Acceptance.
- B. Verify that all control wiring is properly terminated, connected and free of shorts and ground faults. Verify all terminal connections are secure and tight.
- C. Upon completion of the installation, this Contractor shall load all system software and start up the system. This Contractor shall perform all necessary calibration, testing and de-bugging and perform all required operational checks to ensure that the system is functioning in full accordance with these specifications.
- D. This Contractor shall perform tests to verify proper performance of components, routines, and points. Repeat tests until proper performance results. This testing shall include a point-by-point log to validate 100% of the input and output points of the FMCS system operation.

- E. Contractor shall verify the system operation achieves the sequences of operation. Simulate all modes of operation by overriding and varying input set-points and schedules. Tune all DDC algorithms and control loops as needed to optimize start/stop routines and minimize energy consumption.
- F. Contractor shall test all alarms, safeties and interlocks. Simulate each alarm condition and test alarm activation thresholds and reactions by using a simulation signal which will activate the alarm condition. Once alarm conditions are activated test acknowledgment, communication and remediation steps and features.
- G. This Contractor shall prove that the controls network is functioning correctly and within acceptable bandwidth criteria and shall test the system with an approved protocol analysis tool. Provide a log and statistics summary showing that each channel is within acceptable parameters. Each channel shall be shown to have at least 25% spare capacity for future expansion.
- H. Upon completion of the performance tests described above, repeat these tests, point by point, as described in the validation log above in the presence of Owner's Representative, as required. Properly schedule these tests so testing is complete at a time directed by the Owner's Representative. Do not delay tests so as to prevent delay of occupancy permits or building occupancy.
- I. System Acceptance: Satisfactory completion is when this Contractor has performed successfully all the required testing to show performance compliance with the requirements of the Contract Documents to the satisfaction of the Owner's Representative. System acceptance shall be contingent upon completion and review of all corrected deficiencies.

3.6 PREPARATION FOR BALANCING

- A. Verify that all dampers are in the position indicated by the controller (e.g., open, closed or modulating).
- B. Check the calibration and setpoints of all controllers.
- C. Check the locations of all thermostats and humidistats for potential erratic operation from outside influences such as sunlight, drafts, or cold walls.
- D. Check that all sequences operate as specified. Verify that no simultaneous heating and cooling occurs, unless specified. Observe that heating cannot begin at TAB reheat terminals until the unit is at the minimum cfm.
- E. Verify the operation of all interlock systems.

3.7 TESTING AND BALANCING COORDINATION

- A. The Contractor shall furnish a single set of all tools necessary to interface to the control system for test and balance purposes.
- B. The Contractor shall provide a minimum of four (4) hours training for the Balancing Contractor in the use of these tools.
- C. The Contractor shall provide a qualified technician to assist with the Testing, Adjusting and Balancing processes.
- D. The tools used during the test and balance process shall be returned at the completion of the

testing and balancing.

3.8 DEMONSTRATION AND ACCEPTANCE

A. Demonstration:

1. Prior to acceptance, the controls system installing Contractor shall satisfactorily complete a series of performance tests to demonstrate and verify proper operation. Said performance demonstration tests shall be conducted only after said Contractor has completed their installation, system start-up, testing procedures, debugging and commissioning process as required by these Specifications.
2. The demonstration processes shall conform with those approved under Part 1.08 – Submittals, including but not limited to utilizing all approved checklists and forms for all controlled systems. The Owner's designated representatives shall be present to observe and review the demonstration. Attendees shall be extended advanced notification of at least 10 business days prior to start of testing demonstration.
3. The Contractor shall provide at least two qualified staff equipped with two-way communications who shall demonstrate to Owner's designated representatives actual field operation of each control point under all modes of operating conditions including occupied, unoccupied, transitional periods such as optimized start/stop warm up and cool down, temporary occupant override, seasonal changeovers, fire/smoke alarm, emergency switch activation, communication failure and power failure. The sequences of operation for all modes of operation shall be demonstrated to satisfactorily function as intended. A complete demonstration of the controls operator interface must also be provided as part of this procedure.
4. As each control input and output point is functionally demonstrated for each mode of operation, a certified log or checklist shall be completed by Contractor's staff showing the date and times, any corrective actions taken or needed along with technician's initials. Any tests which fail to demonstrate proper operation of the system shall be repeated at a later date. The Contractor shall be responsible for any repairs, modifications, revisions to the hardware, software or programming as needed to successfully complete all tests.
5. Demonstration testing of the DDC loops responses shall be provided. The tests shall demonstrate the loop's response to changes in set-points. Sampling rates shall vary from 10 seconds up to 3 minutes, dependent on the speed of the DDC loop. Documentation of testing results shall be provided by Contractor in the form of trend data using a graphical format. Trend data shall show for each test sample, set-points, controlled device positions and controlled variable values. DDC loops which yield unreasonably over-damped or under-damped control responses shall require further tuning and re-testing by the Contractor.
6. Contractor shall submit Operational Logs in electronic format and printed if requested, for each system which indicate all modes of operation, set-points, operating points, control actuator positions, equipment status and alarms to the Engineer and Owner. Logs shall extend to cover three 48-hour periods using a sampling frequency of not more than 10 minutes.

B. Acceptance:

1. The system shall not be considered accepted until which time that all forms, checklists, trends and logs completed as part of the demonstration are submitted and approved by the Engineer and Owner's designated representative.
2. Acceptance that the control system meets the requirements of the project will be awarded only after all tests and demonstrations included in this Specification Section, related Sections or as notified in writing, have been satisfactorily performed and completed to the satisfaction of both the Engineer and Owner's representative.
3. Any tests or demonstrations which cannot be performed due to circumstances or conditions determined to be beyond the control of the Contractor may be exempted from compliance

requirements if proposed in writing to the Engineer and Owner's representative for consideration. Such tests and demonstrations, if exempted, shall be expeditiously performed by Contractor and at no additional cost as part of the system warranty.

3.9 TRAINING

A. On-Site:

1. After completion of Demonstration testing, the Contractor shall provide a minimum of 8 hours total of on-site or at the Owner's discretion, classroom training for personnel designated by the Owner or their representative. The training course shall enable the Owner's staff representatives to perform Day-to-Day Operations as defined herein.
2. A factory trained and certified instructor with experience in both presenting the training material and system programming for this specific project shall perform the training.
3. Classroom training, if approved, shall be conducted using network controllers, graphics, routines, and programming representative of the actual installed system.

B. Day-to-Day Operations - Training Description:

1. Proficiently operate the system.
2. Understand control system architecture and configuration.
3. Understand FMCS systems components.
4. Understand system operation, including FMCS system control and optimizing routines (algorithms).
5. Operate the workstation and peripherals.
6. Log-on and off the system.
7. Access graphics, point reports, and logs, including set-up of: custom trending reports, points to be trended, sample intervals, formats, start/stop dates/times and transmission of custom trending reports.
8. Adjust and change system setpoints, time schedules, and holiday schedules.
9. Alarms and procedures: alarm classes, criticality, latching enabling and disabling, acknowledgements, silencing, status and notifications.
10. Recognize malfunctions of the system by observation of the printed copy and graphic visual signals.
11. Understand system drawings and Operation and Maintenance manual.
12. Understand the job layout and location of control components.
13. Access data from FMCS controllers and ASC's.
14. Operate portable operator's terminals.

- C. Provide course outline and materials in accordance with the "SUBMITTALS" article in Part 1 of this section. The instructor(s) shall provide one copy of training material per student.

3.10 INSTALLATION OF SENSORS

- A. Install sensors in accordance with the manufacturer's recommendations.
- B. Mount sensors rigidly and adequately for the environment within which the sensor operates.
- C. Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing at same height as light switches.
- D. All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.

- E. Averaging sensors and low limits shall be installed at the top of the assembly with the element on a slight downward incline away from the sensor making a serpentine pattern over the cross-sectional area with elements spaced not over 12" apart and within 6" of the top and bottom of the area.
- F. All pipe-mounted temperature sensors shall be installed in immersion wells. Install all liquid temperature sensors with heat-conducting fluid in thermal wells.
- G. Install outdoor air temperature sensors on exterior of north wall, complete with sun shield at designated location approved by Engineer. TCC shall prime and paint the device enclosure. Color selection by Owner.

END OF SECTION

SECTION 23 21 13

HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes pipe and fitting materials and joining methods for the following:
 - 1. Indoor loop water supply and return piping.
 - 2. Outdoor loop water supply and return piping.
 - 3. Condensate-drain piping.
 - 4. Air-vent piping.
 - 5. Safety-valve-inlet and -outlet piping.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type listed.

1.3 CLOSEOUT SUBMITTALS

- A. Test reports.

1.4 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
 - 1. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

1.5 WARRANTY

- A. PP-R and PP-RCT Manufacturer's Warranty: Manufacturer agrees to repair or replace PP-R and PP-RCT pipe and fittings that fail in materials or workmanship within 10 years from date of Substantial Completion.
 - 1. Warranty is to cover labor and material costs of repairing and/or replacing defective materials and repairing any incidental damage caused by failure of the piping system due to defects in materials or manufacturing.

2. Warranty is to be in effect only upon submission by Contractor to manufacturer of valid pressure/leak documentation indicating that the system was tested and passed manufacturer's pressure/leak test and any other manufacturer requirements.
- 3.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.
- B. DWV Copper Tubing: ASTM B 306, Type DWV.
- C. Wrought-Copper Unions: ASME B16.22.
- D. Copper or Bronze Pressure-Seal Fittings:
 1. Housing: Copper.
 2. O-Rings and Pipe Stops: EPDM.
 3. Tools: Manufacturer's special tools.
 4. Minimum 200-psig working-pressure rating at 250 deg F.

2.2 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, schedule 40 black steel with plain ends; welded and seamless, Grade B.
- B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125.
- C. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.
- D. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 1. Material Group: 1.1.
 2. End Connections: Butt welding.
 3. Facings: Raised face.
- E. Grooved Mechanical-Joint Fittings and Couplings:
 1. Manufacturers: Victaulic.
 2. Source Limitations: Obtain from single manufacturer.
 3. Manufactured in two segments of cast ductile iron, conforming to ASTM A-536, Grade 65-45-12.
 4. Gaskets
 - a. Shall be pressure-responsive synthetic rubber, grade to suit the intended service, conforming to steel pipe outside diameter and coupling housing.
 - b. Manufactured of elastomers as designated in ASTM D-2000.
 - c. EPDM gasket rated for -30 deg. F to +250 deg F.

5. Mechanical Coupling bolts shall be zinc plated (ASTM B-633) heat treated carbon steel track head conforming to ASTM A-449 and ASTM A-183, minimum tensile strength 110,000 psi.
 6. Grooved couplings shall meet the requirements of ASTM F-1476.
 7. Rigid Type
 - a. Coupling housings with offsetting, angle-pattern bolts.
 8. Flexible Type
 - a. Use in locations where vibration attenuation and stress relief are required.
 9. Flange Adapters:
 - a. For use with grooved end pipe and fittings, flat faced, for mating to ANSI Class 125/150 flanges.
 - b. For direct connection to ANSI Class 300 flanges use flange adapters with Class 300 bolt hole patterns.
 10. Grooved End Fittings
 - a. Standard fittings shall be cast of ductile iron conforming to ASTM A-536, Grade 65-45-12, forged steel conforming to ASTM A-234, Grade WPB 0.375" wall, or fabricated from Std. Wt. Carbon Steel pipe conforming to ASTM A-53, Type F, E or S, Grade B.
 11. Fittings provided with an alkyd enamel finish or hot dip galvanized to ASTM A-153.
- F. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

2.3 PLASTIC PIPE AND FITTINGS

- A. Polypropylene (PP-R and PP-RCT) Pipe:
1. Manufacturers:
 - a. Aquatherm.
 - b. Uponour.
 2. Source Limitations: Obtain polypropylene (PP-R and PP-RCT) pipe from single manufacturer.
 3. Description: ASTM F2389; pipe pressure rating to comply with temperature and pressure ratings of code requirements for the applicable service.
 - a. Polypropylene Fittings: ASTM F2389, socket fusion or butt fusion fittings to be used for fusion-welded joints between pipe and fittings.
 - b. Mechanical fittings and transition fittings to be used where transitions are made to other piping materials or to valves and appurtenances.
 - c. Polypropylene pipe is to be unthreaded. Threaded transition fittings in accordance with ASTM F2389 to be used where a threaded connection is required.

2.4 JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless otherwise indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
- B. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- C. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.
- D. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- E. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.5 TRANSITION FITTINGS

- A. Plastic-to-Metal Transition Fittings:
 - 1. One-piece fitting with one threaded brass or copper insert and one solvent-cement-joint end of material and wall thickness to match plastic pipe material.
- B. Plastic-to-Metal Transition Unions:
 - 1. Brass or copper end, solvent-cement-joint end of material and wall thickness to match plastic pipe material, rubber gasket, and threaded union.

2.6 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Nipples:
 - 1. Description:
 - a. Standard: IAPMO PS 66.
 - b. Electroplated steel nipple, complying with ASTM F 1545.
 - c. Pressure Rating: 300 psig at 225 deg F.
 - d. End Connections: Male threaded or grooved.
 - e. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 PIPING INSTALLATIONS

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Select system components with pressure rating equal to or greater than system operating pressure.
- K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
- N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
- P. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- Q. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
- R. Install shutoff valve immediately upstream of each dielectric fitting.
- S. Comply with requirements in Section 23 05 53 "Identification for HVAC Piping and Equipment" for identifying piping.

- T. Install sleeve seals for piping penetrations of concrete walls and slabs.
- U. Install escutcheons for piping penetrations of exposed walls and ceilings.

3.2 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples.

3.3 HANGERS AND SUPPORTS

- A. Comply with requirements in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment" for hangers, supports, and anchor devices.
- B. Install hangers for copper tubing and steel piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- C. Install hangers for plastic piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- D. Support horizontal piping with 12 inches n of each fitting and coupling.
- E. Support vertical runs of copper tubing and steel piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- F. Support vertical runs of PP-R piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.4 PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.
- E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- F. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings.
- G. Pressure-Sealed Joints: Use manufacturer-recommended tool and procedure. Leave insertion marks on pipe after assembly.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.5 TERMINAL EQUIPMENT CONNECTIONS

- A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.
- B. Install control valves in accessible locations close to connected equipment.
- C. Install ports for pressure gages and thermometers at coil inlet and outlet connections. Comply with requirements in Section 23 05 19 "Meters and Gages for HVAC Piping."

3.6 FIELD QUALITY CONTROL

- A. Prepare hydronic piping according to ASME B31.9 and as follows:
 1. Leave joints, including welds, uninsulated and exposed for examination during test.
 2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
 3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
 4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
 5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
- B. Perform the following tests on hydronic piping:
 1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
 2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
 3. Isolate expansion tanks and determine that hydronic system is full of water.
 4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9, "Building Services Piping."

5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

3.7 PIPING APPLICATIONS

A. Loop-water piping:

1. Aboveground, NPS 1-1/2 and smaller, shall be any of the following:
 - a. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
 - b. Type L, drawn-temper copper tubing, pressure-seal fittings.
 - c. Schedule 40, steel pipe; wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings.
2. Aboveground, NPS 2 and larger, shall be any of the following:
 - a. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded or flanged joints.
 - b. Schedule 40, Grade B, steel pipe; Class 150, malleable-iron fittings; welded joints and fittings.
 - c. Schedule 40, steel pipe; grooved mechanical joint coupling and fittings; and grooved mechanical joints.
3. Belowground shall be the following:
 - a. PP-RCP plastic piping and fittings with heat fusion joints.

B. Condensate-drain piping shall be any of the following:

1. Type DWV, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
2. Type DWV, drawn-temper copper tubing, pressure-seal fittings.

C. Air-Vent Piping:

1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.
2. Outlet: Type L, annealed-temper copper tubing with soldered pressure-seal joints.

- D. Safety-Valve-Inlet and -Outlet Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.

END OF SECTION

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SECTION 23 21 14
GEOHERMAL WELLFIELD

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Geothermal Wellfield.
- B. Vertical Heat Exchanger Drilling.

1.2 QUALIFICATIONS

- A. Approved Well Drilling Contractors:
 - 1. Reynolds Drilling, Inc.; Griswold, Iowa; Contact: Michael Reynolds, (712) 763-4442
 - 2. Iowa Geothermal Services; Grimes, Iowa; Contact: Ray Coons, (515) 202-4449
 - 3. Mid-America Drilling Corp.; Oakland, Iowa; Contact: Fred Henry, (712) 482-6911
 - 4. A-One Geothermal, Inc.; Earlham, Iowa; Contact: Luke McNair, (515) 758-2559
- B. Installing contractor shall have on the project a certified International Ground Source Heat Pump Association installer with the following qualifications:
 - 1. Minimum 5 years of experience in vertical heat exchanger drilling.
 - 2. At least three completed projects of underground closed circuit loop field work of at least 30 tons each.
 - 3. Certified by the Iowa Department of Natural Resources as a well installer in the State of Iowa.

1.3 SUBMITTALS FOR REVIEW

- A. The Engineer will review qualification submittals of the drilling contractor. The qualifications submittal shall contain the following information:
 - 1. Contractor's name, and Company name if different.
 - 2. Contractor's business address.
 - 3. Explanation of past experience in vertical geothermal installations meeting criteria above.
 - 4. List of specific job references with contact persons (addresses and telephone numbers).
 - 5. Qualification certifications of personnel who will be performing the work.
 - 6. Certification that Contractor will be performing work with his own forces, and will not subcontract the work.
 - 7. Provide manufacturer, make and model number of drilling machines and grout placement pumps and feeders.
- B. Product Data: Include manufacturer's specifications and catalog data for pipe, fittings, valves and other special items.
- C. Certifications:
 - 1. Proof of heat fusion certification for each of Contractor's personnel installing piping.
 - 2. Written verification that only personnel who are heat fusion certified have joined piping on this project.

3. Written verification that only the prescribed installation methods and materials have been used on this project.

1.4 SUBMITTALS AT PROJECT CLOSEOUT

- A. Project Record Documents: Maintain documents at site during construction and submit at Contract Closeout.
 1. Drilling Contractor shall submit a report which includes the following information:
 - a. Starting and ending dates for drilling activities.
 - b. Boring Logs.
 - c. Drawing indicating accurate as-built locations of all borings and pipe trenches.
 - d. Copies of permits from the City, the County Health Department and the DNR.
 - e. Test results for grout conductivity tests.
 - f. Documentation of circuit cleaning and purging.
 - g. Circuit pressure test logs.
 - h. Percent of solution and quantity of system antifreeze installed.
 - i. Material and installation warranty certificates.
- B. GPS data on vertical well bores and joints and fittings in buried horizontal piping between well bores and vault.
- C. Grout sample test reports after 10%, 50% and 80% drilling completion.

1.5 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Conferences: Conduct a preinstallation conference at Project site minimum one (1) month prior to start of work.
 1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect and Owner's Construction Manager of scheduled meeting dates.
 2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
 - a. Contract Documents.
 - b. Submittals.
 - c. Possible conflicts.
 - d. Warranty requirements.
 - e. Regulations of authorities having jurisdiction.
 - f. Testing and inspecting requirements.
 - g. Installation procedures.
 - h. Coordination with other work.
 - i. Required performance results.
 3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
 4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.
 5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.

PART 2 - PRODUCTS

2.1 GEOTHERMAL WELL FIELD PIPING

- A. Pipe: Virgin polyethylene extrusion in accordance with ASTM D2513, Sections 4.1 and 4.2.
1. Capable of 1600 psi hydrostatic design at 73.4F, per ASTM D2387.
 2. Listed in PPI TR4 as a PE3408 piping formulation.
 3. High density extrusion compound with cell classification of PE345464C.
 4. Compound shall have a UV stabilizer of C, D, or E as specified in ASTM D3350, with the following exceptions:
 - a. The material shall exhibit zero failures when tested for a minimum of 192 hours under ASTM D1693, condition C, as required in ASTM D3350.
 5. Dimensions:
 - a. Pipe with a diameter of less than 1-1/4" (nominal) shall be manufactured in accordance with ASTM D3035 with a minimum (based on pressure rating) dimension ratio of 11.
 - b. Pipe manufactured with a diameter of 1-1/4" (nominal) and larger shall be manufactured in accordance with ASTM D3035 (minimum based on pressure rating dimension ratio of 15.5) or ASTM D2447 (Schedule 40).
 - c. Pipe 3" (nominal) and larger shall be manufactured in accordance with ASTM D3035, (with a minimum based on pressure rating dimension ration of 17) or D2447 (Schedule 40).
 - d. Table of Water Pressure Ratings at 73.4 degrees F. for DR-PR PE 3408 plastic Pipe.

Dimension Ratio	Pressure Rating, psi
7	267
9	200
9.3	193
11	160
13.5	128
15.5	110
17	100
 6. Each section of pipe shall be permanently marked with the manufacturer's name, nominal size, pressure rating, relevant ASTM standards, cell classification number and date of manufacture.
 7. U-Bends: Factory fused u-bends. Approved manufacturers are Performance Pipe and Centennial Plastics.
- B. Fittings: ASTM D2683 (for socket fusion fittings) or ASTM D3261 (for butt/saddle fusion fittings). Each fitting shall be identified with the manufacturer's name, nominal size, pressure rating, relevant ASTM standards and date of manufacture.
- C. Infield Extended Header: The infield extended headers used to connect the heat exchanger u-bends in each circuit shall be constructed as shown on project drawings. Infield extended headers shall be manufactured or field fabricated.
- D. Grout: Thermally enhanced bentonite grout shall enclose the u-bend piping circuit and seal the entire bore hole. The thermally enhanced grout shall have a minimum thermal conductivity of

0.88 Btu/hr ft F., and a permeability rate of less than 1×10^{-7} cm/sec. Grout material shall be listed on the Iowa DNR listing for approved grouts for use in sealing well casings.

2.2 WARNING TAPE

- A. Magnetic detectable conductor, brightly colored plastic covering, imprinted, "CAUTION GEOTHERMAL PIPELINE BURIED BELOW" in large letters.

2.3 AGGREGATE MATERIALS

Sieve Size	Percent Passing

3/8 inch	100

No. 4	90 to 100

No. 8	70 to 100

No 200	0 to 1.5

- A. Horizontal Pipe Bedding Material:
 - 1. Clean, natural river or bank sand.
 - 2. Free from silt, clay, loam, friable or soluble materials, and organic matter.
 - 3. ASTM D2487 Group Symbol SW.
 - 4. Suitable for control compaction as scheduled.
 - 5. Graded in accordance with ASTM C136 and Table I.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Identify required lines, levels, contours, and datum.
- B. Identify known underground, above ground, and aerial utilities. Stake and flag locations.
- C. Give adequate notice to the City, Utility Companies, General Contractor, Owner and Engineer of the proposed work.
- D. Notify the Owner and coordinate the removal and relocation of utilities. At the Owner's direction, the Contractor shall notify utility company to remove and relocate utilities.
- E. Coordinate placement of pipe trenches, horizontal bores, and other components with parking lot and parking lot lights and underground supports, sidewalks, landscaping, underground utilities, paving and the like. Refer to plans for indication of where these items are planned for on the site.

3.2 VERTICAL HEAT EXCHANGER DRILLING

- A. Drilling: The horizontal boreholes shall be drilled to a depth allowing complete insertion of the heat exchanger to its specified depth. The maximum borehole diameter shall be six (6) inches. If a larger diameter is required, it must be approved by the Engineer.
- B. Geothermal bore log: The Loop Field Contractor shall keep daily bore logs that document the history of each bore as it is installed. All boring data shall be compiled and submitted as part of the As-Built documents. The log shall include but is not limited to the following information.
 - 1. Number of bore, and depth of installation.
 - 2. GPS location of bore.
 - 3. As-built drawing showing locations of bores, vault, headers, and interconnecting piping.
 - 4. Date and time bore was finished.
 - 5. Grouting information for each bore.
 - 6. Sign off on bore log each day by the installing contractor's representative and the Owner's Representative and the Mechanical Contractor site representative.
 - 7. The Loop Field Contractor shall provide one copy of the log to the Engineer, Owner, and the Mechanical Contractor as part of the As-Built documents.
- C. Contractor shall be responsible for any repairs and cleanup of the property required as a consequence of installing the loop field.

3.3 EXCAVATION AND BACKFILLING

- A. The Contractor shall do all excavating, backfilling, shoring, bailing, and pumping for the installation of their work and will perform necessary grading to prevent surface water from flowing into trenches or other excavations. Sewer lines shall not be used for draining trenches. The end of all pipes shall be kept sealed and lines left clean and unobstructed during construction. Suitable backfilling materials shall be piled a sufficient distance from banks of trenches to avoid overloading. Unsuitable backfill material shall be removed as directed by the Design Engineer.
- B. Sheathing and shoring shall be done as necessary for protection of work and personnel safety. Unless otherwise indicated, excavation shall be open cut except for short sections. The Contractor shall install geothermal marking (warning) tape 18 inches above all horizontal/header piping.
- C. Prior to drilling or trenching, the Contractor shall be responsible for reviewing the location of underground utilities with the Owner's representative. Contractor shall arrange for utility marking. Existing utility lines uncovered during excavation shall be protected from damage during excavation and backfilling.
- D. Trench Construction: Trenches and trench bottoms shall be constructed in accordance with ASTM D 2321 Section 6, Trench Excavation and Section 7, Installation. The vault structure shall be installed on stable base consisting of 12" class I materials compacted to 95% proctor density per ASTM F 1759, Section 4.2. All safety precautions for vault installation are the responsibility of the installing contractor.
- E. Underpin adjacent structures that will be damaged by excavation work, including utilities and pipe chases.
- F. Excavate subsoil required to accommodate site structures, construction operations, and other work.
- G. Machine slope banks to angle of repose or less, until shored.

- H. Excavation cut not to interfere with normal 45 degree bearing splay of foundation, except where excavation support system is used.
- I. Grade top perimeter of excavation to prevent surface water from draining into excavation.
- J. Notify Engineer immediately of unexpected subsurface conditions.
- K. Stockpile and protect excavated material in area designated on site. Remove clean excess material not being reused to location on site designated by Owner. Remove from site excess excavated material not determined to be clean. Legally dispose of excess excavated material.
- L. Hand trim excavation. Remove loose matter.
- M. Horizontal header pipe bedding:
 - 1. Bedding materials shall be as specified in Part 2 of this Section.
 - 2. Place bedding material at trench bottom, level bedding materials in one continuous layer not exceeding 8 inches (200 mm) compacted depth, compact to 95 percent. Coordinate independent compaction testing with Construction Manager.

3.4 PIPE INSTALLATION

- A. Only Contractor's personnel who have been heat fusion certified, and who are experienced shall bond pipe and fittings. Proof of certification shall be provided.
- B. Contractor shall verify in writing that only personnel who are heat fusion certified have joined piping on this project.
- C. Contractor shall verify in writing that only the prescribed installation methods and materials have been used on the project.
- D. All underground pipe joining shall be heat fused by socket, butt or saddle fusion in accordance with ASTM D2610, ASTM D2683 and the manufacturer's heat fusion specifications.
- E. During installation, all debris shall be kept out of the pipe. Ends of the HDPE pipe shall be sealed until the pipe is joined to the circuits.
- F. Cap piping securely at ends prior to final backfill.
- G. Seal the u-bend pipe ends fusion caps or tape prior to insertion into the borehole. Reasonable care shall be taken to ensure that the geothermal loop field pipe is not crushed, kinked, or cut. Should any pipe be damaged, the damaged section shall be cut out and the pipe reconnected by heat fusion.
- H. The heat exchanger loop shall be connected as indicated on the plans. The header design accounts for balanced flow as well as flushing and purging flow rates. No variations can be made in circuit hookup or the pipe sizes that are indicated without approval from the Engineer. The minimum bend radius for each pipe size shall be 25 times the nominal pipe diameter or the pipe manufacturer's recommendations, whichever is greater. The depth of all headers and supply and return piping is indicated on the drawings and shall be maintained.
- I. All horizontal piping shall be installed at a minimum depth of 5 feet below finished grade.

3.5 GROUTING

- A. Each bore hole shall be grouted from the bottom up in a continuous fashion using at least a 1" HDPE tremie pipe. The tremie pipe shall be pulled fully into the bore hole along side the loop piping, following drilling of the bore. Grout shall be pumped through the tremie pipe as it is pulled out of the bore hole. The tremie pipe's end must be maintained just below grout level within the borehole to ensure complete and uniform grouting of the borehole. All state regulations shall be met for borehole grouting of the boreholes. The tremie pipe size may be increased if needed to reduce the grout pumping friction.
- B. Grout Sampling: The Loop Field Contractor shall take at least three separate grout samples from the grout mixing/holding tank. The samples shall be taken from the actual grouting process. The samples shall be taken after ten percent of bores, 50 percent of the bores and 80 percent of the bores are completed. The Loop Field Contractor shall submit the samples to an independent testing agency to determine permeability and thermal conductivity. The Loop Field Contractor shall submit test results to the Engineer. Grout composition shall be changed as needed to bring non-compliant grout into specification compliance. The Owner reserves the right to take independent grout samples and have them tested during the process to confirm what the contractor testing finds.

3.6 TESTING, CLEANING, FLUSHING, PURGING, FILLING

- A. Final Cleaning of Piping Systems:
 - 1. Flush piping with clean water after testing is complete.
 - 2. Flush pipe and components with clean water until all discharge from system is clean.
 - a. Maintain minimum velocities at all points of 5 feet per second. Flow shall be in same direction as when system is in normal operation. Discharge shall be from low points of lines, ends of headers and as required to flush entire system.
 - b. After flushing, any residual water shall be drained and/or blown out.
- B. All piping shall be pressure tested according to ASME B31.9 before any backfilling of the header trenches is executed.
 - 1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
 - 2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
 - 3. Isolate expansion tanks and determine that hydronic system is full of water.
 - 4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure (100 psig minimum). Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
 - 5. After hydrostatic test pressure has been applied for at least eight (8) hours, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
 - 6. Contractor shall maintain a piping test log for each system, to include:
 - a. Description of the segment(s) of piping tested.
 - b. Date, time, and weather conditions.
 - c. Description of test, including final pressure.
 - d. Description of any leaks, and their locations.
 - e. Description of remedial repairs necessary.
 - f. Description of re-test, as necessary.

- g. Prepare written report of testing.
- C. Utilize Global Position System technology to locate horizontal well bores, and joints and fittings in the horizontal piping systems between horizontal well bores and vault. Make a graphic record of all location data on a plan of the piping system, with the site buildings, fence, pursuit road, and other landmarks visible. Report including data shall be submitted as part of the As-Built documentation.
- D. Drain system and refill with fluids specified in Section 23 21 16 in coordination with mechanical subcontractor.

END OF SECTION

SECTION 23 21 16

HYDRONIC PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Ball Valves.
 - 2. Butterfly Valves.
 - 3. Manual Balancing Valves.
 - 4. Check Valves.
 - 5. Air Vents.
 - 6. Expansion Tanks.
 - 7. Air Separators.
 - 8. Relief Valves.
 - 9. Flexible Connectors.

1.2 ACTION SUBMITTALS

- A. Product Data: For each product listed.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air-control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
 - 1. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooved ends, press ends, solder ends, and weld ends.
 - 3. Set ball valves open to minimize exposure of functional surfaces.
 - 4. Set butterfly valves closed or slightly open.
 - 5. Block check valves in either closed or open position.
 - 6. Set gate valves closed to prevent rattling.

7. Set plug valves to open to minimize exposure of functional surfaces.
- B. Use the following precautions during storage:
1. Maintain valve end protection.
 2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

PART 2 - PRODUCTS

2.1 BALL VALVES

A. Two-Piece, Bronze Ball Valves with Full Port, Stainless-Steel Trim, and Soldered Ends:

1. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 600 psig.
 - c. Body Design: Two piece.
 - d. Body Material: Bronze.
 - e. Ends: Soldered.
 - f. Seats: PTFE.
 - g. Stem: ASTM A276 Type 316 Stainless steel.
 - h. Ball: ASTM A275 Type 316 Stainless steel, vented.
 - i. Port: Full.
 - j. Stem extension handle.

2.2 BUTTERFLY VALVES

A. Butterfly Valves, Single Flange (Lug Type):

1. Standard: MSS SP-67, Type I.
2. CWP Rating: 150 psig.
3. Body Design: Single flange (lug type), suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
4. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
5. Seat: EPDM or NBR.
6. Stem: One- or two-piece stainless steel.
7. Disc: Stainless Steel.
8. Handle: Lever lock.

B. Butterfly Valves, Flangeless (Wafer Type):

1. Standard: MSS SP-67, Type I.
2. CWP Rating: 150 psig.
3. Body Design: Flangeless (wafer type), suitable for bidirectional dead-end service at rated pressure.
4. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
5. Seat: EPDM or NBR.
6. Stem: One- or two-piece stainless steel.
7. Disc: Stainless steel.
8. Handle: Lever lock.

C. Butterfly Valves, Grooved End:

1. Standard: MSS SP-67, Type I.
2. CWP Rating: 175 psig.
3. Body Material: Coated, ductile iron.
4. Ends: Grooved.
5. Stem: Two-piece stainless steel.
6. Disc: Stainless steel.
7. Seat: EPDM.
8. Handle: Lever lock.

2.3 MANUAL BALANCING VALVES

A. Venturi Manual Balancing Valve

1. Manufacturers:
 - a. HCI.
 - b. Pro Hydronic Specialties.
 - c. Griswold Controls.
 - d. Armstrong Pumps, Inc.
 - e. Tour and Andersson.
 - f. Hays Fluid Controls.
2. Body: Brass.
3. Ball: 316 Stainless Steel.
4. Stem: 316 Stainless Steel.
5. Seat: PTFE.
6. Port: Full.
7. End Connections: Match pipe system.
8. Pressure Gage Connections: Integral seals for portable differential pressure meter.
9. Handle Style: Lever, with memory stop to retain set position.
10. Maximum WOG Rating: 300 psig.
11. Maximum Operating Temperature: 250 deg. F.

2.4 FLOW STATIONS

A. Venturi Flow Station

1. Manufacturers:
 - a. HCI.
 - b. Pro Hydronic Specialties.
 - c. Griswold Controls.
 - d. Armstrong Pumps, Inc.
 - e. Tour and Andersson.
2. Body: Brass.
3. End Connections: Match pipe system.
4. Pressure Gage Connections: Integral seals for portable differential pressure meter.
5. Maximum WOG Rating: 300 psig.
6. Maximum Operating Temperature: 250 deg. F.

2.5 CHECK VALVES

- A. Class 125, Bronze Swing Check Valves:
 - 1. Standard: MSS SP-80, Type 3.
 - 2. CWP Rating: 200 psig.
 - 3. Body Design: Horizontal flow.
 - 4. Body Material: ASTM B 62, bronze.
 - 5. Ends: Threaded.
 - 6. Disc: Bronze.
- B. Class 125, Center Guided Globe Check Valves:
 - 1. Standard: MSS SP-125.
 - 2. CWP Rating: 200 psig.
 - 3. Body Material: ASTM A126, gray iron.
 - 4. Style: Globe, spring loaded.
 - 5. Seat: Stainless steel.
 - 6. Plug: Stainless steel.
 - 7. Spring: Stainless steel.
 - 8. Ends: Flanged.
 - 9. Minimum cV at NPS 2-1/2: 100.

2.6 STRAINERS

- A. Y-Pattern Strainers:
 - 1. CWP: 175 psig.
 - 2. Body:
 - a. NPS 2 and smaller: ASTM B 283 forged brass.
 - b. NPS 2-1/2 and larger: ASTM A 126, Class B, cast iron.
 - 3. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
 - 4. Strainer Screen: Stainless-steel, 20-mesh strainer.
 - 5. Accessories:
 - a. Drain valve.
 - b. Extension handle.
 - c. Combination P/T test port.

2.7 AIR-VENTS

- A. Manual Air Vents:
 - 1. Body: Bronze.
 - 2. Internal Parts: Nonferrous.
 - 3. Operator: Screwdriver or thumbscrew.
 - 4. Inlet Connection: NPS 1/2.
 - 5. Discharge Connection: NPS 1/8.
 - 6. CWP Rating: 150 psig.
 - 7. Maximum Operating Temperature: 225 deg F.

B. Automatic Air Vents:

1. Body: Bronze or cast iron.
2. Internal Parts: Nonferrous.
3. Operator: Noncorrosive metal float.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/4.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 240 deg F.

2.8 EXPANSION TANKS

A. Manufacturers:

1. Bell & Gossett.
2. Armstrong Pumps, Inc.
3. Taco.
4. Amtrol.
5. Thrush.
6. American Wheatley.

B. Description:

1. Suitable for horizontal or vertical installation.
2. Tank:
 - a. Welded steel, rated for 125-psig working pressure and 240 deg F maximum operating temperature. Factory test after taps are fabricated and supports installed and are labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
 - b. Painted exterior finish.
3. Diaphragm:
 - a. Heavy duty butyl (non-replaceable).
 - b. Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
4. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.
5. Sight Glass.
6. Provide anchor clips when mounting on housekeeping pad.

2.9 AIR SEPARATORS

A. Manufacturers:

1. Taco.
2. Bell & Gossett.
3. Armstrong Pumps.
4. American Wheatley.
5. Thrush.
6. Amtrol.

B. Coalescing-Type Air and Dirt Separators:

1. Tank: Fabricated steel tank; Painted; ASME constructed and stamped for 125 psig working pressure and 240 deg F maximum operating temperature.
2. Coalescing Medium: Stainless steel.
3. Air Vent: Threaded to top of separator.
4. Inline Inlet and Outlet Connections: Threaded for NPS 2 and smaller; Class 150 flanged or grooved connections for NPS 2-1/2 and larger.
5. Blowdown Connection: Threaded to bottom of separator.
6. Removable cover.

C. Inline-Type Air Separators:

1. Tank: Fabricated steel tank; Painted; ASME constructed and stamped for 125 psig working pressure and 240 deg F maximum operating temperature.
2. Strainer:
 - a. Stainless Steel.
 - b. Removable, inline.
3. Air Vent: Threaded to top of separator.
4. Inline Inlet and Outlet Connections: Threaded for NPS 2 and smaller; Class 150 flanged or grooved connections for NPS 2-1/2 and larger.
5. Blowdown Connection: Threaded to bottom of separator.

2.10 RELIEF VALVES

A. Safety Valves: ASME labeled.

1. Body: Bronze or brass.
2. Disc: Glass and carbon-filled PTFE.
3. Seat: Brass.
4. Stem Seals: EPDM O-rings.
5. Diaphragm: EPT.
6. Wetted, Internal Work Parts: Brass and rubber.
7. Valve Seat and Stem: Noncorrosive.
8. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system.

2.11 FLEXIBLE CONNECTORS

A. Stainless-Steel Bellow, Flexible Connectors:

1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of 3/4-inch misalignment.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250 deg F.

B. Description:

1. Tank: Fabricated steel tank; Painted; ASME constructed and stamped for 125 psig working pressure and 375 deg F maximum operating temperature.

2. Insulation: factory-installed, 1" fiberglass.
3. Inline Inlet and Outlet Connections: Threaded for NPS 2 and smaller; Class 150 flanged or grooved connections for NPS 2-1/2 and larger.
4. Base ring with mounting clips.
5. Bottom drain port.
6. Capacity: 200 gallons.

2.12 CHEMICAL BYPASS FEEDER

- A. Basis of Design: JL Wingert DB-2HD
- B. Description: Steel dome bottom bypass feeder.
 1. Tank: Fabricated steel.
 2. Closure: Cast-iron with quarter-turn closure and o-ring.
 3. Pressure Rating: 200 psig at 200 deg. F.
 4. Capacity: 2.39 gallons.
 5. Inlet, outlet, and drain connections: Threaded.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install check valves for proper direction of flow.

- F. Install valve tags. Comply with requirements for valve tags and schedules in Section 23 05 53 "Identification for HVAC Piping and Equipment."

3.3 VALVE APPLICATIONS

- A. Install shutoff-duty valves at each branch connection to mains and at each piece of equipment.
- B. Install check valves at each pump discharge and elsewhere as required to control flow direction.
- C. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.
- D. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

3.4 HYDRONIC SPECIALTIES INSTALLATION

- A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.
- B. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Install manual vents at heat-transfer coils and elsewhere as required for air venting.
- C. Install tangential air separator in pump suction. Install blowdown piping with gate or full-port ball valve; extend full size to nearest floor drain.
- D. Install expansion tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.
 - 1. Install tank fittings that are shipped loose.
 - 2. Support tank from floor or structure above with sufficient strength to carry weight of tank, piping connections, fittings, plus tank full of water. Do not overload building components and structural members.

END OF SECTION

SECTION 23 21 23

HYDRONIC PUMPS

PART 1 - GENERAL

1.1 ACTION SUBMITTALS

- A. Product Data: For each type of pump. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.

1.2 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 IN-LINE CENTRIFUGAL PUMPS

- A. Manufacturers:
 - 1. Bell and Gossett.
 - 2. Taco.
 - 3. Armstrong Pumps.
 - 4. Wilo Pumps.
 - 5. Grundfoss.
 - 6. Patterson Pumps.
- B. Close-Coupled
 - 1. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally or vertically.
 - 2. Pump Construction:
 - a. Casing: cast iron with threaded companion-flange connections.
 - b. Impeller: bronze or glass-filled PPO.
 - c. Pump Shaft: 300 series stainless steel.
 - d. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket.
 - e. Pump Bearings: Permanently lubricated ball bearings.
 - 3. Motor: Rigidly mounted to pump casing.
 - a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - b. Enclosure: Open, dripproof.
 - c. Enclosure Materials: Cast iron.
 - d. Motor Bearings: Permanently lubricated ball bearings.
 - e. Efficiency: Premium efficient.

C. Wet-Rotor Pumps

1. Description: Factory-assembled and -tested, wet-rotor pump. Pump and motor to form an integral unit with bearings lubricated by the pumped liquid.
2. Pump Construction:
 - a. Body: 100 percent lead-free bronze or cast-iron.
 - b. Impeller: Noryl or Type 304 stainless steel.
 - c. Pump Shaft: Type 304 stainless steel.
 - d. Bearings: Permanently lubricated ball bearings.
 - e. O-ring and Flange Gaskets: EPDM.
3. Motor:
 - a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.
 - b. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 23 05 00 "Common Work Results for HVAC."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.
- C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PUMP INSTALLATION

- A. Comply with HI 1.4 and HI 2.4.
- B. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.
- C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

3.3 CONNECTIONS

- A. Where installing piping adjacent to pump, allow space for service and maintenance.
- B. Connect piping to pumps. Install valves that are same size as piping connected to pumps.
- C. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

- D. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.
- E. Install pressure gages on pump suction and discharge or at integral pressure-gage tapping, or install single gage with multiple-input selector valve.
- F. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- G. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.4 STARTUP SERVICE

- A. Perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Check piping connections for tightness.
 - 3. Clean strainers on suction piping.
 - 4. Perform the following startup checks for each pump before starting:
 - a. Verify bearing lubrication.
 - b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
 - c. Verify that pump is rotating in the correct direction.
 - 5. Prime pump by opening suction valves and closing drains and prepare pump for operation.
 - 6. Start motor.
 - 7. Open discharge valve slowly.

3.5 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps.

END OF SECTION

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SECTION 23 31 13

METAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Single-wall rectangular ducts and fittings.
 - 2. Single-wall round ducts and fittings.
 - 3. Pre-insulated exterior duct and fittings.
 - 4. Double-wall rectangular ducts and fittings.
 - 5. Sheet metal materials.
 - 6. Sealants and gaskets.
 - 7. Hangers and supports.

1.2 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.
- B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.3 ACTION SUBMITTALS

- A. Product Data: For each product listed.
- B. Shop Drawings:
 - 1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
 - 2. Factory- and shop-fabricated ducts and fittings.
 - 3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
 - 4. Elevation of top of ducts.
 - 5. Dimensions of main duct runs from building grid lines.
 - 6. Fittings.
 - 7. Reinforcement and spacing.
 - 8. Seam and joint construction.
 - 9. Penetrations through fire-rated and other partitions.
 - 10. Equipment installation based on equipment being used on Project.
 - 11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
 - 12. Hangers and supports, including methods for duct and building attachment and vibration isolation.
 - 13. Delegated-Design:

- a. Sheet metal thicknesses.
- b. Joint and seam construction and sealing.
- c. Reinforcement details and spacing.
- d. Materials, fabrication, assembly, and spacing of hangers and supports.

1.4 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
 - 2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
 - 3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SINGLE-WALL ROUND DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 DOUBLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. Rectangular Ducts: Fabricate ducts with indicated dimensions for clear internal dimensions of the inner duct.
- B. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
 - 1. Construct ducts of mill phosphatized galvanized sheet steel unless otherwise indicated.
- C. Transverse Joints: Flanged.
- D. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- E. Interstitial Insulation, Fibrous Glass: Duct liner complying with ASTM C1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
 - 1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
 - 2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
- F. Inner Duct: Minimum 24-gauge solid galvanized sheet steel.

2.4 PRE-INSULATED EXTERIOR DUCT AND FITTINGS

- A. General
 - 1. Ductwork to be factory fabricated with pre-insulated and jacketed exterior, adhesives, sealants, connectors, reinforcements, supports and accessories.
 - 2. Turning vanes, reinforcement, support mounts, and connector material to be fabricated from corrosion resistant galvanized steel.
 - 3. Performance:
 - a. Thermal Conductivity: 0.146 BTU/in/ft²/hr./degree F.
 - b. Air Leakage: Class 3 @ 2 in. w.c.
 - c. Maximum Temperature: 185 deg. F.
 - d. Maximum Air Velocity: 5000 fpm.

- e. Maximum Design Pressures: Positive and Negative 10-inch wg.
- f. Permeability: 0.0002 perms maximum when tested according to ASTM E96/E 96M, Procedure A.
- g. Minimum R-Value: R-12.
- h. Color: Gray, as selected by architect.

B. Metal-Clad Pre-Insulated Exterior Duct and Fittings

- 1. Manufacturers:
 - a. Ducts & Cleats.
- 2. Duct Panel Core:
 - a. Aluminum foil scrim closed cell, foil faced, CFC-free phenolic foam panel.
- 3. Exterior Cladding:
 - a. Galvanized color clad, 0.04 in. thick.
 - b. Color: White.

C. Vinyl-Clad Pre-Insulated Exterior Duct and Fittings

- 1. Manufacturers:
 - a. Thermaduct.
- 2. Duct Panel Core:
 - a. Aluminum foil scrim closed cell, foil faced, CFC-free phenolic foam panel.
- 3. Exterior Cladding:
 - a. UV stable, 1000 micron, titanium infused vinyl.
 - b. Color: White.

2.5 TURNING VANES

- A. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
- B. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."
- C. Vane Construction:
 - 1. Duct Pressure Class Less than 1": Single wall.
 - 2. Duct Pressure Class Greater than or Equal To 1": Double wall.

2.6 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction

methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G60.
 - 2. Finishes for Surfaces Exposed to View Where Indicated: Mill phosphatized.
- C. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
 - 1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
- D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.7 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Two-Part Tape Sealing System:
 - 1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
 - 2. Sealant: Modified styrene acrylic.
 - 3. Water resistant.
 - 4. Mold and mildew resistant.
 - 5. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
 - 6. Service: Indoor and outdoor.
 - 7. Service Temperature: Minus 40 to plus 200 deg F.
 - 8. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
 - 9. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Water-Based Joint and Seam Sealant:
 - 1. Application Method: Brush on.
 - 2. Solids Content: Minimum 65 percent.
 - 3. Shore A Hardness: Minimum 20.
 - 4. Water resistant.
 - 5. Mold and mildew resistant.
 - 6. VOC: Maximum 75 g/L (less water).
 - 7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
 - 8. Service: Indoor or outdoor.
 - 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- D. Flanged Joint Sealant: Comply with ASTM C 920.
 - 1. General: Single-component, acid-curing, silicone, elastomeric.

2. Type: S.
 3. Grade: NS.
 4. Class: 25.
 5. Use: O.
 6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
- F. Round Duct Joint O-Ring Seals: Seal shall provide maximum 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.

2.8 HANGERS AND SUPPORTS

- A. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- B. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- C. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- D. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- E. Trapeze and Riser Supports:
1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 2. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings.
- B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install round ducts in maximum practical lengths.
- D. Install ducts with fewest possible joints.
- E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
- K. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

3.2 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Where practical, install concrete inserts before placing concrete.
 - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.

4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Section 23 33 00 "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 PAINTING

- A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer.
- B. Paint double-wall exterior ducts. Finish shall be selected by architect.

3.7 START UP

- A. Air Balance: Comply with requirements in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC."

3.8 DUCT SCHEDULE

- A. Exterior Ductwork Shall Be One of the Following:
 1. Pre-insulated exterior duct and fittings.
 - a. Minimum R-Value: 12.
 - b. Pressure Class: Positive/negative 1 inch wg.
 - c. Minimum SMACNA Seal Class: A.
 2. Double-wall rectangular duct and fittings.
 - a. Minimum R-Value: 12.

- b. Pressure Class: Positive/negative 1 inch wg.
- c. Factory- or field-painted white.
- d. Minimum SMACNA Seal Class: A.

B. Supply Ducts:

- 1. Single-wall round and rectangular
- 2. Pressure Class:
 - a. Upstream of Terminal Units: Positive 2 inch wg.
 - b. Downstream of Terminal Units: Positive 2 inch wg.
- 3. Minimum SMACNA Seal Class: A.

C. Return Ducts:

- 1. Single-wall round and rectangular.
- 2. Pressure Class: Negative 1 inch wg.
- 3. Minimum SMACNA Seal Class: C.

D. Exhaust Ducts:

- 1. Single-wall round and rectangular.
- 2. Pressure Class: Negative 1 inch wg.
- 3. Minimum SMACNA Seal Class: A.

E. Outdoor- and Fresh- Air Ducts:

- 1. Single-wall round and rectangular.
- 2. Pressure Class: Negative 1 inch wg.
- 3. Minimum SMACNA Seal Class: A.

F. Elbow Configuration:

- 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
- 2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
 - a. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
 - b. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

G. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
 - a. Rectangular Main to Rectangular Branch: 45-degree entry.
 - b. Rectangular Main to Round Branch: Spin in or 45-degree entry.
2. Round: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
 - a. Velocity 1500 fpm or lower: Conical tap or 45-degree entry.
 - b. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION

SECTION 23 33 00
AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Manual volume dampers.
 - 2. Barometric relief dampers.
 - 3. Automatic balancing dampers.
 - 4. Duct-mounted access doors.
 - 5. Flexible connectors.
 - 6. Flexible ducts.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.
 - 1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
 - a. Special fittings.
 - b. Manual volume damper installations.
 - c. Control-damper installations.
 - d. Wiring Diagrams: For power, signal, and control wiring.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Control Damper Actuator: Furnish one extra actuator per control damper.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MANUAL VOLUME DAMPERS

- A. Rectangular, Steel, Manual Volume Dampers:
 - 1. Standard leakage rating, with linkage contained in frame.
 - 2. Suitable for horizontal or vertical applications.
 - 3. Maximum Velocity: 1500 fpm at 48 in. width and 2.5 in. w.c. pressure class.
 - 4. Temperatures: Negative 25 deg. F. to 180 deg. F.
 - 5. Frames:
 - a. Hat-shaped, 16 gauge, galvanized sheet steel.
 - b. Mitered and welded corners.
 - 6. Blades:
 - a. Multiple or single blade.
 - b. Multiple blades shall be opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. 16 gauge, galvanized-steel.
 - 7. Blade Axles: Galvanized steel.
 - 8. Bearings:
 - a. Oil-impregnated bronze.
 - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
 - 9. Tie Bars and Brackets: Galvanized steel.
 - 10. Jackshaft:
 - a. Size: 0.5-inch diameter.
 - b. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
 - c. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.
 - 11. Damper Hardware:
 - a. Zinc-plated, die-cast core with dial and handle made of 3/32-inch-thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
 - b. Locking quadrant handle.

- c. Hand quadrant stand-off bracket.
- B. Round, Steel, Manual Volume Dampers:
 - 1. Maximum Velocity: 1500 fpm.
 - 2. Maximum Temperature: 250 deg. F.
 - 3. Frames: 20 gauge, galvanized sheet steel.
 - 4. Blades:
 - a. Single blade with EPDM seal.
 - b. 20 gauge, galvanized-steel.
 - 5. Bearings: Oil-impregnated bronze.
 - 6. Damper Hardware:
 - a. Zinc-plated, die-cast core with dial and handle made of 3/32-inch-thick zinc-plated steel, and a 3/8-inch hexagon locking nut.
 - b. Locking quadrant handle.
 - c. Hand quadrant stand-off bracket.

2.3 BAROMETRIC RELIEF DAMPERS

- A. General Requirements:
 - 1. Suitable for horizontal or vertical mounting.
 - 2. Maximum Air Velocity: 2000 fpm.
 - 3. Maximum System Pressure: 2 inches wg.
- B. Construction:
 - 1. Frame: Hat shaped, 16-gauge-thick, galvanized sheet steel, with welded corners or mechanically attached and mounting flange.
 - 2. Blades:
 - a. Multiple, 16-gauge-thick, galvanized sheet steel.
 - b. Maximum Width: 6 inches.
 - c. Action: Parallel.
 - d. Balance: Gravity.
 - 3. Blade Seals: Neoprene.
 - 4. Blade Axles: Galvanized steel.
 - 5. Tie Bars and Brackets:
 - a. Material: Galvanized steel.
 - b. Rattle free with 90-degree stop.
 - 6. Bearings: Synthetic.
- C. Pressure Adjustment: Counter weight with adjustable tension for varying differential static pressures.

2.4 AUTOMATIC BALANCING DAMPERS

- A. General Requirements (Basis of Design – Ruskin ABD):
1. Pressure Independent Automatic Balancing Damper (ABD) shall maintain a constant airflow volume in HVAC applications. The engineered damper blade is calibrated to automatically adjust to varying pressures.
 2. Air Flow: Each unit is laboratory calibrated to allow a specific volume of air at a specific static pressure.
 - a. Flow ranges shall be tested using AMCA Standard 500-D Figure 1
 3. Each unit shall be classified per UL 2043 and carry the UL mark indicating compliance.
 4. Each unit shall be rated for use in air temperatures ranging from 25degree F to 150 degree F (-4 degree C to 65 degree C).
 5. Frame: Thermoplastic resins with non-caustic antimicrobial preventing organic growth. Passes UL2043 test for heat and smoke emissions.
 6. Spring: Stainless leaf type.
 7. Bearings: Oil-filled, hermetically sealed bearings.
 8. Seals: Full circumference outer rubber gasket-type.
 9. Field convertible flow direction.
 - a. ABD snaps into enclosure utilizing the adapter ring. To change airflow direction, remove the Quick-Connect Adapter Ring, rotate the ABD, and snap the adapter ring back into place.
 10. Tool-free set-point adjustment.

2.5 CONTROL DAMPERS

- A. Furnished by DDC Sub-Contractor. Refer to 23 09 23 "Direct Digital Control (DDC) System for HVAC".

2.6 DUCT-MOUNTED ACCESS DOORS

- A. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."
1. Door:
 - a. Double wall, rectangular.
 - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
 - c. Hinges and Latches: 1-by-1-inchbutt or piano hinge and cam latches.
 - d. Fabricate doors airtight and suitable for duct pressure class.
 2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
 3. Number of Hinges and Locks:
 - a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
 - b. Access Doors up to 18 Inches Square: Continuous and two sash locks.
 - c. Access Doors up to 24 by 48 Inches: Continuous and two compression latches.

2.7 FLEXIBLE CONNECTORS

- A. Materials: Flame-retardant or noncombustible fabrics.
- B. Coatings and Adhesives: Comply with UL 181, Class 1.
- C. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch-wide, 0.028-inch-thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.
- D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
 - 1. Minimum Weight: 26 oz./sq. yd..
 - 2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
 - 3. Service Temperature: Minus 40 to plus 200 deg F.

2.8 FLEXIBLE DUCTS

- A. Insulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.
 - 1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
 - 2. Maximum Air Velocity: 4000 fpm.
 - 3. Temperature Range: Minus 10 to plus 160 deg F.
 - 4. Insulation R-value: 4.0.
- B. Flexible Duct Connectors:
 - 1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.
 - 2. Non-Clamp Connectors: Adhesive plus sheet metal screws.

2.9 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for dampers and instruments installed in duct systems to verify actual locations of connections before installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
- D. Set dampers to fully open position before testing, adjusting, and balancing.
- E. Properly support dampers and actuators, tubing, wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment
- F. Install products in locations that are accessible and that will permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.
- G. Clearance:
 - 1. Locate dampers for easy access and provide separate support of dampers that cannot be handled by service personnel without hoisting mechanism.
 - 2. Install dampers with at least 24 inches of clear space on sides of dampers requiring service access.
- H. Service Access:
 - 1. Dampers and actuators shall be accessible for visual inspection and service.
 - 2. Install access door(s) in duct or equipment located upstream of damper to allow service personnel to hand clean any portion of damper, linkage, and actuator.
- I. Install dampers straight and true, level in all planes, and square in all dimensions. Install supplementary structural steel reinforcement for large multiple-section dampers if factory support alone cannot handle loading.
- J. Attach actuator(s) to damper drive shaft.
- K. Install test holes at fan inlets and outlets and elsewhere as indicated.
- L. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 - 1. On both sides of duct coils.
 - 2. Upstream of control dampers.
 - 3. Control devices requiring inspection.
- M. Install access doors with swing against duct static pressure.

- N. Access Door Sizes:
1. One-Hand or Inspection Access: 12 by 12 inches.
 2. Two-Hand Access: 12 by 12 inches.
 3. Head and Hand Access: 16 by 20 inches.
 4. Head and Shoulders Access: 16 by 20 inches.
 5. Body Access: 24 by 24 inches.
- O. Label access doors according to Section 23 05 53 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
- P. Install flexible connectors to connect ducts to equipment.
- Q. Connect diffusers or light troffer boots to ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place.
- R. Connect flexible ducts to metal ducts with adhesive plus sheet metal screws.
- S. Install duct test holes where required for testing and balancing purposes.

END OF SECTION

SECTION 23 37 13

DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated, include the following:
 - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
 - 2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers:
 - 1. Price.
 - 2. Titus.
 - 3. Nailor.
 - 4. Krueger.
 - 5. Tuttle and Bailey.
 - 6. Anemostat.
- B. Refer to schedule on drawings.

2.2 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.
- D. Install balancing damper in branch duct serving each diffuser, register, and grille.
- E. Install balancing damper in each duct mounted diffuser, register, and grille.

3.3 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION

SECTION 23 52 16
CONDENSING BOILERS

PART 1 - GENERAL

1.1 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for boilers.
 - 2. Include rated capacities, operating characteristics, and furnished specialties and accessories.

1.2 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For boilers to include in emergency, operation, and maintenance manuals.

1.4 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.
 - 1. Heat Exchanger Warranty: 10 years from date of Substantial Completion.
 - 2. All other Parts Warranty: 5 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASME Compliance: Fabricate and label boilers to comply with 2010 ASME Boiler and Pressure Vessel Code.
- C. ASHRAE/IES 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."

- D. UL Compliance: Test boilers for compliance with UL 795. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.
- E. State of Iowa Code Chapter 89 "Boilers and Unfired Steam Pressure Vessels".

2.2 FIRE-TUBE CONDENSING BOILERS

- A. Manufacturers:
 - 1. Laars.
 - 2. Thermal Solutions.
 - 3. Aerco.
 - 4. Lochinvar.
 - 5. Triangle Tube.
- B. Description: Factory-fabricated, -assembled, and -tested, vertical fire-tube boilers with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket, flue-gas vent, water-supply and -return connections, and controls.
- C. Heat Exchanger: Stainless-steel, with aluminum fins.
- D. Combustion Chamber: Stainless steel, sealed.
- E. Burner: Natural gas, forced draft drawing from gas premixing valve.
- F. Blower: Centrifugal fan to operate during each burner firing sequence and to prepurge and postpurge the combustion chamber.
- G. Gas Train: Combination gas valve with manual shutoff and pressure regulator.
- H. Ignition: Silicone carbide hot-surface ignition that includes flame safety supervision and 100 percent main-valve shutoff.
- I. Integral Circulator: Cast-iron body and stainless-steel impeller sized for minimum flow required in heat exchanger.
- J. Casing:
 - 1. Jacket: Sheet metal.
 - 2. Finish: Epoxy.
 - 3. Combustion-Air Connections: Inlet and vent duct collars.

2.3 ACCESSORIES

- A. Include devices sized to comply with ASME B31.9.
- B. Safety Relief Valve: ASME rated.
- C. Concentric Vent Kit.
- D. CSD-1 Trim.

- E. Condensate Neutralizer.

2.4 CONTROLS

- A. Refer to Section 23 09 23 "Direct Digital Control (DDC) System for HVAC".
- B. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.
 - 1. High Cutoff: Automatic reset stops burner if operating conditions rise above maximum boiler design temperature.
 - 2. Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be automatic-reset type.
 - 3. Blocked Inlet Safety Switch: Manual-reset pressure switch field mounted on boiler combustion-air inlet.
 - 4. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.
- C. Building Automation System Interface: Factory install hardware and software to enable building automation system to monitor, control, and display boiler status and alarms.
 - 1. Hardwired Points:
 - a. Monitoring: On/off status and common trouble alarm.
 - b. Control: On/off operation and hot-water-supply temperature set-point adjustment.

2.5 SOURCE QUALITY CONTROL

- A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.
- B. Test and inspect factory-assembled boilers, before shipping, according to 2010 ASME Boiler and Pressure Vessel Code.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting performance of the Work.
 - 1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
- B. Examine mechanical spaces for suitable conditions where boilers will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 BOILER INSTALLATION

- A. Equipment Mounting:
- B. Install gas-fired boilers according to NFPA 54.
- C. Assemble and install boiler trim.
- D. Install electrical devices furnished with boiler but not specified to be factory mounted.
- E. Install control wiring to field-mounted electrical devices.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to boiler to allow service and maintenance.
- C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.
- D. Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service. Flexible connectors and their installation are specified in Section 23 21 16 "Hydronic Piping Specialties."
- E. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas-train connection. Provide a reducer if required.
- F. Connect hot-water piping to supply- and return-boiler tapings with shutoff valve and union or flange at each connection.
- G. Install piping from safety relief valves to nearest floor drain.
- H. Boiler Venting:
 - 1. Install flue venting kit and combustion-air intake.
 - 2. Connect full size to boiler connections.
- I. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- J. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Perform installation and startup checks according to manufacturer's written instructions.
 2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
 3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level, and water temperature.
 - b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- C. Boiler will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. Performance Tests:
1. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
 2. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
 3. Perform field performance tests to determine capacity and efficiency of boilers.
 - a. Test for full capacity.
 - b. Test for boiler efficiency at 10, 30, 50, 70, and 90 percent of full capacity. Determine efficiency at each test point.
 4. Repeat tests until results comply with requirements indicated.
 5. Provide analysis equipment required to determine performance.
 6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are inadequate.
 7. Notify Owner and Architect 7 days minimum in advance of test dates.
 8. Document test results in a report and submit to Architect.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain boilers.

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SECTION 23 74 33

DEDICATED OUTDOOR-AIR UNITS

PART 1 - GENERAL

1.1 ACTION SUBMITTALS

- A. Product Data: For each dedicated outdoor-air unit.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - 3. Include unit dimensions and weight.
 - 4. Include cabinet material, metal thickness, finishes, insulation, and accessories.
 - 5. Fans:
 - a. Certified fan-performance curves with system operating conditions indicated.
 - b. Certified fan-sound power ratings.
 - c. Fan construction and accessories.
 - d. Motor ratings, electrical characteristics, and motor accessories.
 - 6. Include certified coil-performance ratings with system operating conditions indicated.
 - 7. Include filters with performance characteristics.
 - 8. Include heat exchangers with performance characteristics.
 - 9. Include dampers, including housings, linkages, and operators.

1.2 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For dedicated outdoor-air units to include in emergency, operation, and maintenance manuals.

1.3 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Filters: One set for each unit.

1.4 WARRANTY

- A. Warranty: Manufacturer agrees to replace components of dedicated outdoor-air units that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for all Parts: Two years from date of Substantial Completion.
 - 2. Warranty Period for Compressors: Five years from date of Substantial Completion.
 - 3. Warranty Period for Rotary Heat Exchangers: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an "NRTL" (nationally recognized testing laboratory), and marked for intended location and application.
- B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of units and components.
- C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- D. ASHRAE 15 and ASHRAE 34 Compliance: For refrigeration system safety.
- E. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- F. ASHRAE 84 Compliance: Comply with capacity ratings for heat-wheel energy-recovery equipment.
- G. UL Compliance: Comply with requirements in UL 60335-2-40/CSA 22.2 No. 236 and UL/CSA UL 1995/CSA C22.2 No. 236 "Safety Standard for Heating and Cooling Equipment."

2.2 DEDICATED OUTDOOR-AIR UNITS

- A. Manufacturers:
 - 1. Addison.
 - 2. AAON.
 - 3. Daikin.
 - 4. Trane.
 - 5. York.
- B. Unit Casing:
 - 1. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.
 - 2. Configuration: Horizontal unit with bottom discharge.
 - 3. Casing Performance:
 - a. Factory Leakage: Less than 1% total airflow when tested per AHRI 340/360.
 - b. Deflection: Capable of withstanding positive/negative 4 inches wg of internal static pressure, without exceeding a midpoint deflection of L/200.
 - 4. Double-Wall Configuration:
 - a. Outside Casing Wall: G90 Galvanized steel with manufacturer's standard finish and knockouts with grommet seals for electrical and piping connections and lifting lugs.
 - 1) ASTM B 117-95 Salt Spray: 2,500 hr

- b. Inside Casing Wall: G90 Galvanized steel, solid.
- c. Casing Insulation:
 - 1) Materials: ASTM D1929-11 foam insulation.
 - 2) Casing Panel R-Value: Minimum R-13.
 - 3) Thermal Break: Provide continuity of insulation with no through-casing metal in casing walls, floors, or roofs of air-handling unit.
- 5. Floor Plate: reinforced to limit deflection when walked on by service personnel. Insulation is provided below metal walking surface.
- 6. Roof: Standing seam; sloped to drain water with rain break overhangs.
- 7. Panels and Doors:
 - a. Panels:
 - 1) Fabrication: Formed and reinforced double-wall and insulated panels of same materials and thicknesses as casing.
 - 2) Fasteners: Lockable handle(s). Arrangement shall allow panels to be opened against airflow.
 - 3) Gasket: Neoprene, applied around entire perimeters of panel frames.
 - 4) Size: Large enough to allow unobstructed access for inspection and maintenance of unit's internal components.
 - b. Doors:
 - 1) Fabrication: Formed and reinforced double-wall and insulated panels of same materials and thicknesses as casing.
 - 2) Hinges: Stainless steel piano hinge.
 - 3) Latches: Two wedge-lever latches, operable from inside and outside. Arrange doors to be opened against airflow.
 - 4) Gasket: Neoprene, applied around entire perimeters of panel frames.
 - 5) Size: Large enough to allow for unobstructed access for inspection and maintenance of air-handling unit's internal components.
- 8. Condensate Drain Pans:
 - a. Location: Each refrigerant coil and rotary heat exchanger.
 - b. Construction: Single-wall, stainless steel sheet.
 - c. Size: Large enough to collect condensate from cooling coils, including coil piping connections, coil headers, and return bends.
 - d. Width: Entire width of water-producing device.
 - e. Depth: A minimum of 2 inches deep.
 - f. Provide units having stacked coils with intermediate drain pan to collect condensate from top coil.

C. Fans, Drives, And Motors:

- 1. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.
- 2. Supply-Air Fans and Exhaust Fans: Backward-inclined, unhooded plenum; galvanized or painted steel; mounted on solid-steel shaft.
 - a. Shafts: With field-adjustable alignment. Turned, ground, and polished hot-rolled steel with keyway.

- b. Shaft Bearings: Heavy-duty, self-aligning, pillow-block type with an L-50 rated life of minimum 200,000 hours in accordance with ABMA 9.
 - c. Mounting: For internal vibration isolation. Factory mount fans with manufacturer's standard vibration isolation mounting devices having a minimum static deflection of 1 inch.
 - d. Shaft Lubrication Lines: Extended to a location outside the casing.
- 3. Drive, Direct: Factory-mounted direct drive.
- 4. Motor Type:
- 5. Motors:
 - a. Comply with NEMA designation, temperature rating, service factor, enclosure type and efficiency requirements for motors specified in Section 23 05 00 "Common Work Results for HVAC."
 - b. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 - c. Enclosure Type: Open, dripproof or electronically commutated variable speed.
 - d. Efficiency: Premium efficient as defined in NEMA MG 1.
 - e. Inverter-duty.
 - f. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
- 6. Variable-Frequency Motor Controller (if applicable):
 - a. Manufactured Units: Pulse-width modulated; constant torque for inverter-duty motors.
 - b. Output Rating: Three phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.
 - c. Unit Operating Requirements:
 - 1) Self-Protection and Reliability Features:
 - a) Surge suppression.
 - b) Loss of input signal protection.
 - c) Under- and overvoltage trips.
 - d) Variable-frequency motor controller and motor-overload/overtemperature protection.
 - e) Critical frequency rejection.
 - f) Loss-of-phase protection.
 - g) Reverse-phase protection.
 - h) Motor-overtemperature fault.
 - 2) Bidirectional autospeed search.
 - 3) Torque boost.
 - 4) Motor temperature compensation at slow speeds.
 - a) Panel-mounted operator station.
 - b) Historical logging information and displays.
 - c) Digital indicating devices.
 - 5) Control Signal Interface: Electric.
 - 6) Proportional Integral Directive (PID) control interface.
 - d. Line Conditioning:

- 1) Input line conditioning.
- 2) Output filtering.
- 3) EMI/RFI filtering.

D. Coils:

1. General Requirements for Coils:

- a. Comply with AHRI 410.
- b. Fabricate coils section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
- c. Coils are not to act as structural component of unit.

2. Supply-Air and Hot-Gas Reheat Refrigerant Coils:

- a. Tubes: Copper.
- b. Fins: Aluminum.
- c. Fin and Tube Joints: Mechanical bond.
- d. Headers: Seamless-copper headers with brazed connections.
- e. Frames: Galvanized steel.
- f. Coatings: None.
- g. Ratings: Designed, tested, and rated in accordance with ASHRAE 33 and AHRI 410.
- h. Working Pressure: Minimum 300 psig.

3. Indirect-Fired Gas Furnace Heating

- a. Description: Factory assembled, piped, and wired; and complying with ANSI Z21.47 and with NFPA 54.
- b. CSA Approval: Designed and certified by and bearing label of CSA.
- c. Fuel: Natural gas.
- d. Gas Control Valve: Electronic modulating.
- e. Gas Train: Single-body, regulated, redundant, 24 V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff
- f. Venting, Power: Power vented, with integral, motorized centrifugal fan interlocked with gas valve

4. Condenser Refrigerant Coils:

- a. Fin: Material: Aluminum
- b. Tubing: Copper inner tube.
- c. Fine and Tube Joint: Mechanical bond.
- d. Coating: None.

E. Refrigeration Circuit Components:

1. Compressors: Minimum one, hermetic, variable-speed scroll compressors, mounted on integral vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief, and crankcase heater.
2. Minimum Capacity Turndown: 15% of full load.
3. Refrigerant:
 - a. R-454B.
 - b. R-32.

4. Exterior of compressor shall be wrapped with a high-density sound-attenuating blanket and housed in an acoustically treated enclosure.
5. Refrigeration Specialties:
 - a. Electronic expansion valve.
 - b. Refrigerant filter/dryer.
 - c. Manual-reset high-pressure safety switch.
 - d. Automatic-reset low-pressure safety switch.
 - e. Minimum off-time relay.
 - f. Automatic-reset compressor motor thermal overload.
 - g. Thermostat for coil freeze-up protection during low-ambient-temperature operation or loss of air.
 - h. Brass service valves installed in discharge and liquid lines.
 - i. Modulating hot-gas reheat solenoid valve with a replaceable magnetic coil.
6. Refrigerant Piping Materials: ASTM B743 copper tube with wrought-copper fittings and brazed joints.
7. Pipe Insulation: Refrigerant minimum 3/8-inch-thick, flexible elastomeric insulation on piping exposed to airflow through the unit. Maximum 25/50 flame-spread/smoke-developed indexes according to ASTM E84.
8. Condenser Fan: Variable-speed controlled, mounted on shaft of permanently lubricated ECM motor.

F. Air Filtration:

1. Description: Pleated factory-fabricated, self-supported disposable air filters with holding frames.
2. Filter Unit Class: UL 900.
3. Media: Interlaced glass, synthetic, or cotton fibers coated with nonflammable adhesive and antimicrobial coating.
4. Filter-Media Frame: High wet-strength beverage board with perforated metal retainer, or metal grid, on outlet side.
5. MERV Ratings:
 - a. Supply: MERV-13.
 - b. Exhaust: MERV-8.

G. Rotary Heat Exchanger:

1. General:
 - a. Integral purge section limiting carryover of exhaust air.
 - b. Casing seals on periphery of rotor and on duct divider and purge section.
 - c. Support horizontal rotors on tapered roller bearings.
2. Rotor: Polymer segmented wheel, strengthened with radial spokes impregnated with nonmigrating, water-selective, molecular-sieve desiccant coating.
3. Drive: Fractional horsepower motor, with speed changed by variable-frequency controller.
4. Wheel Bearings:
 - a. Permanently lubricated.
 - b. L-10 minimum rated life of 400,000 hours.
5. Controls:

- a. Starting relay, factory mounted and wired, and manual motor starter for field wiring.
- b. Variable-frequency controller, factory mounted and wired, permitting input of 4-20 mA or 1-10 V control signal.
- c. Bypass dampers to assist energy recovery control.
- d. Speed Settings: Adjustable settings for maximum and minimum rotor speed limits.

H. Dampers:

- 1. Outdoor- and Relief-Air Dampers: Low-leakage, double-skin, airfoil-blade, aluminum dampers with compressible jamb seals and extruded-vinyl blade edge seals in parallel-blade arrangement with zinc-plated steel operating rods rotating in sintered bronze or nylon bearings mounted in a single aluminum frame, and with operating rods connected with a common linkage. Leakage rate shall not exceed 20 cfm/sq. ft. at 4 inch wg.
- 2. Electronic Damper Operators:
 - a. Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
 - b. Electronic damper position indicator shall have visual scale indicating percentage of travel and 2 to 10 V dc feedback signal.
 - c. Coupling: V-bolt and V-shaped, toothed cradle.
 - d. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
 - e. Fail-Safe Operation: Mechanical, spring-return mechanism.
 - f. Temperature Rating: Minus 22 to plus 122 deg F.

I. Intake And Relief Openings:

- 1. Type: Manufacturer's standard hood at all unit intake and relief openings.
- 2. Materials: Match material and finish of casing exterior.
- 3. Bird Screen.
- 4. Configuration: Designed to inhibit wind-driven rain and snow from entering unit.

J. Electrical Power Connections:

- 1. Single-Point Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other necessary electrical devices shall provide a single-point field power connection to unit.
- 2. Wiring: Numbered and color-coded to match wiring diagram.
- 3. Wiring Location: Install factory wiring outside an enclosure in a raceway.
- 4. Power Interface: Field power interface to be NEMA KS 1, heavy-duty, nonfused disconnect switch.
- 5. Factory-Mounted, Overcurrent-Protection Service: For each motor.
- 6. Transformer: Factory mounted with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.

K. Controls:

- 1. Comply with requirements in Section 23 09 23 "Direct Digital Control (DDC) System for HVAC" and sequence of operations on drawings.
- 2. Control Wiring: Factory wire connection for controls' power supply.
- 3. Control Devices: Sensors, transmitters, relays, switches, detectors, operators, actuators, and valves shall be manufacturer's standard items to accomplish indicated control functions.
- 4. Basic Unit Control Modes and Devices:
 - a. Dehumidification mode.

- b. Unit shutdown on high or low refrigerant pressures.
 - c. Low- and high-voltage protection.
 - d. Overcurrent protection for compressor and fan motor.
 - e. Random time delay, three to ten seconds, start on power-up.
 - f. Time delay override for servicing.
 - g. Control voltage transformer.
 - h. Air-coil freeze protection.
 - i. Condensate overflow shutdown switch.
 - j. Automatic intelligent reset. Unit shall automatically reset five minutes after trip if the fault has cleared. Should a fault reoccur three times sequentially, lockout requiring manual reset occurs.
 - k. Ability to defeat time delays for servicing.
 - l. Light-emitting diodes (LED) to indicate high pressure, low pressure, low voltage, and high voltage.
 - m. The low-pressure switch SHALL NOT be monitored for the first 90 seconds after a compressor start command to prevent nuisance safety trips.
 - n. Remote fault-type indication.
 - o. Selectable 24-V dc or pilot duty dry contact alarm output.
 - p. Electric heat output to control electric heat (emergency heat).
 - q. Service test mode for troubleshooting and service.
5. Controller:
- a. Controller shall have volatile-memory backup.
 - b. Scheduled Operation: Occupied and unoccupied periods on 365-day clock with a minimum of four programmable periods per day.
6. Interface Requirements for HVAC Instrumentation and Control System:
- a. Provide BACnet compatible interface for central HVAC control workstation for the following:
 - 1) Adjusting set points.
 - 2) Monitoring supply fan start, stop, and operation.
 - 3) Inquiring data to include outdoor-air damper position, supply-air temperature and humidity.
 - 4) Monitoring occupied and unoccupied operations.
 - 5) Monitoring constant and variable motor loads.
 - 6) Monitoring variable-frequency drive operation.
 - 7) Monitoring cooling load.
 - 8) Monitoring economizer cycles.
 - 9) Monitoring air-distribution static pressure and ventilation air volume.

2.3 PLENUM CURBS

- A. Internally reinforced plenum curb units capable of supporting superimposed dead and live loads, including equipment loads and other construction indicated on Drawings, bearing continuously on supporting surface, and capable of meeting performance requirements; with welded or mechanically fastened and sealed corner joints, straight sides, and integrally formed equipment-mounting flange at top and base.
- B. Size: Coordinate dimensions with DOAS manufacturer's required equipment connections, roughing-in information, and Shop Drawings. Provide curb dimensions to align with and match DOAS supply and return air openings.

- C. Steel: Zinc-coated (galvanized) steel sheet.
- D. Construction:
 - 1. Curb Profile: Manufacturer's standard, designed specifically for grade-mounted DOAS applications.
 - 2. Height: Fabricate curb to minimum height of 24 inches above finished grade unless otherwise indicated. Coordinate final height with ductwork routing and DOAS connection requirements.
 - 3. Top Surface: Level and continuous top surface suitable for mounting DOAS equipment.
 - 4. Insulation: Factory insulated with 1-1/2-inch-thick glass-fiber board insulation on all faces. Seal all insulation joints to provide an airtight assembly.
 - 5. Equipment Mounting: Provide continuous equipment mounting flange at top of curb. Coordinate flange dimensions and attachment requirements with DOAS manufacturer.
 - 6. Base: Provide continuous base flange suitable for anchorage to concrete equipment pad. Provide sealed joints between curb and supporting surface to prevent water and air infiltration.
 - 7. Duct Connections: Provide integral supply and return air plenum sections and transitions as required to connect DOAS openings to ductwork indicated on Drawings. Seal all duct-to-curb connections airtight.
 - 8. Weather Protection: Provide weathertight construction at all exterior portions of plenum curb. Slope exposed horizontal surfaces to drain water away from equipment and duct openings.
 - 9. Condensate and Drainage: Provide drainage provisions as required to prevent accumulation of water within the plenum curb. Coordinate with DOAS condensate drain connection.
 - 10. Access: Provide removable or hinged access panels where required for access to dampers, flexible connections, controls, or other components located within the plenum curb.
 - 11. Anchorage: Provide factory-installed or field-installed attachment points and hardware required to secure DOAS to curb and curb to concrete equipment pad. Coordinate with structural requirements.
 - 12. Sealing: Seal all curb joints, equipment connections, duct connections, and penetrations with sealant compatible with adjacent materials. Provide airtight construction to prevent uncontrolled air leakage.
 - 13. Flexible Connections: Provide flexible duct connections between DOAS discharge/inlet openings and plenum curb where required by equipment manufacturer. Flexible connections shall be airtight and suitable for outdoor exposure.
- E. Finish: Factory-applied corrosion-resistant coating over galvanized steel where exposed to weather

2.4 SOURCE QUALITY CONTROL

- A. AHRI 920: Manufacturer to certify that performance ratings are in accordance with AHRI 920 if AHRI 920 certification program is not in place. Provide AHRI 920 certification if AHRI 920 certification program is in place.
- B. AHRI 260 or AMCA 311 Sound Performance Rating Certification: Test, rate, and label unit fan sound ratings in accordance with AHRI 260 or AMCA 311.
- C. Fan Aerodynamic Performance Rating: Test and rate fan performance for airflow, pressure, power, air density, rotation speed, and efficiency.
 - 1. Fan Aerodynamic Performance Rating: Test and rate fan performance in accordance with AMCA 210.

2. AMCA Fan Aerodynamic Certification Rating: Test, rate, and label, in accordance with AMCA 211.
- D. Fan Energy Index (FEI): Test in accordance with AMCA 210 and rate in accordance with AMCA 99, AMCA 207, and AMCA 208.
- E. Fan Operating Limits: Classify fans in accordance with AMCA 99, Section 14.
- F. Damper Leakage and Air Performance:
 1. Damper Rating: Test and rate dampers for leakage and air performance in accordance with AMCA 510.
 2. AMCA Damper Certification: Test, rate, and label in accordance with AMCA 511.
- G. Refrigerant Coils: Factory tested to minimum 300 psig internal pressure and to minimum 300 psig internal pressure while under water, in accordance with AHRI 410 and ASHRAE 33.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.
- C. Examine roof curbs and equipment supports for suitable conditions where units will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF DEDICATED OUTDOOR-AIR UNITS

- A. Plenum Curb: Install on concrete base, level and secure, in accordance with AHRI Guideline B. Install unit on curb. Secure unit to upper curb rail, and secure curb base to concrete base with anchor bolts. Coordinate size and location of plenum curb with actual equipment provided.
- B. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing with new, clean filters.
- C. Install separate devices furnished by manufacturer and not factory installed.
- D. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.

3.3 PIPING CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to units, allow space for service and maintenance.
- C. Connect piping to units mounted on vibration isolators with flexible connectors.

D. Duct Connections:

1. Comply with requirements in Section 23 31 13 "Metal Ducts."
2. Drawings indicate the general arrangement of ducts.
3. Connect ducts to units with flexible duct connectors. Comply with requirements for flexible duct connectors in Section 23 33 00 "Air Duct Accessories."

3.4 ELECTRICAL CONNECTIONS

- A. Connect wiring in accordance with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- B. Ground equipment in accordance with Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.
- D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
 1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 26 05 53 "Identification for Electrical Systems."
 2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.5 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring in accordance with Section 26 05 23 "Control-Voltage Electrical Power Cables."

3.6 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 1. Complete installation and startup checks in accordance with manufacturer's written instructions.
 2. Inspect units for visible damage to furnace combustion chamber.
 3. Inspect units for visible damage to refrigerant compressor, condenser and evaporator coils, and fans.
 4. Start refrigeration system when outdoor-air temperature is within normal operating limits. and measure and record the following:
 - a. Cooling coil leaving-air, dry- and wet-bulb temperatures.
 - b. Cooling coil entering-air, dry- and wet-bulb temperatures.
 5. Simulate maximum cooling demand and inspect the following:
 - a. Compressor refrigerant suction and hot-gas pressures.
 6. Inspect casing insulation for integrity, moisture content, and adhesion.
 7. Verify that clearances have been provided for servicing.
 8. Verify that controls are connected and operable.

9. Verify that filters are installed.
10. Clean coils and inspect for construction debris.
11. Inspect and adjust vibration isolators.
12. Verify bearing lubrication.
13. Clean fans and inspect fan-wheel rotation for movement in correct direction without vibration and binding.
14. Adjust belts to proper alignment and tension.
15. Start unit.
16. Inspect and record performance of interlocks and protective devices, including response to smoke detectors by fan controls and fire alarm.
17. Operate unit for run-in period.
18. Calibrate controls.
19. Adjust and inspect high-temperature limits.
20. Inspect outdoor-air dampers for proper stroke.
21. Verify operational sequence of controls.
22. Assist testing, adjusting, and balancing sub-contractor.
23. Assist building automation system sub-contractor.

- B. After startup, change filters, verify bearing lubrication, and adjust belt tension.
- C. Remove and replace components that do not properly operate, and repeat startup procedures as specified above.
- D. Prepare written report of the results of startup services.

3.7 ADJUSTING

- A. Adjust initial temperature and humidity set points.
- B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

3.8 CLEANING

- A. After completing system installation; testing, adjusting, and balancing dedicated outdoor-air unit and air-distribution systems; and completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, casings, dampers, coils, and filter housings, and install new, clean filters.

3.9 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform the following tests and inspections:
 1. Charge refrigerant coils with refrigerant and test for leaks.
 2. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

3.10 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION

SECTION 23 81 46

WATER-SOURCE UNITARY HEAT PUMPS

PART 1 - GENERAL

1.1 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each water-source unitary heat pump.
 - 2. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and mounting and attachment details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.

1.2 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For water-source unitary heat pumps to include in emergency, operation, and maintenance manuals.

1.3 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of water-source unitary heat pumps that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, refrigeration components.
 - 2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an "NRTL" (nationally recognized testing laboratory), and marked for intended location and application.
- B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of units and components.
- C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- D. ASHRAE 15 and ASHRAE 34 Compliance: For refrigeration system safety.

- E. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- F. ASHRAE 84 Compliance: Comply with capacity ratings for heat-wheel energy-recovery equipment.
- G. UL Compliance: Comply with requirements in UL 60335-2-40/CSA 22.2 No. 236 and UL/CSA UL 1995/CSA C22.2 No. 236 "Safety Standard for Heating and Cooling Equipment."

2.2 WATER-SOURCE UNITARY HEAT PUMPS

- A. Manufacturers:
 - 1. Carrier.
 - 2. Waterfurnace.
 - 3. Climate Master.
 - 4. Trane.
 - 5. Daikin.
- B. Description: Packaged water-source unitary heat pump with temperature controls; factory assembled, piped, wired, tested, and rated according to ASHRAE/ARI/ISO-13256-1.
 - 1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency and marked for intended location and application.
- C. Cabinet and Chassis: Galvanized-steel casing with the following features:
 - 1. Access panel for access and maintenance of internal components.
 - 2. Knockouts for electrical and piping connections.
 - 3. Cabinet Insulation: Glass-fiber liner, minimum 1/2 inch, thick, complying with UL 181, ASTM C1071, and ASTM G21.
- D. Water Circuits:
 - 1. Refrigerant-to-Water Heat Exchangers:
 - a. Source-side coaxial heat exchangers with copper water tube, with enhanced heat-transfer surfaces inside a steel shell; both shell and tube are leak tested to 450 psig on refrigerant side and 400 psig on water side.
 - b. Load-side coaxial heat exchangers with copper water tube, with enhanced heat-transfer surfaces inside a steel shell; both shell and tube are leak tested to 450 psig on refrigerant side and 400 psig on water side.
- E. Refrigerant Circuit Components:
 - 1. Sealed Refrigerant Circuit:
 - a. R-454B.
 - b. R-32.
 - 2. Filter-Dryer: Factory installed to clean and dehydrate the refrigerant circuit.
 - 3. Charging Connections: Service fittings on suction and liquid for charging and testing on each circuit.
 - 4. Reversing Valve: Four-way, solenoid-activated valve designed to be fail-safe in heating position with replaceable magnetic coil.

5. Compressor:

- a. Scroll.
- b. Two stage.
- c. Installed on vibration isolators and mounted on a structural steel base plate and full-length channel stiffeners.
- d. Exterior of compressor shall be wrapped with a high-density sound-attenuating blanket and housed in an acoustically treated enclosure.
- e. Refrigeration Specialties:
 - 1) Electronic expansion valve.
 - 2) Refrigerant filter/dryer.
 - 3) Manual-reset high-pressure safety switch.
 - 4) Automatic-reset low-pressure safety switch.
 - 5) Minimum off-time relay.
 - 6) Automatic-reset compressor motor thermal overload.
 - 7) Thermostat for coil freeze-up protection during low-ambient-temperature operation or loss of air.
 - 8) Brass service valves installed in discharge and liquid lines.
 - 9) Single compressor with evaporator and condenser coil within the refrigerant section to provide initial pre-cooling and to reheat for humidity control.
 - 10) Modulating hot-gas reheat solenoid valve with a replaceable magnetic coil.

6. Refrigerant Piping Materials: ASTM B743 copper tube with wrought-copper fittings and brazed joints.

7. Pipe Insulation: Refrigerant minimum 3/8-inch-thick, flexible elastomeric insulation on piping exposed to airflow through the unit. Maximum 25/50 flame-spread/smoke-developed indexes according to ASTM E84.

F. Controls:

1. Basic Unit Control Modes and Devices:

- a. Unit shutdown on high or low refrigerant pressures.
- b. Unit shutdown on low water temperature.
- c. Low- and high-voltage protection.
- d. Overcurrent protection for compressor.
- e. Random time delay, three to 10 seconds, start on power-up.
- f. Time delay override for servicing.
- g. Control voltage transformer.
- h. Water-coil freeze protection (selectable for water or antifreeze).
- i. Automatic intelligent reset. Unit shall automatically reset five minutes after trip if the fault has cleared. Should a fault reoccur three times sequentially, lockout requiring manual reset occurs.
- j. Ability to defeat time delays for servicing.
- k. Digital display to indicate high pressure, low pressure, low voltage, and high voltage.
- l. The low-pressure switch shall not be monitored for the first 90 seconds after a compressor start command to prevent nuisance safety trips.
- m. Remote fault-type indication at thermostat.
- n. Selectable 24-V dc or pilot duty dry contact alarm output.
- o. 24-V dc output to cycle a motorized water valve with compressor contactor.
- p. Service test mode for troubleshooting and service.
- q. Unit-performance sentinel warns when heat pump is running inefficiently.
- r. Compressor soft start.

2. DDC interface requirements as further described in Section 23 09 23 "Direct Digital Control (DDC) System for HVAC" and drawings.
 - a. Interface relay for scheduled operation.
 - b. Interface relay to provide indication of fault at central workstation.
 - c. Provide BACnet interface for central DDC workstation for the following functions:
 - 1) Set-point adjustment.
 - 2) Start/stop and operating status of heat-pump unit.
 - 3) Occupied and unoccupied schedules.
- G. Electrical Connection: Single electrical connection with fused disconnect.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping and electric installations for water-source unitary heat pumps to verify actual locations of piping connections and electrical conduits before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF WATER-SOURCE UNITARY HEAT PUMPS

- A. Equipment Mounting:
 1. Install water-source, unitary heat pumps on structural-mounted equipment supports.
 2. Comply with requirements for vibration-isolation and seismic-restraint devices specified in Section 23 05 48 "Vibration Controls for HVAC."

3.3 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install electrical devices furnished by manufacturer but not specified to be factory mounted.
- C. Install piping adjacent to machine to allow space for service and maintenance.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform the following field tests and inspections:
 1. After installing water to water heat pumps and after electrical circuitry has been energized, test units for compliance with requirements.
 2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

- 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Heat pumps will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Inspect for visible damage to unit casing.
 - 3. Inspect for visible damage to compressor and coils.
 - 4. Inspect internal insulation.
 - 5. Verify that labels are clearly visible.
 - 6. Verify that clearances have been provided for servicing.
 - 7. Verify that controls are connected and operable.
 - 8. Adjust vibration isolators.
 - 9. Start unit according to manufacturer's written instructions.
 - 10. Complete startup sheets and attach copy with Contractor's startup report.
 - 11. Inspect and record performance of interlocks and protective devices; verify sequences.
 - 12. Operate unit for an initial period as recommended or required by manufacturer.
 - 13. Inspect controls for correct sequencing of heating, refrigeration, and normal and emergency shutdown.

3.6 ADJUSTING

- A. Adjust initial temperature set points.
- B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

3.7 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain water-source unitary heat pumps.

END OF SECTION

SECTION 23 82 39

UNIT HEATERS

PART 1 - GENERAL

1.1 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Indeeco.
- B. Berko.
- C. Markel.
- D. Qmark.
- E. Stelpro.

2.2 DESCRIPTION

- A. Assembly including chassis, electric heating coil, fan, motor, and controls. Comply with UL 2021.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 CABINET

- A. Front Panel: Extruded-aluminum bar grille, with removable panels fastened with tamperproof fasteners.
- B. Finish: Baked enamel over baked-on primer with manufacturer's standard color selected by Architect, applied to factory-assembled and -tested wall and ceiling heaters before shipping.
- C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- D. Surface-Mounted Cabinet Enclosure: Steel with finish to match cabinet.

2.4 COIL

- A. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in corrosion-resistant metallic sheath. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware, and limit controls for high-temperature protection. Provide integral circuit breaker for overcurrent protection.

2.5 FAN AND MOTOR

- A. Fan: Aluminum propeller directly connected to motor.
- B. Motor: Permanently lubricated.

2.6 CONTROLS

- A. Controls: Low-voltage relay with transformer kit.
- B. Electrical Connection: Factory wire motors and controls for a single field connection with disconnect switch.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive wall and ceiling unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for electrical connections to verify actual locations before unit-heater installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install wall and ceiling unit heaters to comply with NFPA 90A.
- B. Install wall and ceiling unit heaters level and plumb.
- C. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

END OF SECTION

SECTION 26 05 01

SELECTIVE ELECTRICAL DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Extension of existing electrical systems.
 - 2. Maintaining electrical systems services.
 - 3. Electrical systems switchovers.
 - 4. Electrical demolition.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Materials and equipment for patching and extending work: Match existing unless otherwise specified in individual Sections.

PART 3 - EXECUTION

3.1 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. Only items critical to performance of new systems and extensions to existing systems have been verified to extent practicable by field observations.
- D. Report discrepancies to Architect before disturbing existing installation.
- E. Beginning of demolition means installer accepts existing conditions.
- F. 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.

3.2 PREPARATION

- A. Disconnect electrical systems in walls, floors, and ceilings to be removed.
- B. Coordinate utility service outages with Owner.
- C. 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.

- D. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.
 - 1. Obtain permission from Owner at least two weeks before partially or completely disabling system(s) for a duration of longer than one hour.
 - 2. Obtain permission from Owner at least 24 hours before partially or completely disabling system for one hour or less.
 - 3. Make temporary connections to maintain service in areas adjacent to work area for outages longer than one hour duration.
- E. Existing Telephone System: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.
 - 1. Notify Owner at least 24 hours before partially or completely disabling system.
 - 2. Make temporary connections to maintain service in areas adjacent to work area.

3.3 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

- A. Remove, relocate, and extend existing installations to accommodate new construction.
- B. Remove 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 boxes 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. Repair gypsum and concrete walls exposed after removal of panelboards and electrical equipment. Patch walls and paint to match surrounding surfaces.
- J. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.
- K. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.
- L. Verify proper phase rotation on new service entrances prior to temporary service entrance connections. Ensure proper re-connection of all feeders.

3.4 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 11

REQUIREMENTS FOR ELECTRICAL INSTALLATIONS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Furnish and install electrical wiring, systems, equipment and accessories in accordance with the specifications and drawings. Capacities and ratings of motors, transformers, cable, panelboards, and other items and arrangements for the specified items are shown on drawings or schedules.
- B. Electrical service entrance equipment shall conform to NEC requirements. Coordinate fuses, circuit breakers and relays with the 15kV system, and obtain Owner approval for sizes and settings of these devices.
- C. Wiring ampacities specified, scheduled, or shown on the drawings are based on copper conductors unless otherwise noted, with the conduit and raceways accordingly sized.

1.2 MINIMUM REQUIREMENTS

- A. References to the International Building Code (IBC), National Electrical Code (NEC), Underwriters Laboratories, Inc. (UL) and National Fire Protection Association (NFPA) are minimum installation requirement standards.
- B. Drawings and other specification sections shall govern in those instances where requirements are greater than those specified in the above standards.

1.3 TEST STANDARDS

- A. All materials and equipment shall be listed, labeled or certified by a nationally recognized testing laboratory to meet Underwriters Laboratories, Inc., standards where test standards have been established. Equipment and materials which are not covered by UL Standards will be accepted provided equipment and material is listed, labeled, certified or otherwise determined to meet safety requirements of a nationally recognized testing laboratory. Equipment of a class which no nationally recognized testing laboratory accepts, certifies, lists, labels, or determines to be safe, will be considered if inspected or tested in accordance with national industrial standards, such as NEMA, or ANSI. Evidence of compliance shall include certified test reports and definitive shop drawings.
- B. Definitions:
 - 1. Listed: Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production or listed equipment or materials or periodic evaluation of services, and whose listing states that the equipment, material, or services either meets appropriate designated standards or has been tested and found suitable for a specified purpose.
 - 2. Labeled: Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

3. Certified: equipment or product which:
 - a. Has been tested and found by a nationally recognized testing laboratory to meet nationally recognized standards or to be safe for use in a specified manner.
 - b. Production of equipment or product is periodically inspected by a nationally recognized testing laboratory.
 - c. Bears a label, tag, or other record of certification.
4. Nationally recognized testing laboratory; laboratory which is approved, in accordance with OSHA regulations, by the Secretary of Labor.

1.4 QUALIFICATIONS (PRODUCTS AND SERVICES)

- A. Manufacturers Qualifications: The manufacturer shall regularly and presently produce, as one of the manufacturer's principal products, the equipment and material specified for this project, and shall have manufactured the item for at least three years.
- B. Product Qualification: Manufacturer's product shall have been in satisfactory operation, on three installations of similar size and type as this project, for approximately three years.
- C. Service Qualifications: There shall be a permanent service organization maintained or trained by the manufacturer which will render satisfactory service to this installation within four hours of receipt of notification that service is needed. Submit name and address of service organizations.

1.5 MANUFACTURED PRODUCTS

- A. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts shall be available.
- B. When more than one unit of the same class or type of equipment is required, such units shall be the product of a single manufacturer.
- C. Equipment Assemblies and Components:
 1. Components of an assembled unit need not be products of the same manufacturer.
 2. Manufacturers of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.
 3. Components shall be compatible with each other and with the total assembly for the intended service.
 4. Constituent parts which are similar shall be the product of a single manufacturer.
- D. Factory wiring shall be identified on the equipment being furnished and on all wiring diagrams.

1.6 EQUIPMENT PROTECTION

- A. Equipment and materials shall be protected during shipment and storage against physical damage, vermin, dirt, corrosive substances, fumes, moisture, cold and rain.
 1. Store equipment indoors in clean dry space with uniform temperature to prevent condensation. Equipment shall include but not be limited to switchgear, switchboards, panelboards, transformers, motor control centers, motor controllers, uninterruptible power systems, enclosures, controllers, circuit protective devices, cables, wire, light fixtures, wiring devices, electronic equipment, and accessories.
 2. During installation, equipment shall be protected against entry of foreign matter; and be vacuum-cleaned both inside and outside before testing and operating. Compressed air shall not be used to clean equipment. Remove loose packing and flammable materials from inside equipment.

3. Damaged equipment shall be, as determined by the Engineer, placed in first class operating condition or be returned to the source of supply for repair or replacement.
4. Painted surfaces shall be protected with factory installed removable heavy kraft paper, sheet vinyl or equal.
5. Damaged paint on equipment and materials shall be refinished with the same quality of paint and workmanship as used by the manufacturer so repaired areas are not obvious.

1.7 WORK PERFORMANCE

- A. All electrical work must comply with the requirements of NFPA 70 (NEC), NFPA 70B, NFPA 70E, OSHA Part 1910 subpart J, OSHA Part 1910 subpart S and OSHA Part 1910 subpart K in addition to other references required by contract.
- B. Contractor shall be responsible for all permits and inspections required to complete the work.
- C. Job site safety and worker safety is the responsibility of the contractor.
- D. Electrical work shall be accomplished with all affected circuits or equipment de-energized. When an electrical outage cannot be accomplished in this manner for the required work, the following requirements are mandatory:
 1. Electricians must use full protective equipment (i.e., certified and tested insulating material to cover exposed energized electrical components, certified and tested insulated tools, etc.) while working on energized systems in accordance with NFPA 70E.
 2. Electricians must wear personal protective equipment while working on energized systems in accordance with NFPA 70E.
 3. Before initiating any work, a job specific work plan must be developed by the contractor with a peer review conducted and documented. The work plan must include procedures to be used on and near the live electrical equipment, barriers to be installed, safety equipment to be used and exit pathways.
 4. Work on energized circuits or equipment cannot begin until prior written approval is obtained from the Owner.
- E. For work on existing buildings, arrange, phase and perform work to assure electrical service for other buildings at all times.
- F. New work shall be installed and connected to existing work neatly, safely and professionally. Disturbed or damaged work shall be replaced or repaired to its prior conditions. Existing installation conditions discovered or uncovered during the course of new work shall be reported to Construction Manager or Engineer as soon as practical and not later than the end of the day the condition is discovered.
- G. Coordinate location of all equipment and conduit with other trades to minimize interferences.

1.8 ELECTRICAL INSTALLATIONS

- A. Equipment location shall be as close as practical to locations shown on the drawings.
- B. Working spaces shall not be less than specified in the NEC for all voltages specified.

- C. Inaccessible Equipment:
1. Where the Engineer determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, the equipment shall be removed and reinstalled as directed at no additional cost to the Owner.
 2. "Conveniently accessible" is defined as being capable of being reached quickly for operation, maintenance, or inspections without the use of ladders, or without climbing or crawling under or over obstacles such as, but not limited to, motors, pumps, belt guards, transformers, piping, ductwork, conduit and raceways.
- D. Verify all dimensions by field measurements.
- E. Arrange for chases, slots, and openings in other building components to allow for electrical installations.
- F. 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.
- G. 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.
- H. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
- I. Install systems, materials, and equipment to conform to project requirements and 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 Engineer.
- J. Systems, materials, and equipment, which will be exposed in finished areas shall be installed level and plumb, parallel and perpendicular to other building systems and components.
- K. Install electrical services and overhead equipment to provide the maximum headroom possible, where mounting heights are not detailed or dimensioned.
- L. Install electrical equipment to facilitate maintenance and repair or replacement of equipment components. Maintain code clearances in front of and about all electrical equipment. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
- M. Coordinate the installation of electrical materials and equipment above ceilings with suspension system, mechanical equipment and systems, and structural components.
- N. Include in the work all labor, materials, equipment, services, apparatus, drawings (in addition to the Contract Documents) as required to complete the intended work.
- O. Only new, clean and perfect equipment, apparatus, materials and supplies of latest design and manufacture shall be incorporated in the work in order to assure an electrical system of high quality.
- P. The work required to be done by the contractor, the utility companies and the owner, in order to obtain utility services such as telephone and electric, is delineated in these specifications and

on the drawings. Unless otherwise noted, construction or connection charges (except for temporary power) by those companies shall be paid by the Owner.

1.9 CONNECTIONS TO EQUIPMENT AND APPLIANCES

- A. In many instances the drawings show an outlet box and power supply for specific equipment, be it Owner or contractor furnished. It is to be understood, unless otherwise noted, that the work includes a connection from the box to the equipment or appliance. Verify circuit conductor quantities and sizes and overcurrent device number of poles and rating as well as any special grounding requirements, for all owner furnished equipment and adjust the required work accordingly.

1.10 CUTTING AND PATCHING

- A. General: 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.
 - d. Remove samples of installed Work as specified for testing.
 - e. Install equipment and materials in existing structures.
 - f. Cut, remove, and legally dispose of selected electrical equipment, components, and materials as indicated, including, but not limited to, removal of electrical items indicated to be removed and items made obsolete by the new Work.
 - 2. Coordinate the cutting and patching of building components to accommodate the installation of electrical equipment and materials.
 - 3. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
 - 4. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

1.11 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. Installer Qualifications: Engage an experienced Installer for the installation and application of sealers and access panels and access doors.
- C. Fire-Resistance Ratings: Where a fire-resistance classification is indicated, provide access door assembly with panel door, frame, hinge, and latch from manufacturer listed in the UL "Building Materials Directory" for rating shown.
- D. Provide UL Label on each fire-rated access door.

1.12 SEQUENCE AND SCHEDULING

- A. Coordinate the shut-off and disconnection of electrical and communication services with the Owner and the utility companies.

1.13 EQUIPMENT AND PATHWAY IDENTIFICATION

- A. As defined in Section 260553 - Identification for Electrical Systems.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 26 05 13

MEDIUM-VOLTAGE CABLES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Cables.
 - 2. Connectors.
 - 3. Solid terminations.
 - 4. Splice kits.
 - 5. Medium-voltage tapes.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of cable. Include splices and terminations for cables and cable accessories.

PART 2 - PRODUCTS

2.1 CAMP DODGE MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Cables:
 - 1. General Cable Technologies Corporation.
 - 2. Okonite Company.
 - 3. Prysmian Cables & Systems.
 - 4. Southwire Company.
- C. Cable Splicing and Terminating Products and Accessories:
 - 1. Adalet.
 - 2. DSG-Canusa;
 - 3. Engineered Products Company.
 - 4. G&W Electric Company.
 - 5. MP Husky.
 - 6. RTE Components; Cooper Power Systems, Inc.
 - 7. Thomas & Betts Corporation/Elastimold.
 - 8. 3M; Electrical Markets Division.
 - 9. Tyco Electronics; Raychem Products.

2.2 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with IEEE C2 and NFPA 70.
- C. Source Limitations: Obtain cables and accessories from single source from single manufacturer.

2.3 CABLES

- A. Cable Type: Type MV 90.
- B. Conductor Insulation: Ethylene-propylene rubber.
 - 1. Voltage Rating: 15 kV.
 - 2. Insulation Thickness: 133 percent insulation level.
- C. Conductor: Copper.
- D. Comply with UL 1072, AEIC CS8, ICEA S-93-639/NEMA WC 74, and ICEA S-97-682.
- E. Conductor Stranding: Compact round, concentric lay, Class B.
- F. Shielding: Solid copper wires, helically applied over semiconducting insulation shield.
- G. Shielding and Jacket: Corrugated copper drain wires embedded in extruded, chlorinated, polyethylene jacket.

2.4 CONNECTORS

- A. Comply with ANSI C119.4 for connectors between aluminum conductors or for connections between aluminum to copper conductors.
- B. Copper-Conductor Connectors: Copper barrel crimped connectors.

2.5 SOLID TERMINATIONS

- A. Shielded-Cable Terminations: Comply with the following classes of IEEE 48. Insulation class shall be equivalent to that of cable. Include shield ground strap for shielded cable terminations.
 - 1. Class 1 Terminations:
 - a. Modular type, furnished as a kit, with stress-relief tube; multiple, molded-silicone-rubber, insulator modules; shield ground strap; and compression-type connector.

2.6 SPLICE KITS

- A. Description: For connecting medium voltage cables; type as recommended by cable or splicing kit manufacturer for the application.
- B. Standard: Comply with IEEE 404.

- C. Splicing Products: As recommended, in writing, by splicing kit manufacturer for specific sizes, materials, ratings, and configurations of cable conductors. Include all components required for complete splice, with detailed instructions.
 - 1. Combination tape and cold-shrink-rubber sleeve kit with re-jacketing by cast-epoxy-resin encasement or other waterproof, abrasion-resistant material.
 - 2. Heat-shrink splicing kit of uniform, cross-section, polymeric construction with outer heat-shrink jacket.
 - 3. Premolded, cold-shrink-rubber, in-line splicing kit.
 - 4. Premolded, EPDM splicing body kit with cable joint sealed by interference fit of mating parts and cable.

2.7 MEDIUM-VOLTAGE TAPES

- A. Description: Electrical grade, insulating tape rated for medium voltage application.
- B. Ethylene/propylene rubber-based, 30 mil (0.76 mm) splicing tape, rated for 130 deg C operation. Minimum 3/4 inch (20 mm) wide.
- C. Silicone rubber-based, 12 mil (0.30 mm) self-fusing tape, rated for 130 deg C operation. Minimum 1-1/2 inch (38 mm) wide.

2.8 SOURCE QUALITY CONTROL

- A. Test and inspect cables according to ICEA S-97-682 before shipping.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install cables according to IEEE 576.
- B. Proof conduits prior to conductor installation by passing a wire brush mandrel and then a rubber duct swab through the conduit. Separate the wire brush and the rubber swab by 48 to 72 inch (1200 to 1800 mm) on the pull rope.
 - 1. Wire Brush Mandrel: Consists of a length of brush approximately the size of the conduit inner diameter with stiff steel bristles and an eye on each end for attaching the pull ropes. If an obstruction is felt, pull the brush back and forth repeatedly to break up the obstruction.
 - 2. Rubber Duct Swab: Consists of a series of rubber discs approximately the size of the conduit inner diameter on a length of steel cable with an eye on each end for attaching the pull ropes. Pull the rubber duct swab through the duct to extract loose debris from the duct.
- C. Pull Conductors: Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
 - 1. Where necessary, use manufacturer-approved pulling compound or lubricant that does not deteriorate conductor or insulation.
 - 2. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips, that do not damage cables and raceways. Do not use rope hitches for pulling attachment to cable.
 - 3. Use pull-in guides, cable feeders, and draw-in protectors as required to protect cables during installation.
 - 4. Do not pull cables with ends unsealed. Seal cable ends with rubber tape.
- D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

- E. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."
- F. Install "buried-cable" warning tape 12 inch (305 mm) above cables.
- G. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit; support cables at intervals adequate to prevent sag.
- H. Install sufficient cable length to remove cable ends under pulling grips. Remove length of conductor damaged during pulling.
- I. Install terminations at ends of conductors, and seal cable ends with standard kits.
- J. Install separable insulated-connector components as follows:
 - 1. Protective Cap: At each terminal junction, with one on each terminal to which no feeder is indicated to be connected.
 - 2. Portable Feed-Through Accessory: At each terminal junction, with one on each terminal.
 - 3. Standoff Insulator: At each terminal junction, with one on each terminal.
- K. Install fault indicators on each phase where indicated.
- L. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware.
- M. Identify cables according to Section 260553 "Identification for Electrical Systems." Identify phase and circuit number of each conductor at each splice, termination, pull point, and junction box. Arrange identification so that it is unnecessary to move the cable or conductor to read the identification.

3.2 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
 - 2. After installing medium-voltage cables and before electrical circuitry has been energized, test for compliance with requirements.
 - 3. Perform direct-current High Potential test of each new conductor according to NETA ATS, Ch. 7.3.3. Do not exceed cable manufacturer's recommended maximum test voltage.
 - 4. Perform Partial Discharge test of each new conductor according to NETA ATS, Ch. 7.3.3 and to test equipment manufacturer's recommendations.
 - 5. Perform Dissipation Factor test of each new conductor according to NETA ATS, Ch. 7.3.3 and to test equipment manufacturer's recommendations.
- B. Medium-voltage cables will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

END OF SECTION

SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Building wires and cables rated 1000 V and less.
 - 2. Connectors, splices, and terminations rated 1000 V and less.

1.2 ACTION SUBMITTALS

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

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
 - 2. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.
 - 3. Notify Engineer of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. Copper Conductors: Comply with NEMA WC 70/ICEA S-95-658.
- B. Conductor Insulation: Type THHN/THWN-2 and Type XHHW-2.
- C. Minimum 90 degree C insulation rating.

2.2 CONNECTORS AND SPLICES

- A. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.
- B. Wiring Connectors for Splices and Taps:
 - 1. Where a circuit passes through an outlet box and is tapped, all leads are to be pigtailed to the wiring device, including the equipment ground, to prevent loss of neutral or ground during maintenance work.
 - 2. Copper Conductors Sized #8 and larger: Use compression connectors.

- C. Wiring Connectors for Terminations:
 - 1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.
 - 2. Provide connections insulated with heat-shrink tubing for motor connections #8 AWG or larger.
- D. Do not use split bolt connectors or scotch lock type wire connectors.

2.3 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that interior of building has been protected from weather.
- B. Verify that work likely to damage wire and cable has been completed.
- C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.
- D. Verify that raceway installation is complete and supported.
- E. Verify that field measurements are as shown on the drawings.
- F. Verify that conditions are satisfactory for installation prior to starting work.

3.2 CONDUCTOR MATERIAL APPLICATIONS

- A. General: Provide wire and cable suitable for the temperature, conditions and location where installed.
- B. Feeders: Copper. Solid for No. 12 AWG and smaller; stranded for No. 8 AWG and larger.
- C. Branch Circuits: Copper. Solid for No. 12 AWG and smaller for lighting circuits and non-vibrating power utilization equipment; stranded for No. 8 AWG and larger. Provide stranded conductors, regardless of size, for connections to vibrating equipment such as motors and transformers.
- D. Conductors of AWG Number 10 and smaller for lighting circuits and non-vibrating power utilization equipment may be stranded if used with devices, lugs and connectors specifically applicable for stranded conductors. Stranded conductors are not to be used with screw head binding, such as with side wired devices. Proper back-wired or pressure devices UL listed for stranded conductor termination must be used where stranded conductors are selected.
- E. Use stranded conductors for control circuits.
- F. Use conductor not smaller than 12 AWG for power and lighting circuits.

- G. Use conductor not smaller than 14 AWG for control circuits.
- H. Use 10 AWG conductors for 20 ampere, 120 volt branch circuits longer than 75 feet (25 m).

3.3 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type XHHW-2, single conductors in raceway.
- B. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway.
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN/THWN-2, single conductors in raceway.
- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THWN-2, single conductors in raceway.
- E. Exposed Branch Circuits, Including in Crawlspace: Type THHN/THWN-2, single conductors in raceway.
- F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway.
- G. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THWN-2, single conductors in raceway.
- H. Metal Clad Cable is not permitted for use except as whip connections to light fixtures no longer than six feet (6'-0").
- I. Conductor Color Coding:
 - 1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
 - 2. Color Coding Method: Integrally colored insulation.
 - 3. Color Code:
 - a. 208Y/120 V, 3 Phase, 4 Wire System:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - 4) Neutral/Grounded: White.
 - b. Equipment Ground, All Systems: Green.
 - c. Switch legs: Pink with ends taped to match phase color.
 - d. Travelers for 3-Way and 4-Way Switching: Violet with ends taped to match phase color.

3.4 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- B. Complete raceway installation between conductor and cable termination points according to Section 26 05 33 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables. All conductors and cables to be installed in conduit unless otherwise noted.

- C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- F. Support cables according to Section 26 05 29 "Hangers and Supports for Electrical Systems."

3.5 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than un-spliced conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 150 mm (6 inches) of slack.

3.6 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 26 05 53 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

END OF SECTION

SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes grounding and bonding systems and equipment.

1.2 ACTION SUBMITTALS

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

1.3 CLOSEOUT SUBMITTALS

- A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

2.2 CONDUCTORS

- A. Insulated Conductors: Copper or tinned-copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Stranded Conductors: ASTM B 8.
 - 3. Tinned Conductors: ASTM B 33.
 - 4. Grounding Electrode Conductor: Copper, stranded cable.
 - 5. Bonding Conductor: Copper, stranded cable.
 - 6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; No. 30 gage bare copper wire.
- C. Insulated Copper Conductors:
 - 1. Equipment Grounding Conductor: Copper, green insulated.

2.3 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy.

- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions. Exothermic to be provided on all buried connections.
- D. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression -type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2.4 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel; 3/4 by 120 inches (18 by 3050 mm).

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 12 AWG and smaller, and stranded conductors for No. 10 AWG and larger unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare copper conductor, size as indicated on Drawings.
 - 1. Bury at least 24 inches (600 mm) below grade.
- C. Grounding Bus: Install where indicated on drawings.
 - 1. Install bus horizontally, on insulated spacers 2 inches (50 mm) minimum from wall, 6 inches (150 mm) above finished floor unless otherwise indicated.
- D. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
 - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
 - 4. When making ground bonding connections, apply a corrosion inhibitor to all contact surfaces. Use corrosion inhibitor appropriate for protecting a connection between the metals used.
- E. Make grounding and bonding connections using specified connectors.
 - 1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
 - 2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
 - 3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
 - 4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
 - 5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- F. Identify grounding and bonding system components in accordance with Section 26 05 53.

3.2 GROUNDING AT THE SERVICE

- A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.
- B. Metallic Piping, Building Steel, and Supplemental Electrode(s):
 - 1. Provide a grounding electrode conductor sized per NEC between the service equipment ground bus and all metallic water and gas pipe systems, building steel, and supplemental or made electrodes. Jumper insulating joints in the metallic piping. All connections to electrodes shall be made with fittings that conform to UL 467.
 - 2. Provide a supplemental ground electrode and bond to the grounding electrode system.

3.3 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements.
- B. Pad-Mounted Transformers and Switches: Install four ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install copper conductor, size indicated on drawings, for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches (150 mm) from the foundation. All buried bonding connections to be exothermically welded.

3.4 EQUIPMENT AND PATHWAY GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Conduit Systems:
 - 1. Ground all metallic conduit systems. All metallic conduit systems shall contain an equipment grounding conductor.
 - 2. Non-metallic conduit systems shall contain an equipment grounding conductor, except that non-metallic feeder conduits which carry a grounded conductor from exterior transformers to interior or building-mounted service entrance equipment need not contain an equipment grounding conductor.
 - 3. Conduit containing only a grounding conductor, and which is provided for mechanical protection of the conductor, shall be bonded to that conductor at the entrance and exit from the conduit.
- C. Boxes, Cabinets, Enclosures, and Panelboards:
 - 1. Bond the equipment grounding conductor to each pullbox, junction box, outlet box, device box, cabinets, and other enclosures through which the conductor passes (except for special grounding systems for intensive care units and other critical units shown).
 - 2. Provide lugs in each box and enclosure for equipment grounding conductor termination.
 - 3. Provide ground bars in panelboards, bolted to the housing, with sufficient lugs to terminate the equipment grounding conductors.
- D. Motors and Starters: Provide lugs in motor terminal box and starter housing or motor control center compartment to terminate equipment grounding conductors.
- E. Receptacles shall not be grounded through their mounting screws. Ground with a jumper from the receptacle green ground terminal to the device box ground screw and the branch circuit equipment grounding conductor.

- F. Ground lighting fixtures to the equipment grounding conductor of the wiring system when the green ground is provided; otherwise, ground the fixtures through the conduit systems. Fixtures connected with flexible conduit shall have a green ground wire included with the power wires from the fixture through the flexible conduit to the first outlet box.

3.5 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade unless otherwise indicated.
 - 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
- C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
 - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
 - 3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.
- D. Grounding and Bonding for Piping:
 - 1. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- E. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.
- F. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; use a minimum of 20 feet (6 m) of bare copper conductor not smaller than No. 4 AWG.
 - 1. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

3.6 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 - 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
 - 3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural

drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.

- b. Perform tests by fall-of-potential method according to IEEE 81.
- B. Grounding system will be considered defective if it does not pass tests and inspections.
- C. Report measured ground resistances that exceed the following values:
 - 1. Power Distribution Units or Panelboards Serving Electronic Equipment: 5 ohm(s).
 - 2. Manhole Grounds: 5 ohms.
- D. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

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SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Hangers and supports for electrical equipment and systems.

1.2 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 - 1. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 - 2. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 - 3. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 - 4. Channel Dimensions: Selected for applicable load criteria.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron with hot-dip galvanized finish.
- E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 - 1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

2. Mechanical-Expansion Anchors: Insert-wedge-type, carbon steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Steel Brackets: Fabricated of angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as scheduled in NECA 1, where its Table 1 lists maximum spacings less than stated in NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 1. Secure raceways and cables to these supports with two-bolt conduit clamps or single-bolt conduit clamps.
- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

- C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
1. To Wood: Fasten with lag screws or through bolts.
 2. To New Concrete: Bolt to concrete inserts.
 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 4. To Existing Concrete: Expansion anchor fasteners.
 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
 6. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
 7. To Light Steel: Sheet metal screws.
 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
- D. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

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SECTION 26 05 33

RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Metal conduits, tubing, and fittings.
 - 2. Nonmetal conduits, tubing, and fittings.
 - 3. Metal wireways and auxiliary gutters.
 - 4. Nonmetal wireways and auxiliary gutters.
 - 5. Boxes, enclosures, and cabinets.

1.2 ACTION SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for conduit, surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, exterior handholes and boxes, fabric innerduct, and cabinets.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

- A. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. IMC: Comply with ANSI C80.6 and UL 1242.
- C. PVC-Coated Steel Conduit: PVC-coated RMC or IMC as indicated.
 - 1. Comply with NEMA RN 1.
 - 2. Coating Thickness: 1 mm (0.040 inch), minimum.
- D. EMT: Comply with ANSI C80.3 and UL 797.
- E. FMC: Comply with UL 1; zinc-coated steel.
- F. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
- G. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
 - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
 - 2. Fittings for EMT:
 - a. Material: Steel.
 - b. Type: Compression or set screw.
- H. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
- I. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 1 mm (0.040 inch), with overlapping sleeves protecting threaded joints.

- J. Joint Compound for IMC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

- A. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- C. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.
- B. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- C. Wireway Covers: Hinged type unless otherwise indicated.
- D. Finish: Manufacturer's standard enamel finish.

2.4 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

- A. Listing and Labeling: Nonmetallic wireways and auxiliary gutters shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Description: Fiberglass polyester, extruded and fabricated to required size and shape, without holes or knockouts. Cover shall be gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections shall be flanged and have stainless-steel screws and oil-resistant gaskets.
- C. Description: PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.
- D. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.

2.5 BOXES, ENCLOSURES, AND CABINETS

- A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- B. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, aluminum, Type FD, with gasketed cover.

- D. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- E. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 23 kg (50 lb). Outlet boxes designed for attachment of luminaires weighing more than 23 kg (50 lb) shall be listed and marked for the maximum allowable weight.
- F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- G. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.
- H. Device Box Dimensions: 100 mm square by 60 mm deep (4 inches square by 2-1/8 inches deep).
- I. Gangable boxes are prohibited.
- J. Hinged-Cover Enclosures: Comply with UL 50 with continuous-hinge cover with flush latch unless otherwise indicated.
 - 1. NEMA 250, Type 1: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. NEMA 250, Type 4X: Corrosion resistant type 316 stainless steel with brushed finish. Seamless poured in-place gasketed cover for protection against dust and moisture.
- K. Cabinets:
 - 1. NEMA 250, Type 1: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. NEMA 250, Type 4X: Corrosion resistant type 316 stainless steel with brushed finish. Seamless poured in-place gasketed cover for protection against dust and moisture.
 - 3. Hinged door in front cover with flush latch and concealed hinge.
 - 4. Key latch to match panelboards.
 - 5. Metal barriers to separate wiring of different systems and voltage.
 - 6. Accessory feet where required for freestanding equipment.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
 - 1. Exposed Conduit: All exterior conduits shall be concealed.
 - 2. Underground Conduit: RNC.
 - 3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 - 4. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R unless otherwise noted.
- B. Indoors: Apply raceway products as specified below unless otherwise indicated:
 - 1. Exposed, Not Subject to Physical Damage or Corrosive Environment: EMT.
 - 2. Exposed and Subject to Physical Damage (ex. Mechanical Rooms): IMC.
 - 3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 - 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment).
 - a. Dry Locations: FMC.
 - b. Damp or Wet Locations: LFMC.
 - 5. Boxes and Enclosures in Dry Spaces: NEMA 250, Type 1.
- C. Minimum Raceway Size: 21-mm (3/4-inch) trade size.

- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
 - 1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 - 2. EMT: Use compression, steel fittings. Comply with NEMA FB 2.10.
 - 3. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- F. Do not install nonmetallic conduit where ambient temperature exceeds 49 deg C (120 deg F).

3.2 INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- B. Complete raceway installation before starting conductor installation.
- C. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for hangers and supports.
- D. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- E. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 300 mm (12 inches) of changes in direction.
- F. Support conduit within 300 mm (12 inches) of enclosures to which attached.
- G. Raceways Embedded in Slabs:
 - 1. Arrange raceways to keep a minimum of 50 mm (2 inches) of concrete cover in all directions.
 - 2. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
 - 3. Change from RNC to the specified conduit after rising above the floor when concealed within walls. Where rising above a floor exposed within the room the threaded coupling is to be straight, flush with floor, and aligned with adjacent conduits.
- H. Stub-ups to Above Accessible Ceilings:
 - 1. Use EMT, IMC, or RMC for raceways.
 - 2. Use a conduit bushing with insulated throat and ground lug to terminate stub-ups not terminated in hubs or in an enclosure.
- I. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- J. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.
- K. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 35mm (1-1/4-inch) trade size and insulated throat metal bushings on 41-mm (1-1/2-inch) trade size and larger conduits terminated with locknuts.

Install insulated throat metal grounding bushings on service conduits and feeder conduits from the main distribution panelboard.

- L. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- M. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- N. Cut conduit perpendicular to the length. For conduits 53-mm (2-inch) trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- O. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 90-kg (200-lb) tensile strength. Leave at least 300 mm (12 inches) of slack at each end of pull wire. Cap underground raceways designated as spare flush with grade alongside raceways in use.
- P. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.
- Q. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
 - 1. Where conduits pass from warm to cold locations, such as boundaries of the office, mechanic bay, and storage spaces.
 - 2. Where an underground service raceway enters a building or structure.
 - 3. Where otherwise required by NFPA 70.
- R. Comply with manufacturer's written instructions for solvent welding RNC and fittings.
- S. Raceways shall be held down from roof deck a minimum of 6".
- T. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 1830 mm (72 inches) of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
 - 1. Use LFMC in damp or wet locations.
- U. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
- V. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- W. Locate boxes so that cover or plate will not span different building finishes.
- X. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- Y. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

3.3 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 26 05 44 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.4 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

1.1 SUMMARY

- ## 1.2 ACTION SUBMITTALS

- ## PART 2 - PRODUCTS

- A. Shall be modular, mechanical type. General Characteristics: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable or between raceway and cable.
- B. Inter-locking synthetic rubber links shaped to continuously fill the annular space between the pipe and the wall opening.
- C. Elastomeric element shall be sized and selected per manufacturer's recommendations and have the following properties as designated by ASTM:
 - 1. Coloration shall be throughout elastomer for positive field inspection.
 - 2. Each link shall have a permanent identification of the size and manufacturer's name molded into it.
- D. Options:
 - 1. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 2. Pressure Plates: Carbon steel.
 - 3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

A. General Characteristics: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit must have plastic or rubber waterstop collar with center opening to match piping OD.

3.1 INSTALLATION OF SLEEVES FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Sleeves for Conduits Penetrating Above-Grade, Non-Fire-Rated, Concrete and Masonry-Unit Floors and Walls:
 - 1. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 2. Size pipe sleeves to provide 1/4 inch (6.4 mm) annular clear space between sleeve and raceway or cable, unless sleeve-seal system is to be installed.
 - 3. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
 - 4. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inch (50 mm) above finished floor level. Install sleeves during erection of floors.
- B. Sleeves for Conduits Penetrating Non-Fire-Rated Wall Assemblies:
 - 1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 2. Seal space outside of sleeves with approved joint compound for wall assemblies.
- C. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- D. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve-seal systems. Size sleeves to allow for 1 inch (25 mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

BBS 23067 SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING
Building M-04 Renovation & Addition 26 05 44 - 2
Camp Dodge, Johnston, Iowa

SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Electrical identification requirements.
- B. Underground line marking tape and tracer wire.
- C. Identification nameplates and labels.
- D. Wire and cable markers.
- E. Conduit markers.
- F. Warning signs and labels.

1.2 REFERENCE STANDARDS

- A. ANSI Z535.2 - American National Standard for Environmental and Facility Safety Signs; 2007.
- B. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels; 2007.
- C. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. UL 969 - Marking and Labeling Systems; Current Edition, Including All Revisions.

1.3 ACTION SUBMITTALS

- A. Product Data: Provide catalog data for nameplates, labels, and markers.
- B. 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.

PART 2 - PRODUCTS

2.1 IDENTIFICATION REQUIREMENTS

- A. Identification for Equipment:
 - 1. Use identification nameplate, labels, and markers to identify each piece of electrical distribution, control equipment and associated sections, compartments, and components.

- B. Identification for Conductors and Cables:
 - 1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26 05 19.
 - 2. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.

2.2 UNDERGROUND LINE MARKING TAPE AND TRACER WIRE

- A. Tracer Wire:
 - 1. Tracer wire: Solid, AWG #12, blue insulated, direct bury, Type TWHN.
 - 2. Underground splices: Scotchcast splicing kits, 3M Company or pre-approved equal.
- B. Marking Tape:
 - 1. Permanent, bright-colored, continuous-printed, plastic, tape compounded for direct-burial service not less than 6 inches wide by 4 mils thick.
 - 2. Tape shall have integral metallic facing or metallic core to allow locating buried tape with electronic detection equipment.
 - 3. Printed legend shall be indicative of general type of underground line below, such as "CAUTION – BURIED ELECTRIC LINE BELOW," "CAUTION - BURIED TELEPHONE LINE BELOW," etc.

2.3 NAMEPLATES

- A. Nameplates shall be laminated black phenolic resin with a white core with engraved lettering for normal power system.
- B. Nameplates shall be laminated red phenolic resin with white core with engraved lettering for emergency power system.
- C. Nameplates shall identify the following:
 - 1. Equipment ID.
 - 2. Voltage/Phase/# of Wires.
 - 3. Wire Size.
 - 4. Where the equipment is Fed From.
- D. Locations:
 - 1. All motor starters, motor controls, motor control centers, push-button stations, control panels and time switches.
 - 2. All disconnect switches including factory installed disconnects in mechanical equipment.
 - 3. Variable frequency drives, automatic transfer switches, panelboards, switchboards.
 - 4. Circuit breakers, contactors, electrical meters, surge protective devices and relays in separate enclosures.
- E. Secure Nameplates with screws or permanent adhesive.
- F. Letter Size:
 - 1. Use 1/2 inch high capital letters. Minimum font size 48.
- G. Provide nameplate at service entrance panelboard identifying the available fault current.
- H. Provide nameplate at each panelboard identifying the color code for conductors.

2.4 CIRCUIT IDENTIFICATION LABELS

- A. Labels shall identify panelboard and branch circuit breaker position for installed power wiring.
- B. Locations:
 - 1. Electrical outlet faceplates.
 - 2. Blank cover plates on gutters, pull boxes, and junction boxes.
- C. Labels: Embossed adhesive tape, with 3/16 inch black letters on clear background.

2.5 WIRE AND CABLE MARKERS

- A. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth, wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, plastic sleeve, plastic clip-on, or vinyl split sleeve type markers suitable for the conductor or cable to be identified.
- B. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.
- C. Legend: Power source and circuit number or other designation indicated.
- D. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.
- E. Minimum Text Height: 1/8 inch.
- F. Color: Black text on white background unless otherwise indicated.
- G. Description: Vinyl cloth or Nylon type self-adhesive wire markers.
- H. Locations: Each conductor at panelboard termination, gutters, pull boxes, outlet boxes, junction boxes and load connection.

2.6 CONDUIT MARKERS

- A. Minimum Size: 3/8 inch high letters.
- B. Color: Black text on white background unless otherwise indicated.
- C. Description: Vinyl cloth or Nylon type self-adhesive marker.
- D. Location:
 - 1. All conduits entering or leaving a panelboard or switchboard to be identified with the far end location.
 - 2. Furnish markers identified in Legend at 20 ft. spacing for each conduit longer than 6 feet.
- E. Legend:
 - 1. 208 Volt System: 208V.
 - 2. 120 Volt System: 120V.
 - 3. Communications: TELECOM.
 - 4. CATV System: CATV.

2.7 WARNING SIGNS AND LABELS

- A. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.

- B. Warning Signs:
 - 1. Engraved, Plastic-Laminated Labels as described in this Section.
 - 2. The letters shall be at least $\frac{3}{4}$ in. in height. Size 72 font.
 - 3. Locations:
 - a. Electrical Service Entrance: A sign shall be located at the service-entrance equipment, indicating the type and location of on-site emergency power sources/disconnects and fire pump disconnect location, if applicable.
 - 1) Sign shall be laminated yellow phenolic resin with a black core with engraved lettering.
 - 2) Descriptive text size: $\frac{1}{4}$ " high all capital letters. Minimum font size of 28.
- C. Nameplates shall be laminated black phenolic resin with a white core with engraved lettering for normal power system.
- D. Warning Labels:
 - 1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester, or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
 - 2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.
 - 3. Minimum Size: The letters shall be at least $\frac{1}{2}$ " (13 mm) in height.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean surfaces to receive adhesive products according to manufacturer's instructions.
- B. Degrease and clean surfaces to receive nameplates and labels.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
 - 1. Surface-Mounted Equipment: Enclosure front.
 - 2. Flush-Mounted Equipment: Inside of equipment door.
 - 3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
 - 4. Elevated Equipment: Legible from the floor or working platform.
 - 5. Interior Components: Legible from the point of access.
 - 6. Conductors and Cables: Legible from the point of access.
- C. Install identification products centered, level, and parallel with lines of item being identified.
- D. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.
- E. Install Nameplates, Labels, and Markers on all equipment, boxes, wire, conduit, and devices identified in Part 2 Products of this Section.

3.3 UNDERGROUND LINE MARKING TAPE AND TRACER WIRE

- A. Tracer wire shall be provided on all site utilities, including but not limited to:
 - 1. Telecommunication/copper.
 - 2. Empty conduits.
 - 3. Storm.
 - 4. Sanitary.
 - 5. Gas.
 - 6. Water.
 - 7. Geothermal.
 - 8. Exceptions:
 - a. Straight storm runs with daylight each end do not require tracer wire).
 - b. Underground electrical lines do not require tracer wire.
- B. Install tracer wire in trench attached directly to, parallel with, and centered above or below the utility.
- C. Marking Tape:
 - 1. Install 8" to 10" below grade directly above buried utilities.
- D. Demonstration:
 - 1. After all utilities have been installed but prior to substantial completion, Contractor shall demonstrate, in the presence of the Owner, continuity of all tracer wires from end to end at all underground utilities. Tracer wires which fail a continuity test shall be repaired or replaced and re-tested until a successful continuity test is achieved. Provide Owner 48 hour notice of this activity.

END OF SECTION

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SECTION 26 09 14

ELECTRICAL POWER MONITORING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Instrument transformers.
- B. Meters and meter switches and relays.

1.02 REFERENCE STANDARDS

- A. ANSI C12.1 - American National Standard Code for Electricity Metering; 2008.
- B. IEEE C12.1 - American National Standard Code for Electricity Metering; Institute of Electrical and Electronic Engineers; 1988.
- C. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.03 SUBMITTALS

- A. Product Data: Provide electrical ratings, adjustment ranges, enclosure type, outline dimensions, mounting dimensions, and terminal connection information.
- B. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

1.04 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Products: Furnish products listed and classified by Underwriters Laboratories Inc. as suitable for purpose specified and indicated.

PART 2 PRODUCTS

2.01 POWER MONITORS

- A. Manufacturers:
 - 1. Meter: Square D 9761E5560R1A, factory built enclosed meter with CPT, fuse blocks, terminals, and PM5560 power monitor.
- B. Electronic meter.
- C. Mounting height: 42" to 60" AFF.
- D. Three Phase, 4 Wire.
- E. Measurements include:
 - 1. Voltage.
 - 2. Current.
 - 3. Power.
 - 4. Energy (Watt-Hours).
 - 5. Peak power demand.
 - 6. Total harmonic distortion.
 - 7. Power factor.
 - 8. All measurements total and per phase.
 - 9. Measure current, voltage, power and energy simultaneously.
- F. Provide Ethernet communications card and Cat 6 patch cable.

- G. Provide type 12 factory assembled carbon steel enclosure with power-coat finish.

2.02 POWER MONITOR TRANSFORMERS

- A. Provide metering transformers compatible with monitor.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- A. Install Cat 6 patch cable from meter to data jack in equipment rack.
- B. Provide Digi-Key Lockable Wing Knob Cam Latch, Part No. RPC2357-ND. Replace standard cam with lockable cam.

END OF SECTION

SECTION 26 09 23

LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Digital-Network lighting controls.
 - a. Local room controller.
 - b. Digital indoor occupancy sensors.
 - c. Digital switches.
 - d. Digital dimmers.
 - 2. Standard indoor occupancy sensors.
 - 3. Time Switches.
 - 4. Outdoor photoelectric switches.
 - 5. Device Finishes.
 - 6. Cables and conductors.

1.2 RELATED SECTIONS

- A. Section 26 05 19 – Low-voltage Electrical Power Conductors and Cables.
- B. Section 26 05 53 – Identification for Electrical Systems.
- C. Section 26 27 26 – Wiring Devices.
- D. Section 26 51 00 – Interior Lighting.
- E. Section 27 15 00 – Communications Horizontal Cabling.

1.3 REFERENCES

- A. NFPA 70 - National Electrical Code; National Fire Protection Association.
- B. NEMA - National Electrical Manufacturers Association.
- C. FCC emission standards.
- D. UL 2043 - Standard for Fire Test for Heat and Visible Smoke Release for Discrete Products Installed in Air-Handling Spaces.
- E. UL 20 - General Use Switches.
- F. UL 924 - Standard for Emergency Lighting and Power Equipment.

1.4 DESIGN / PERFORMANCE REQUIREMENTS

- A. System shall conform to requirements of NFPA 70.

- B. System shall comply with FCC emission standards specified in part 15, sub-part J for commercial and residential application.
- C. System shall be listed under UL sections 916 and/or 508.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product provide the following. Provide mark-ups to product data to indicate the specific model and accessories for each device.
 - 1. Physical dimensions.
 - 2. Material and color.
 - 3. Wiring connections.
 - 4. Adjustable settings.
 - 5. Rated ampacity.
 - 6. Rated temperature and humidity.
 - 7. Occupancy sensor coverage patterns with dimensions for each technology (PIR, ultrasonic, microphonic).
 - 8. Installation details. Include recommended mounting locations for sensors.
 - 9. Where multiple models are listed on data sheets, indicate the model and all applicable options/accessories.
- B. Shop Drawings:
 - 1. Bill of Materials.
 - 2. Floor plans indicating the location of each device.
 - a. Where manufacturer's recommended location differs from the drawings, note on floor plans.
 - b. Where devices are connected to a main controller in a daisy-chained configuration indicate the manufacturer's recommended circuiting path on floor plans to stay within the manufacturer's maximum length and connected load tolerances.
 - 3. Manufacturer specific wiring diagrams for each wiring diagram shown on the lighting drawings. Indicate the following in each diagram:
 - a. Device description or model number.
 - b. All Terminations.
 - 1) Include conductors not used to be capped.
 - c. Wire and cable types.
 - 1) Insulation colors where pigtails are provided on devices.
 - 2) Distance limitations.

1.6 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual installed locations, settings, and addresses for lighting control devices.
- B. Operation and Maintenance Manual:
 - 1. Include approved Shop Drawings and Product Data.
 - 2. Include Sequence of Operation, identifying operation for each room or space.
 - 3. Include manufacturer's maintenance information.
 - 4. Operation and Maintenance Data: Include detailed information on device programming and setup.
 - 5. Include startup and test reports.

1.7 QUALITY ASSURANCE

- A. System Components: Demonstrate that individual components have undergone quality control and testing prior to shipping.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Store products in a clean, dry space in original manufacturer's packaging in accordance with manufacturer's written instructions until ready for installation.

1.9 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.
- B. Do not install equipment until following conditions can be maintained in spaces to receive equipment:
 - 1. Ambient temperature: 32 to 104 degrees F (0 to 40 degrees C).
 - 2. Relative humidity: Maximum 90 percent, non-condensing.

1.10 WARRANTY

- A. Manufacturer shall provide a 5 year limited warranty on products within this installation, except where otherwise noted, and consisting of a one for one device replacement.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Approved Manufacturers:
 - 1. Legrand Wattstopper.
 - 2. Crestron.
 - 3. Hubbell.
- B. All control devices shall be supplied by the same manufacturer.
 - 1. Exceptions:
 - a. Astronomical Time Clock.

2.2 ROOM CONTROLLERS:

- A. All Room Controllers:
 - 1. Shall automatically bind the room's circuited lighting loads to the connected digital switches and sensors in the space without commissioning or the use of any tools.
 - 2. Room Controllers connected to the digital-network in star topology shall be provided with a minimum of two RJ-45 ports for connection to switches and sensors.
 - 3. Room Controllers connected to the digital-network in point-to-point topology shall be provided with a minimum of three RJ-45 ports for connection to switches, sensors, and other room controllers.
 - 4. Shall restore itself to one of the following configurable states upon power up following the loss of normal power:
 - a. On to 100%.

- b. Remain off.
 - c. Turn on to last level. (Dimmable controllers only).
 - 5. Each load controlled by occupancy sensor shall be configurable to operate in:
 - a. Auto-on/Auto-off.
 - b. Manual-on/Auto-off.
 - 6. Each load shall have an independently configurable preset time to switch on for Normal Hours and off for After Hours. Switches operated during the After Hours period shall allow lights to turn on for configurable duration before automatically turning off.
 - 7. UL 2043 plenum rated.
 - 8. Manual override and LED indication for each load.
 - 9. Dual voltage 120/277 volt models rated for 10A or 16A total load.
 - 10. Zero cross relay switching for each load.
 - 11. All digital parameter data programmed into an individual room controller or plug load controller shall be retained in non-volatile FLASH memory within the controller itself. Memory shall have an expected life of no less than 10 years.
- B. On/Off/Dimming Room Controllers shall also include:
- 1. One dimming output per relay.
 - a. Each dimming output channel shall have an independently configurable minimum and maximum calibration trim level to set the dimming range to match the true dynamic range of the connected ballast or driver.
 - b. Each dimming output shall have an independently configurable preset on level for Normal Hours and After Hours events to allow different dimmed levels to be established at the start of both Normal Hours and After Hours events.
 - 2. Fade rates for dimming loads shall be specific to bound switch buttons, and the load shall maintain a default value for any bound buttons that do not specify a unique value.
 - 3. Each dimming output shall have the capability to change the following attributes:
 - a. Set preset level for each load from 0-100%.
 - b. Set high and low trim for each load.
 - 4. Override button for each load provides the following functions:
 - a. Press and release for on/off control.
 - b. Press and hold for dimming control.

2.3 DIGITAL OCCUPANCY SENSORS

- A. Wall or ceiling mounted (to suit installation) passive infrared (PIR), ultrasonic or dual technology digital (PIR and ultrasonic or PIR and microphonic) occupancy sensor. See lighting control schedule on drawings for additional information.
- B. Digital Occupancy Sensors shall provide graphic LCD display for digital calibration and electronic documentation. Features include the following:
 - 1. Digital calibration and pushbutton configuration for the following variables:
 - a. Sensitivity – 0-100% in 10% increments.
 - b. Time delay – 1-30 minutes in 1 minute increments.
 - c. Test mode – Five second time delay.
 - d. Detection technology – PIR, Ultrasonic or Dual Technology activation and/or re-activation.
 - e. Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are included in the digital lighting network.
 - 2. Programmable control functionality including:
 - a. Each sensor may be programmed to control specific loads within a local network.
 - b. Adjustable retrigger time period for manual-on loads. Load will retrigger (turn on) automatically within a configurable period of time after turning off.

2.4 DIGITAL WALL SWITCHES

- A. Low voltage momentary pushbutton switches in 1, 2, 3, 4, and 5 button configurations. Wall switches shall include the following features:
 - 1. Removable buttons for field replacement with engraved buttons and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.
- B. Each switch shall have two RJ-45 ports for connection to other sensors or switches in point-to-point topology.
- C. Each switch shall have the capability to change the following attributes:
 - 1. Each button may be programmed to function as:
 - a. Toggle for individual or multi-load control.
 - b. On-Only for individual or multi-load control.
 - c. Off-Only for individual or multi-load control.
 - d. Scene selector, where any load connected to the digital-network is set to a programmed on, off, or dimmed state.
 - 2. Fade Up and Fade Down times for individual scenes may be adjusted from 0 seconds to a minimum of 15 seconds.
 - 3. Switch buttons may be bound to any load on a room controller and are not load type dependent; each button may be bound to multiple loads.

2.5 DIGITAL WALL DIMMER SWITCHES

- A. Low voltage momentary pushbutton switch for on, off, and dimming control:
 - 1. Removable buttons for field replacement with engraved buttons and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.

2.6 INDOOR OCCUPANCY SENSORS

- A. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensors with a separate power pack.
- B. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 1. Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 20 minutes.
 - 2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.
 - 3. Power Pack: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
 - 4. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Relay: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
- C. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
 - 1. Bypass Switch: Override the "on" function in case of sensor failure.

2.7 POWER PACKS:

- A. Description: Plenum rated, self-contained low voltage class 2 transformer and relay compatible with specified low voltage occupancy sensors for switching of line voltage loads.
- B. Provide quantity and configuration of power and slave packs with all associated wiring and accessories as required to control the load indicated on the drawings.
- C. Input Supply Voltage: Dual rated for 120/277 V ac.
- D. Load Rating: As required to control the load indicated on the drawings.

2.8 TIME SWITCHES

- A. Electronic Time Switches: Solid state, programmable, with alphanumeric display; complying with UL 917.
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Contact Configuration: SPST.
 - 3. Contact Rating: 20A, 120VAC.
 - 4. Programs: Two on-off set points on a 24-hour schedule, allowing different set points for each day of the week.
 - 5. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program.
 - 6. Astronomic Time: All channels.
 - 7. Automatic daylight savings time changeover.
 - 8. Battery Backup: Not less than seven days reserve, to maintain schedules and time clock.

2.9 OUTDOOR PHOTOELECTRIC SWITCHES

- A. Description: Solid state, with SPST dry contacts rated for 120VAC, 20A, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.
- B. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 1. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lux), with an adjustment for turn-on and turn-off levels within that range and a directional lens in front of the photocell to prevent fixed light sources from causing turn-off.
 - 2. Time Delay: Fifteen second minimum, to prevent false operation.
 - 3. Mounting: Stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

2.10 EMERGENCY BYPASS RELAY DEVICES

- A. Emergency Bypass Relay - A UL 924 listed device that monitors a switched circuit providing normal lighting to an area. The unit provides normal ON/OFF control of emergency lighting along with the normal lighting. Upon normal power failure the emergency lighting circuit will close, forcing the emergency lighting ON until normal power is restored. Features include:
 - 1. 120/277 volts, 50/60 Hz, 20 amp ballast rating.

2. Push to test button.
 3. Auxiliary contact for remote test or fire alarm system interface.
- B. Emergency Bypass Relay with 0-10V Dimming – Similar to Emergency Bypass Relay above, but with the added feature of providing 0-10V dimming signal control with normal power lighting in addition to ON/OFF control. Upon normal power failure relays for the emergency lighting circuit and the 0-10V circuit will close forcing the emergency lighting ON to 100% output.

2.11 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 24 AWG. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" and 27 15 00 "Communications Horizontal Cabling."
1. Provide all low voltage cables associated with the lighting control system with a green insulating jacket.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Do not begin installation until measurements have been verified and work areas have been properly prepared.
- B. Verify that required pre-installation meeting specified in Part 1 of this specification has been completed.

3.2 GENERAL INSTALLATION

- A. Install system in accordance with the approved system shop drawings and manufacturer's instructions.
- B. Install all room/area devices using manufacturer's factory-tested Cat 5e cable with pre-terminated RJ-45 connectors.
1. If pre-terminated cable is not used for room/area wiring, each field-terminated cable shall be tested following installation and testing results submitted to the Manufacturer's Representative for approval prior to proceeding with the Work.
 2. Install all room to room network devices using manufacturer-supplied LM-MSTP network wire. Network wire substitution is not permitted and may result in loss of product warranty.
 3. Low voltage wiring topology must comply with manufacturer's specifications.
 4. Route network wiring as indicated on the Drawings as closely as possible. Document final wiring location, routing and topology on as built drawings.
- C. All line voltage connections shall be tagged to indicate circuit and switched legs.
- D. Test all devices to ensure proper communication.

- E. Calibrate all sensor time delays and sensitivity to guarantee proper detection of occupants and energy savings. Adjust time delay so that controlled area remains lighted while occupied.
- F. Provide written or computer-generated documentation on the configuration of the system including room by room description including:
 - 1. Sensor parameters, time delays, sensitivities, and daylighting setpoints.
 - 2. Sequence of operation, (e.g. manual ON, Auto OFF. etc.).
 - 3. Load Parameters (e.g. blink warning, etc.).
- G. Post start-up tuning - Adjust sensor time delays and sensitivities to meet the Owner's requirements 30 days from beneficial occupancy. Provide a detailed report to the Architect / Owner of post start-up activity.
- H. Tighten all panel Class I conductors from both circuit breaker and to loads to torque ratings as marked on enclosure UL label.
- I. All Class II cabling shall enter enclosures from within low-voltage wiring areas and shall remain within those areas. No Class I conductors shall enter a low-voltage area.
- J. Run separate neutrals for any phase dimmed branch load circuit. Different types of dimming loads shall have separate neutral.
- K. Verify all non-panel-based lighting loads to be free from short circuits prior to connection to room controllers.
- L. Remote Access for Network Systems: Ensure Segment Manager enclosure is installed in a location with good to excellent cellular phone coverage based on building orientation and geographic location, and mount magnetic antenna for the modem. For cases where alternate mounting locations are not available and a stronger cellular signal is needed, the manufacturer shall offer additional antenna options to improve signal quality. Verify final mounting location with Engineer and Owner prior to proceeding with the Work.

3.3 SENSOR INSTALLATION

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
- B. Aim photoelectric sensors according to manufacturer's recommendations. Locate sensor free of obstructions (ex. trees, signage).
- C. Set photoelectric sensors serving exterior lights for 1 footcandle turn-on.
- D. Locate daylight sensors from windows and/or skylights according to the manufacturer's recommendation. Measure light levels at the work-surface (30 inches above finished floor) with electric light only (no daylight contribution) and set daylight sensors to maintain that light level in the space.
- E. Install and aim occupancy sensors in locations to achieve not less than 90 percent coverage of major motion areas. Locate sensors near areas of minor motion (ex. desks, classroom seating, toilet partitions) taking into consideration blind spots from columns, furniture, or other obstructions. Do not exceed coverage limits specified in manufacturer's written instructions.

- F. Install and aim occupancy sensors that are auto-on to prevent “false-on” activity from motion outside of the lighting control zone.
- G. Do not install ultrasonic or microphonic occupancy sensors within two feet of a HVAC supply, return or exhaust diffuser.
- H. All occupancy sensors shall be set to manual on, automatic off except in restrooms.

3.4 WIRING INSTALLATION

- A. Wiring Method: Comply with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- C. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.5 FINISHES

- A. Provide recessed wall mounted device finishes and cover plates according to Section 26 27 26 “Wiring Devices”.
- B. Provide corner mount occupancy sensors with white finish.
- C. Provide all ceiling mount devices with white finish.

3.6 IDENTIFICATION

- A. Identify components and power and control wiring according to Section 26 05 53 "Identification for Electrical Systems."
 - 1. Identify controlled circuits in lighting control panels by their zone description; include location and fixture type. Ensure description is unique and distinguishable from other labels. (Ex. “East Parking Lot Light Fixture” or “West Exterior Canopy Downlights”).
 - 2. Identify luminaires controlled by photoelectric and occupancy sensors at each sensor.

3.7 FIELD QUALITY CONTROL

- A. Field Service: Engage a third-party service to test and inspect components, assemblies, and equipment installations.
- B. Operational Test: After installing sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
 - 1. Test that emergency egress lighting for automatically turns on in the event of a normal power failure and remains on for a minimum of 90 minutes.
 - 2. Test that failure of a photoelectric turns the controlled light fixtures on.
 - 3. Test dimming controls over full dimmable range.
 - 4. Test occupancy sensors for proper operation:
 - a. Test duration-on.

- b. Test sensor coverage. Use small hand movements to detect minor motion coverage around workstations.
 - c. Test that auto-on sensor immediately turn-on when entering the controlled zone and do not turn-on in adjacent areas outside of the controlled zone.
 - d. Test that auto-off sensor turns-off while laundry machines are operating, but space is unoccupied.
- C. Document all tests in report as pass or fail. Organize report first by floor, then by room name and number, followed by the tested sensor. Submit report according to the "Informational Submittal" requirements.
- D. Lighting control devices will be considered defective if they do not pass tests and inspections.

3.8 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide two visits to Project during other-than-normal occupancy hours for this purpose.

3.9 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION

PAD-MOUNTED, LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS

1.1 SUMMARY

- ## 1.2 DEFINITIONS

- ### 1.3 ACTION SUBMITTALS

- [illegible]

2.5 SOURCE QUALITY CONTROL

- A. Testing Administrant: Engage qualified electrical testing agency to evaluate transformer.
- B. Testing: Test and inspect transformer in accordance with IEEE C57.12.90.
- C. Factory Tests and Inspections: Perform the following tests and inspections, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, before delivering to site. Affix label with name and date of manufacturer's certification of system compliance on control units.
 - 1. Resistance.
 - 2. Turns ratio, polarity, and phase relation.
 - 3. Transformer no-load losses and excitation current at 100 percent of ratings.
 - 4. Transformer impedance voltage and load loss.
 - 5. Operation of devices.
 - 6. Lightning impulse.
 - 7. Low frequency.
 - 8. Leak.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine pad-mounted, liquid-filled, medium-voltage transformers upon delivery.
1. Upon delivery of transformers and prior to unloading, inspect equipment for damage that may have occurred during shipment or storage.
 2. Verify that tie rods and chains are undamaged and tight, and that blocking and bracing is tight. Verify that there is no evidence of load shifting in transit, and that readings from transportation shock recorders, if equipped, are within manufacturer's recommendations.
 3. Verify that there is no indication of external damage and no dents or scratches in doors and sill, tank walls, radiators and fins, or termination provisions.
 4. Verify that there is no evidence of insulating-liquid leakage on transformer surfaces, at weld seams, on line- or load-side bushing parts, and at transformer base.
 5. Verify that there is positive pressure or vacuum on tank. Check pressure gauge; it is required to read other than zero.
 6. Compare transformers and accessories received with bill of materials to verify that shipment is complete. Verify that transformers and accessories conform with manufacturer's quotation and shop drawings. If shipment is incomplete or does not comply with Project requirements, notify manufacturer in writing immediately.
 7. Verify presence of polychlorinated biphenyl content labeling.
 8. Unload transformers carefully, observing packing label warnings and handling instructions.
 9. Open termination compartment doors and inspect components for damage or displaced parts, loose or broken connections, cracked or chipped insulators, bent mounting flanges, dirt or foreign material, and water or moisture.
- B. Handling:
1. Handle transformers carefully, in accordance with manufacturer recommendations, to avoid damage to enclosure, termination compartments, base, frame, tank, and internal components. Do not subject transformers to impact, jolting, jarring, or rough handling.
 2. Protect transformer termination compartments against entrance of dust, rain, and snow.
 3. Transport transformers upright, to avoid internal stresses on core and coil mounting assembly and to prevent trapping air in windings. Do not tilt or tip transformers.
 4. Verify that transformer weights are within rated capacity of handling equipment.

- C. Storage:

- D. Examine areas and space conditions for compliance with requirements for pad-mounted, liquid-filled, medium-voltage transformers and other conditions affecting performance of the Work.

1. Wiring entries comply with layout requirements.
2. Entries are within conduit-entry tolerances specified by manufacturer, and no feeders will cross section barriers to reach load or line lugs.

1. Verify removal of shipping bracing after placement.
2. Remove sample of insulating liquid in accordance with ASTM D923. Insulating-liquid values must comply with NETA ATS, Table 100.4. Sample must be tested for the following:
 - a. Dielectric Breakdown Voltage: ASTM D877 or ASTM D1816.
 - b. Acid Neutralization Number: ASTM D974.
 - c. Interfacial Tension: ASTM D971.
 - d. Color: ASTM D1500.
 - e. Visual Condition: ASTM D1524.

- I. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install transformers on cast-in-place concrete equipment base(s). Transformer must be installed level and plumb and must tilt less than 1.5 degrees while energized.
- B. Maintain minimum clearances and workspace at equipment in accordance with manufacturer's published instructions and IEEE C2.

3.3 CONNECTIONS

- A. Ground equipment in accordance with Section 26 05 26 "Grounding and Bonding for Electrical Systems."
 - 1. For counterpoise, use tinned bare copper cable not smaller than 4/0 AWG, buried not less than 30 inch (765 mm) below grade interconnecting grounding electrodes. Bond surge arrester and neutrals directly to transformer enclosure and then to grounding electrode system with bare copper conductors, sized as shown. Keep lead lengths as short as practicable, with no kinks or sharp bends.
 - 2. Make joints in grounding conductors and loops by exothermic weld or compression connector.
 - 3. Terminate grounding and bonding conductors on common equipment grounding terminal on transformer enclosure.
 - 4. Complete transformer tank grounding and lightning arrester connections prior to making other electrical connections.
- B. Connect wiring in accordance with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
 - 1. Maintain air clearances between energized live parts and between live parts and ground for exposed connections in accordance with manufacturer recommendations.
 - 2. Bundle associated phase, neutral, and equipment grounding conductors together within transformer enclosure. Arrange conductors such that there is not excessive strain that could cause loose connections. Allow adequate slack for expansion and contraction of conductors.
- C. Terminate medium-voltage cables in incoming section of transformers in accordance with Section 26 05 13 "Medium-Voltage Cables."

3.4 SIGNS AND LABELS

- A. Comply with installation requirements for labels and signs specified in Section 26 05 53 "Identification for Electrical Systems."
- B. Install warning signs as required to comply with 29 CFR 1910.269.
- C. Identification labels to match existing installations.

3.5 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. General Field-Testing Requirements:
 - a. Comply with provisions of "Testing and Test Methods" Chapter in NFPA 70B.
 - b. Perform visual and mechanical inspections and electrical tests. Certify compliance with test parameters.

- END OF SECTION**

SECTION 26 24 16

PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Lighting and appliance branch-circuit panelboards.

1.2 DEFINITIONS

A. MCCB: Molded-case circuit breaker.

B. LTPU: Long-Time Pick-Up.

C. LTD: Long-Time Delay.

D. STPU: Short-Time Pick-Up.

E. STD: Short-Time Delay.

F. INST: Instantaneous Pick-Up.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of panelboard.

1. Include materials, switching and overcurrent protective devices, accessories, and components indicated.
2. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details.
2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
4. Detail bus configuration, current, and voltage ratings.
5. Short-circuit current rating of panelboards and overcurrent protective devices.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. Include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Keys: Two spares for each type of panelboard cabinet lock.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: ISO 9001 or 9002 certified.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.
- B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.8 FIELD CONDITIONS

- A. Environmental Limitations:
 - 1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
 - 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding 23 deg F (minus 5 deg C) to plus 104 deg F (plus 40 deg C).
 - b. Altitude: Not exceeding 6600 feet (2000 m).

1.9 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.
 - 1. Panelboard Warranty Period: 12 months from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide the products by the following:
 - 1. Square D Company.

2.2 PANELBOARDS COMMON REQUIREMENTS

- A. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA PB 1.
- D. Comply with NFPA 70.
- E. Enclosures: Surface-mounted, dead-front cabinets.
 - 1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - b. Outdoor or Damp or Wet Interior Locations: NEMA 250, Type 3R.
 - c. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
 - 2. Height: 84 inches (2.13 m) maximum.
 - 3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
 - 4. Finishes:
 - a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - b. Back Boxes: Same finish as panels and trim.
- F. Incoming Mains:
 - 1. Location: Convertible between top and bottom.
 - 2. Main Breaker: Main lug interiors up to 400 amperes shall be field convertible to main breaker.
- G. Phase, Neutral, and Ground Buses:
 - 1. Material: Hard-drawn copper, 98 percent conductivity.
 - a. Plating shall run entire length of bus.
 - b. Bus shall be fully rated the entire length.
 - c. Neutral bus to be rated at 100 percent of the main bus rating.
 - 2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.
 - a. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box. Equipment ground bus shall be large enough and have sufficient quantity and sizes of terminations to allow for termination of panelboard feeder plus one equipment grounding conductor per circuit, based on the maximum number of branch circuit protective devices allowed in the panelboard plus 6 additional conductors.
 - b. Ground bus to be rated minimum 25% per cent of the main bus rating.
 - 3. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.
- H. Conductor Connectors: Suitable for use with conductor material and sizes.
 - 1. Material: Hard-drawn copper, 98 percent conductivity.
 - 2. Terminations shall allow use of 75 deg C rated conductors without derating.

3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
 4. Main and Neutral Lugs: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.
 5. Ground Lugs and Bus-Configured Terminators: Mechanical type, with a lug on the bar for each pole in the panelboard.
 6. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
- I. Future Devices: Panelboards shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices as identified on schedules.
 - J. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity. Reference one-line drawing for available fault current at each panelboard. Provide overcurrent protection devices with minimum kAIC rating at 110% of available short circuit current.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- B. Mains: As identified on schedules.
- C. Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
 1. Provide electronic breakers with adjustable LTPU, LTD, STPU, STD, and INST trip settings for all breaker frames 225A or greater.
 2. Provide thermal magnetic breakers less than 225A.
 3. Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 150 A and larger.
 4. Standard frame sizes, trip ratings, and number of poles.
 - a. Lugs: Mechanical style, suitable for number, size, trip ratings, and material of conductors.
 5. Box: Box shall be nominally 5-3/4 inches deep by 20 inches wide.
 6. Circuit Numbering: Provide factory fabricated circuit numbers adjacent to each circuit breaker pole position. Numbering shall be continuous from top most pole position to last possible pole position. Number sequence on left shall be 1-3-5-7, etc., and number sequence on right shall be 2-4-6-8. etc. Numbering material shall be insert or strip type, as manufactured by the panelboard manufacturer for the specific panelboard. Adhesive markers and pen type markers are not acceptable.
- D. Doors: Door-in-door construction with concealed hinges; secured with multipoint latch with tumbler lock; keyed alike. Outer door shall permit full access to the panel interior. Inner door shall permit access to breaker operating handles and labeling, but current carrying terminals and bus shall remain concealed.

2.4 IDENTIFICATION

- A. Panelboard Label:

1. Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.
 2. Refer to Division 26 Section "Identification for Electrical Systems."
- B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.
- C. Circuit Directory: Computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.
1. Circuit directory shall identify the type and load for each circuit as shown on panelboard schedule.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.
- B. Receive, inspect, handle, and store panelboards according to NECA 407.
- C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.
- D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Comply with NECA 1.
- C. Install panelboards and accessories according to NECA 407.
- D. Equipment Mounting:
1. Attach panelboard to the vertical finished or structural surface behind the panelboard.
- E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- F. Mount top of trim 84 inches above finished floor unless otherwise indicated.
- G. Mount panelboard cabinet plumb and rigid without distortion of box.

- H. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- I. Mount surface-mounted panelboards to steel slotted supports 5/8 inch (16 mm) in depth. Orient steel slotted supports vertically.
- J. Install overcurrent protective devices and controllers not already factory installed.
 - 1. Set field-adjustable, circuit-breaker trip ranges.
 - 2. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.
- K. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.
- L. Install filler plates in unused spaces.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 26 05 53 "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."
- E. Install warning signs complying with requirements in Section 26 05 53 "Identification for Electrical Systems" identifying source of remote circuit.

3.4 ADJUSTING

- A. Set field-adjustable circuit-breaker trip ranges as indicated.

3.5 PROTECTION

- A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION

SECTION 26 27 26

WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Receptacles, receptacles with integral GFCI, and associated device plates.
 - 2. Weather-resistant receptacles.
 - 3. Cord and plug sets.

1.2 DEFINITIONS

- A. GFCI: Ground-fault circuit interrupter.
- B. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

1.3 ACTION SUBMITTALS

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

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide the products by the following:
 - 1. Hubbell Incorporated.
 - 2. Cooper Wiring Devices.
 - 3. Leviton Manufacturing Inc.
 - 4. Pass and Seymour.
- B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. Color: Gray except as otherwise indicated or required.

2.3 STRAIGHT-BLADE RECEPTACLES

- A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6, UL 498, and FS W-C-596.
 - 1. Configuration: 5-20R unless noted otherwise on drawings.

2.4 GFCI RECEPTACLES

- A. General Description:
 - 1. Straight blade, non-feed-through type.
 - 2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
 - 3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.
- B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

2.5 WALL PLATES

- A. Single and combination types shall match corresponding wiring devices.
 - 1. Plate-Securing Screws: Metal with head color to match plate finish.
 - 2. Material for Recessed Devices: Type 302 Stainless steel with matte finish.
 - 3. Material for Surface Devices: Galvanized steel.
 - 4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for while-in-use in wet and damp locations.
- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with powder coat finish. Rated for while-in-use with the cover closed. Verify finish with architect.

2.6 FINISHES

- A. Device Color:
 - 1. Wiring Devices Connected to Normal Power System: Gray unless otherwise indicated on drawings or required by NFPA 70.

2.7 IDENTIFICATION

- A. Label the front face of each receptacle with the panelboard name and circuit ID with ½" wide clear tape and type written black lettering.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.
- B. Coordination with Other Trades:
 - 1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.

2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:
 - a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtail existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the left.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

H. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

- A. Install separate non-feed-through-type GFCI receptacles at each GFCI outlet location identified on Drawings.

3.3 IDENTIFICATION

- A. Comply with Section 26 05 53 "Identification for Electrical Systems."

END OF SECTION

SECTION 26 51 00
INTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Interior lighting fixtures.
 - 2. Exit signs.
 - 3. Lighting fixture supports.

1.2 DEFINITIONS

- A. CC: Constant Current Dimming Technology.
- B. CCT: Correlated color temperature.
- C. CRI: Color-rendering index.
- D. LER: Luminaire efficacy rating.
- E. Lumen: Measured output of lamp and luminaire, or both.
- F. Luminaire: Complete lighting fixture, including ballast housing if provided.
- G. PWM: Pulse Width Modulation Dimming Technology.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
 - 1. Physical description:
 - a. Dimensions.
 - b. Materials and thicknesses.
 - 2. Electrical Characteristics:
 - a. Voltage.
 - b. Power Consumption.
 - c. Power Factor.
 - d. Efficacy.
 - e. Surge Protection.
 - 3. Light Characteristics:
 - a. CCT.
 - b. CRI.
 - c. LED Chip Manufacturer and Model.
 - d. Rated Life (L70, L80, or L90).
 - e. Lumen Output (Absolute).
 - f. Distribution (Candela Plot).

- 4. Driver Characteristics:
 - a. Voltage.
 - b. Dimming Technology (PWM, CC, or other).
 - c. Minimum dimmable output.
 - d. Rated Life.
 - B. Shop Drawings: For nonstandard or custom lighting fixtures. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Wiring Diagrams: For power, signal, and control wiring.
 - C. Installation instructions.
- 1.4 **INFORMATIONAL SUBMITTALS**
- A. Warranty: Sample of special warranty.
- 1.5 **CLOSEOUT SUBMITTALS**
- A. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.
 - 1. Provide a list of all lamp types or light engines used on Project; use ANSI and manufacturers' codes.
 - 2. Provide a list of all drivers used on Project.
 - 3. Provide instructions for accessing lamps, light engines, and drivers in each fixture.
- 1.6 **COORDINATION**
- A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide product indicated on Drawings.

2.2 PRODUCT REQUIREMENTS

- A. Each light fixture type shall maintain the same design construction and utilize the same LED chipset / light engine through-out the duration of the multi-phase project. Chipsets shall have equal color temperature and light output tolerances to ensure light fixtures installed in different phases of the project have an equal appearance.

2.3 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

- A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
- B. Metal Parts: Free of burrs and sharp corners and edges.

- C. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.
- D. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- E. Diffusers and Globes:
 - 1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
- F. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and drivers. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
 - 1. Label shall include the following lamp and ballast characteristics:
 - a. "USE ONLY" and include specific lamp type.
 - b. CCT and CRI for all luminaires.

2.4 EXIT SIGNS

- A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
 - 1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Lighting fixtures:
 - 1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.
 - 2. Install lamps in each luminaire.
- B. Temporary Lighting: If it is necessary, and approved by Architect, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps, and reinstall.
- C. Lay-in Ceiling Lighting Fixtures Supports: Use grid as a support element.
 - 1. Install ceiling support system rods or wires, independent of the ceiling suspension devices, for each fixture. Locate not more than 6 inches (150 mm) from lighting fixture corners.
 - 2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
 - 3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch (20-mm) metal channels spanning and secured to ceiling tees.

D. Suspended Lighting Fixture Support:

1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
4. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.

E. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.2 IDENTIFICATION

- A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.3 FIELD QUALITY CONTROL

- A. Verify that self-luminous exit signs are installed according to their listing and the requirements in NFPA 101.
- B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION

SECTION 27 00 00
COMMUNICATIONS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Fiber Optic Cables.
- B. Horizontal Station Cables.
- C. Coaxial Cables.
- D. Fiber Patch Panels.
- E. Copper Patch Panels.
- F. 110 Blocks.
- G. Information Outlets.
- H. Equipment Rack.
- I. Duct Plugs.

1.2 RELATED SECTIONS

- A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- B. Section 26 05 33 - Raceway and Boxes for Electrical Systems.

1.3 REFERENCES

- A. NFPA 70 - National Electric Code.
- B. TIA-568.1-D - Commercial Building Telecommunications Cabling Standard.
- C. TIA-568.2-D - Balanced Twisted-Pair Telecommunications Cabling and Components Standard.
- D. TIA-568.3-D – Optical Fiber Cabling Components Standard.
- E. TIA-569-D - Commercial Building Standard for Telecommunications Pathways and Spaces.
- F. TIA-606-C - Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.
- G. TIA-607-C - Commercial Building Grounding and Bonding Requirements for Telecommunications.

- H. BICSI Telecommunications Distribution Methods Manual.
- I. Iowa Army National Guard Telecommunications Cabling Template and Technical Specifications – current edition.

1.4 SYSTEM DESCRIPTION

- A. Underwriters Laboratory (UL) listed cables, patch panels, and information outlets to form “total solution” wiring systems.
- B. Cable and raceway systems.

1.5 SUBMITTALS FOR REVIEW

- A. Product Data: For equipment and systems components.
 - 1. Include “total solution” documentation.
- B. Additional information: Provide training and certification documentation for installers as indicated.

1.6 SUBMITTALS AT PROJECT CLOSEOUT

- A. Project Record Documents:
 - 1. Maintain documents at site during construction and submit at Contract Closeout.
 - 2. Contractor shall prepare two copies of the as-built floor plans that show locations of each wall information jack by room #, by jack #.
 - 3. Provide test documentation in accordance with Field Quality Control requirements.
- B. Operation and Maintenance Data: Include manufacturers' descriptive literature, operating instructions, and maintenance and repair data.

1.7 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70.
- B. Products: Labeled or listed and classified by Underwriters Laboratories, Inc., or other testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.8 WARRANTY

- A. Installer is to have manufacturer certification to install the system being proposed. The contractor awarded the cabling contract will provide written proof documenting this certification prior to the cabling being installed and terminated. The warranty shall include the following:
 - 1. Fifteen year or greater written Application Assurance Warranty certifying that the wiring system will support all the applications that it was designed to support as specified herein.
 - 2. Fifteen year or greater written Extended Product Warranty for all passive products installed in the cabling system.
 - 3. Fifteen year or greater written Labor Warranty for the replacement of any installed cabling system product found to be defective.

1.9 QUALITY CONTROL

A. QUALIFICATIONS

1. COMPANY QUALIFICATIONS

- a. At least 5 years experience installing telecommunications systems.
- b. Provide three (3) references for projects of similar scope and specifications.

2. INSTALLATION PERSONNEL QUALIFICATIONS

- a. All installation personnel shall be factory certified on all products installed.
- b. Submit proof of attendance and successful completion of an approved installation course.
- c. All employees performing the installation must be certified by one of the methods listed below.
- d. Report any modifications to the work crew approved in submittals or identified to the Program Manager.
- e. Provide certificates prior to that individual beginning work on site.

3. FOREMAN QUALIFICATIONS AND REQUIREMENTS

- a. Identify the foreman for Telecommunications work by name prior to beginning work.
- b. Provide proof of successful completion of "Data/voice Foreman" course from those listed below.
- c. Named individual shall be on-site whenever any work is being performed.
- d. The foreman shall not be changed during the course of the project unless they leave the employment of the company.

B. APPROVED CERTIFICATIONS

1. APPROVED COURSES AND MANUFACTURERS - Course for on-site Construction Foreman and each member of the on-site installation crew shall be the following courses or prior approved equivalent.

- a. Data/Voice Company Certification - Factory Certification is required of the Contractor performing the installation.
- b. CommScope.

2. Data/Voice Installation Foreman: Certification by any one of the following:

- a. SYSTIMAX - ND 3321 PDS Design & Engineering.
- b. SYSTIMAX - ND 3341 PDS Installation & Maintenance.
- c. Ortronics - Installation Supervisor Training.
- d. BICSI - Installation Supervisor Training, including RCDD certification.
- e. Siemon - Installation Supervisor Training.

3. Data/Voice Installation Personnel - ALL MEMBERS CERTIFIED by any one of the following:

- a. Panduit Factory Certification.
- b. Ortronics Factory Certification.
- c. BICSI Installer Level 1.
- d. Siemon Installer Training.
- e. IBEW Installer / Technician Apprenticeship program.

C. PROOF OF ATTENDANCE

1. Submit copies of training certificates per Figure 14 of this Section.
2. Submit certificate for Foreman and each person performing installation.

D. REMOVAL OF PERSONNEL - The Owner shall have the right to request removal from the job an employee of any Contractor or subcontractor. Such a request will be made in consultation with the Program Manager and shall not be made without good cause. Should such a request be made, the Contractor shall immediately and permanently remove that individual from the job.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable manufacturers of the Category 6 solutions will match existing system(s) utilized in facility and be limited to solutions that can provide a “total solution” including cabling, patch panels, patch cables and workstation jacks.

2.2 RACEWAY AND WIRING SYSTEMS COMPONENTS

- A. Conduit: Refer to Section 26 05 33.
- B. Outlet, Pull, and Junction Boxes: Refer to Section 26 05 33.

2.3 GUARDNET COMMUNICATIONS

- A. Fiber Optic Cables:
 - 1. Strand count: Identified on Drawings.
 - 2. Multi-mode strands:
 - a. Corning OM1.
 - b. 62.5/125 µm.
 - 3. Single-mode strands:
 - a. Equal to Corning OS1.
 - b. 8.3/125 µm.
 - 4. Outside Plant (OSP) fiber optic cable construction:
 - a. Equal to Corning ALTOS Lite.
 - b. Loose Tube Hybrid Cable.
 - c. Gopher Resistant Armored Cable.
 - d. UV resistant polyethylene outer jacket.
 - e. For use in conduit or duct.
- B. Inside Plant Copper Cable (ISP);
 - 1. 6 pair or 25 pair, as indicated on Drawings.
 - 2. 22 AWG, twisted pair.
 - 3. Plenum rated.
- C. Horizontal Station Cable:
 - 1. Cat 6.
 - 2. Plenum rated.
 - 3. Jacket color coordinated with Owner's program.
- D. Fiber Optic Patch Panels:
 - 1. Rack Mount Panel:
 - a. Corning CCH-04U.
 - b. Supply one CCH Connector Panel for each cable termination and kits required for fusion splicing.
 - 2. SC terminations Connectors: Verify with Owner's Telecom representative (DCSIM) prior to preparation of submittals.
 - 3. With label space.

E. Copper Patch Panels:

1. Cat 6.
2. EIA/TIA-568B jacks for insulation displacement termination.
3. 19" Rack mountable.
4. With label space.
5. 12, 24, 48 or 96 port as indicated on Drawings.

F. 110 Blocks;

1. 100-Pair 110 Wiring Block Kit.
2. 5-pair connecting blocks for backbone cable terminations.
3. 4-pair connecting blocks for horizontal cable terminations.
4. Identification holders with labels.
5. Cable management rings for x-connect wiring.

G. Information Outlets:

1. Jacks:
 - a. TIA 568B.
 - b. 8-position modular jack.
 - c. Color:
 - 1) NIPR: Gray.
2. Faceplates:
 - a. Four Position.
 - b. With recessed label field, label card and clear plastic cover.
 - c. Insert dust covers into un-used ports.

H. Copper Patch Cords:

1. Cat 6.
2. Jacket color: Blue.
3. Length:
 - a. Patch Panel end:
 - 1) 2 meter.
 - 2) Provide one patch cord per 4-position information outlet and one per wall phone.
 - b. Information Outlet end:
 - 1) 5 meter.
 - 2) Provide one patch cord per 4-position information outlet and one per wall phone.

I. Equipment Rack:

1. Basis of Design: Panduit R2P 2-Post Rack..
2. Standard EIA/TIA 19" rack.
3. Height: 45U (rack units).
4. Accessories: Provide horizontal and vertical cable managers for cable routing.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 01 14 00 - General Requirements: Verification of site conditions.

3.2 RACEWAY AND WIRING INSTALLATION

- A. Raceway and Boxes:

1. Install all cables in a continuous raceway from each information outlet box to accessible space above ceilings or as indicated.
2. Outlet box shall be 4" x 4" x 2 1/8" deep box with single gang plaster ring.
3. Locate box within 24" of power receptacle location shown on power plans. Notify Engineer in the event of conflicts.
4. Provide a continuous raceway to telecommunication closet in areas without accessible ceilings.
5. Conduit size shall be 1-inch minimum, provide insulated, grounding bushings at the open ends of the conduit.
6. Ensure all pathway and raceway components are grounded to main telecommunications ground buss. Refer to Section 26 05 26 - Grounding and Bonding for Electrical Systems.

- B. Horizontal Station Cable:

1. The cable lengths on all horizontal runs shall be within the Cat 6 specifications.
2. Provide one cable per position per faceplate (four per faceplate (typical)) unless otherwise indicated.
3. Provide one each 5-meter Cat. 6 workstation patch cable and one each 2-meter Cat. 6 patch panel cable for each data and phone cable installed.
4. Terminate each pair on appropriate outlet or patch panel.
5. Provide sufficient cable slack of 1 meter above wall jack in ceiling and 3 meters at patch panel to allow for re-termination of the cable in the future.
6. Pairs shall be terminated in accordance with manufacturer's specification and as specified in TIA/EIA Standards.
7. Manufacturer's rated cable pulling tension shall not be exceeded.
8. Cable shall not be stressed such that twisting, stretching or kinking occurs.
9. Cable shall not be spliced.
10. Exposed copper cable not in a cable tray shall be suspended a minimum of 8 inches above accessible ceilings by cable supports no greater than 36 inches apart.
11. Cable shall not be run through structural members or in contact with pipes, ducts, lighting fixtures, or other potentially damaging or tangling exposures.
12. Placement of cable parallel to power conductors shall be avoided. Maintain a minimum separation of 12 inches when such placement cannot be avoided.
13. Cables shall be terminated and labeled at both ends unless otherwise indicated on Drawings.
14. Minimum bending radius shall not be exceeded during installation or once installed.
15. Velcro fasteners are the only method authorized for securing cables. Cable ties are not allowed.
16. Protect cables from paint and overspray. Painting the jacket of any cable will void the warranty on the cabling and contractor shall be required to replace.

- C. Fiber Optic and Copper Cable:

1. Terminate each pair on appropriate patch panel or 110 block location.
2. Provide label with far end locations identified.

3. Provide sufficient cable slack in patch panel storage to allow for re-termination of the cable in the future.
4. Pairs shall be terminated in accordance with manufacturer's specification and as specified in TIA/EIA Standards.
5. Manufacturer's rated cable pulling tension shall not be exceeded.
6. Cable shall not be stressed such that twisting, stretching or kinking occurs.
7. Splice only for approved termination methods.
8. Cables shall be terminated at both ends.
9. Minimum bending radius shall not be exceeded during installation or once installed.
10. Velcro fasteners are the only method authorized for securing cables. Cable ties are not allowed.
11. Install dust boots after testing is complete.

D. Information Outlet and Patch Panel Labeling:

1. Labels shall be typewritten or computer-printer-generated on the labeling field cards.
2. Coordinate labeling scheme with Owner's Telecom representative (DCSIM) and TIA-606-C.

3.3 FIELD QUALITY CONTROL

- A. Test all horizontal station cables from and including the termination device in the telecommunications room to and including the modular jack at information outlet. Test all Category 6 channels using a test set that meets the accuracy requirements of TIA standards. Testing shall use the full channel including system-matched procedure.
- B. Test all backbone copper cables for continuity, shorts, and crossovers. Correct all identified problems and retest.
- C. Test all fiber optic cables after installation.
 1. Test bi-directionally in accordance with TIA-568.3-D.
- D. Document all test results and furnish them to Engineer both electronic and hard copy format. Furnish the hard copy in a properly organized 3-ring binder. Requirements for electronic copy shall be coordinated with Owner.

END OF SECTION

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SECTION 27 05 26

GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Grounding conductors.
 - 2. Grounding connectors.
 - 3. Grounding busbars.
 - 4. Building entrance primary surge protectors.
 - 5. Grounding labeling.

1.2 DEFINITIONS

- A. BCT: Bonding conductor for telecommunications.
- B. EMT: Electrical metallic tubing.
- C. TGB: Telecommunications grounding busbar.
- D. TMGB: Telecommunications main grounding busbar.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

- A. As-Built Data: Plans showing as-built locations of grounding and bonding infrastructure, including the following:
 - 1. TMGB and routing of their bonding conductors.
- B. Qualification Data: For Installer, installation supervisor, and field inspector.
- C. Qualification Data: For testing agency and testing agency's field supervisor.
- D. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 - 1. Installation Supervision: Installation shall be under the direct supervision of ITS Installer 2, who shall be present at all times when Work of this Section is performed at Project site.
 - 2. Field Inspector: Currently registered by BICSI as ITS Installer 2 to perform the on-site inspection.

PART 2 - PRODUCTS

2.1 SYSTEM COMPONENTS

- A. Comply with J-STD-607-A.

2.2 CONDUCTORS

- A. Comply with UL 486A-486B.
- B. Insulated Conductors: Stranded copper wire, green or green with yellow stripe insulation, insulated for 600 V, and complying with UL 83.
 - 1. Ground wire for custom-length equipment ground jumpers shall be No. 6 AWG, 19-strand, UL-listed, Type THHN wire.
- C. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Stranded Conductors: ASTM B 8.
 - 3. Tinned Conductors: ASTM B 33.
 - 4. Bonding Cable: 28 kcmils (14.2 sq. mm), 14 strands of No. 17 AWG conductor, and 1/4 inch (6.3 mm) in diameter.
 - 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 - 6. Bonding Jumper: Tinned-copper tape, braided conductors terminated with two-hole copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

2.3 CONNECTORS

- A. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.
- B. Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.
 - 1. Electroplated tinned copper, C and H shaped.
- C. Signal Reference Grid Connectors: Combination of compression wire connectors, access floor grounding clamps, bronze U-bolt grounding clamps, and copper split-bolt connectors, designed for the purpose.
- D. Busbar Connectors: Cast silicon bronze, solderless compression -type, mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch (15.8- or 25.4-mm) centers for a two-bolt connection to the busbar.
- E. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.4 GROUNDING BUSBARS

- A. TMGB: Predrilled, wall-mounted, rectangular bars of hard-drawn solid copper, 1/4 by 4 inches (6.3 by 100 mm) in cross section, 12" length or indicated on Drawings. The busbar shall be NRTL listed for use as TMGB and shall comply with J-STD-607-A.

1. Predrilling shall be with holes for use with lugs specified in this Section. Minimum of 28 holes with pattern suitable for 2 hole lugs.
 2. Mounting Hardware: Stand-off brackets that provide a 4-inch ((100-mm)) clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
 3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.
- B. Rack and Cabinet Grounding Busbars: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with J-STD-607-A. Predrilling shall be with holes for use with lugs specified in this Section.
1. Cabinet-Mounted Busbar: Terminal block, with stainless-steel or copper-plated hardware for attachment to the cabinet.
 2. Rack-Mounted Horizontal Busbar: Designed for mounting in 19- or 23-inch (483- or 584-mm) equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.

2.5 LABELING

- A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
- B. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm). Overlay shall provide a weatherproof and UV-resistant seal for label.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the ac grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of the electrical system.
- B. Inspect the test results of the ac grounding system measured at the point of BCT connection.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- D. Proceed with connection of the BCT only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Bonding shall include the ac utility power service entrance, the communications cable entrance, and the grounding electrode system. The bonding of these elements shall form a loop so that each element is connected to at least two others.
- B. Comply with NECA 1.
- C. Comply with J-STD-607-A.

3.3 APPLICATION

- A. Conductors: Install solid conductor for No. 8 AWG and smaller and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
 - 1. The bonding conductors between the TGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.
 - 2. The bonding conductors between the TMGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.
- B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2 AWG minimum.
- C. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
 - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
 - 4. Connections to Structural Steel: Welded connectors.
- D. Conductor Support:
 - 1. Secure grounding and bonding conductors at intervals of not less than 36 inches ((900 mm).)
- E. Grounding and Bonding Conductors:
 - 1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.
 - 2. Install without splices.
 - 3. Support at not more than 36-inch (900-mm) intervals.
 - 4. Install grounding and bonding conductors in 3/4-inch (21-mm) PVC conduit until conduit enters a telecommunications room. The grounding and bonding conductor pathway through a plenum shall be in EMT. Conductors shall not be installed in EMT unless otherwise indicated.
 - a. If a grounding and bonding conductor is installed in ferrous metallic conduit, bond the conductor to the conduit using a grounding bushing that complies with requirements in Section 27 05 28 "Pathways for Communications Systems," and bond both ends of the conduit to a TGB.

3.4 GROUNDING ELECTRODE SYSTEM

- A. The BCT between the TMGB and the ac service equipment ground shall not be smaller than No. 1/0 AWG.

3.5 GROUNDING BUSBARS

- A. Indicate locations of grounding busbars on Drawings. Install busbars horizontally, on insulated spacers 2 inches (50 mm) minimum from wall, 12 inches (300 mm) above finished floor unless otherwise indicated.
- B. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

3.6 CONNECTIONS

- A. Bond metallic equipment in a telecommunications equipment room to the grounding busbar in that room, using equipment grounding conductors not smaller than No. 6 AWG.
- B. Stacking of conductors under a single bolt is not permitted when connecting to busbars.
- C. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:
 - 1. Use crimping tool and the die specific to the connector.
 - 2. Pretwist the conductor.
 - 3. Apply an antioxidant compound to all bolted and compression connections.
- D. Primary Protector: Bond to the TMGB with insulated bonding conductor.
- E. Interconnections: Interconnect all TGBs with the TMGB with the telecommunications backbone conductor. If more than one TMGB is installed, interconnect TMGBs using the grounding equalizer conductor. The telecommunications backbone conductor and grounding equalizer conductor size shall not be less than 2 kcmils/linear foot (1 sq. mm/linear meter) of conductor length, up to a maximum size of No. 3/0 AWG unless otherwise indicated.
- F. Telecommunications Enclosures and Equipment Racks: Bond metallic components of enclosures to the telecommunications bonding and grounding system. Install top-mounted rack grounding busbar unless the enclosure and rack are manufactured with the busbar. Bond the equipment grounding busbar to the TGB No. 2 AWG bonding conductors.
- G. Raceway
 - 1. Conduit: Use insulated 16 mm² (6 AWG) bonding jumpers to ground metallic conduit at each end and to bond at all intermediate metallic enclosures.
- H. Structural Steel: Where the structural steel of a steel frame building is readily accessible within the room or space, bond each TGB and TMGB to the vertical steel of the building frame.
- I. Electrical Power Panelboards: Where an electrical panelboard for telecommunications equipment is located in the same room or space, bond each TGB to the ground bar of the panelboard.
- J. Shielded Cable: Bond the shield of shielded cable to the TGB in communications rooms and spaces. Comply with TIA/EIA-568-B.1 and TIA/EIA-568-B.2 when grounding screened, balanced, twisted-pair cables.
- K. Rack- and Cabinet-Mounted Equipment: Bond powered equipment chassis to the cabinet or rack grounding bar. Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section.

3.7 IDENTIFICATION

- A. Labels shall be preprinted or computer-printed type.
 - 1. Label TMGB(s) with "fs-TMGB," where "fs" is the telecommunications space identifier for the space containing the TMGB.

2. Label TGB(s) with "fs-TGB," where "fs" is the telecommunications space identifier for the space containing the TGB.
3. Label the BCT and each telecommunications backbone conductor at its attachment point: "WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

3.8 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
 2. Test the bonding connections of the system using an ac earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing a TMGB and a TGB and using the process recommended by BICSI TDMM. Conduct tests with the facility in operation.
 - a. Measure the resistance between the busbar and the nearest available grounding electrode. The maximum acceptable value of this bonding resistance is 100 milliohms.
 3. Test for ground loop currents using a digital clamp-on ammeter, with a full-scale of not more than 10 A, displaying current in increments of 0.01 A at an accuracy of plus/minus 2.0 percent.
 - a. With the grounding infrastructure completed and the communications system electronics operating, measure the current in every conductor connected to the TMGB and in each TGB. Maximum acceptable ac current level is 1 A.
- B. Grounding system will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

END OF SECTION

SECTION 27 05 28

PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Pathways and boxes for containment of communication cables.

1.2 DEFINITIONS

- A. ARC: Aluminum rigid conduit.
- B. GRC: Galvanized rigid steel conduit.
- C. IMC: Intermediate metal conduit.

1.3 ACTION SUBMITTALS

- A. Product Data: For surface pathways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Pathway routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
 - 1. Structural members in paths of pathway groups with common supports.
 - 2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

PART 2 - PRODUCTS

2.1 CONDUIT

- A. Product Description: As specified in Section 26 05 36.

2.2 J-HOOKS

- A. Manufacturers:
 - 1. Equal to B-Line BCH64H 4" hooks.
- B. Product Description:
 - 1. Open-top cable supports rated for use with Category 6A UTP cables.
 - 2. Zinc plated for heavy duty use (100 lbs.)
 - 3. With heavy duty support bar for multi-tier use.

2.3 OUTLET BOXES

- A. Product Description: As specified in Section 26 05 33, except as noted below.
- B. Outlet boxes double-gang (4"x4"), extra deep (3-1/4") wall outlet box unless otherwise noted on drawings.
- C. Include single gang mud ring as required for faceplate installation.

PART 3 - EXECUTION

3.1 PATHWAY APPLICATION

- A. Minimum Pathway Size: 1-inch (27-mm) trade size.
- B. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- C. Install surface pathways only where indicated on Drawings. Channel and repair where required for installation on existing walls and ceilings.
- D. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F (49 deg C) .

3.2 INSTALLATION

- A. Comply with NECA 1, NECA 101, and TIA-569-B for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum pathways. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.
- B. Keep pathways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.
- C. Complete pathway installation before starting conductor installation.
- D. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for hangers and supports.
- E. Arrange stub-ups so curved portions of bends are not visible above finished slab. Stub up minimum of 3 inches at telecom backboards.
- F. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches (300 mm) of changes in direction. Utilize long radius ells for all optical-fiber cables.
- G. Provide pull boxes in conduit runs greater than 100 ft. (30 m).
- H. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- I. Support conduit within 12 inches (300 mm) of enclosures to which attached.
- J. Maintain the following separation distances from possible sources of electromagnetic interference (EMI):

1. Open or nonmetal pathways near unshielded power lines or electrical equipment. Electrical power source - Minimum separation distance:
 - a. Less than 2 kVA - 5 in. (127 mm)
 - b. 2 to 5 kVA - 12 in. (305 mm)
 - c. Greater than 5 kVA - 24 in. (610 mm)
 2. Grounded enclosed metal pathway near unshielded power lines or electrical equipment. Electrical power source - Minimum separation distance:
 - a. Less than 2 kVA - 2.5 in. (64 mm)
 - b. 2 to 5 kVA - 6 in. (152 mm)
 - c. Greater than 5 kVA - 12 in. (305 mm)
 3. Grounded enclosed metal pathway near power lines or electrical equipment in grounded metal pathway. Electrical power source - Minimum separation distance:
 - a. 2 to 5 kVA - 3 in. (76 mm)
 - b. Greater than 5 kVA - 6 in. (152 mm)
 4. Electrical motors and transformers: Maintain 48 in (1.22 m) minimum separation distance.
- K. Install cable tray, conduits, and pull boxes with minimum 6 inches of clear vertical space to ensure accessibility. Install J-hooks with minimum 12" of clear vertical space.
- L. Install J-Hooks at maximum of 4 ft. spacing supported directly to structure or with minimum ¼" all thread rod.
- M. Stub-ups to Above Recessed Ceilings:
1. Use EMT, IMC, or RMC for pathways.
 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- N. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.
- O. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.
- P. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.
- Q. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- R. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- S. Cut conduit perpendicular to the length. For conduits of 2-inch (53-mm) trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.
- T. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Cap underground pathways designated as spare above grade alongside pathways in use.
- U. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:

1. 1-Inch (27-mm) Trade Size and Larger: Install pathways in maximum lengths of 75 feet (23 m).
 2. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.
- V. Install pathway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway sealing fittings according to NFPA 70.
- W. Install devices to seal pathway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 2. Where an underground service pathway enters a building or structure.
 3. Where otherwise required by NFPA 70.
- X. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.
- Y. Expansion-Joint Fittings:
1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F (17 deg C), and that has straight-run length that exceeds 25 feet (7.6 m). Install in each run of aboveground RMC conduit that is located where environmental temperature change may exceed 100 deg F (55 deg C) and that has straight-run length that exceeds 100 feet (30 m).
 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.
 - d. Attics: 135 deg F (75 deg C) temperature change.
 - e. .
 3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C) of temperature change for metal conduits.
 4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
 5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

- Z. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
- AA. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- BB. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- CC. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- DD. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

3.3 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 26 05 44 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.4 FIRESTOPPING

- A. Install firestopping at penetrations of fire rated floor and wall assemblies.
- B. Firestop System installation must meet requirements of UL 1479 tested assemblies that provide fire/smoke rating equal to that of construction being penetrated. Utilize firestop products identified under Products in this section in assemblies. Provide additional products as required for complete assembly.
- C. Provide formed sheet metal barrier around opening to protect wall from physical damage and prevent intumescent material from falling into wall cavity at cable tray penetrations. Size wall penetration to accommodate full capacity of cable tray.
- D. Identify through-penetration firestop systems with self-adhesive, vinyl label. Attach labels permanently to surface of penetrated construction on both sides of each firestop system. Include the following information on the labels:
 1. "Warning – Through Penetration Firestop System – Do Not Disturb. Notify Building Management of Any Damage."
 2. Contractor's name, address, and phone number.
 3. Through-Penetration firestop system designation of applicable testing and inspecting agency.
 4. Date of installation.
 5. Through-Penetration firestop system manufacturer's name.
 6. Installer's name.

3.5 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage or deterioration.
 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

SECTION 28 31 11

DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Fire-alarm control unit.
 - 2. Manual fire-alarm boxes.
 - 3. System smoke detectors.
 - 4. Notification appliances.
 - 5. Addressable interface device.

1.2 DEFINITIONS

- A. EMT: Electrical Metallic Tubing.
- B. FACP: Fire Alarm Control Panel.
- C. HLI: High Level Interface.
- D. NICET: National Institute for Certification in Engineering Technologies.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product, including furnished options and accessories.
 - 1. Include construction details, material descriptions, dimensions, profiles, and finishes.
 - 2. Include rated capacities, operating characteristics, and electrical characteristics.
- B. Shop Drawings: For fire-alarm system.
 - 1. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
 - 2. Include plans, elevations, sections, details, and attachments to other work.
 - 3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
 - 4. Detail assembly and support requirements.
 - 5. Include voltage drop calculations for notification-appliance circuits.
 - 6. Include battery-size calculations.
 - 7. Include input/output matrix.
 - 8. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this Specification and in NFPA 72.
 - 9. Include performance parameters and installation details for each detector.
 - 10. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
 - 11. Provide program report showing that air-sampling detector pipe layout balances pneumatically within the airflow range of the air-sampling detector.

12. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale; coordinate location of duct smoke detectors and access to them.
 - a. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.
 - b. Show field wiring required for HVAC unit shutdown on alarm.
 - c. Locate detectors according to manufacturer's written recommendations.
 13. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.
- C. General Submittal Requirements:
1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
 2. Shop Drawings shall be prepared by persons with the following qualifications:
 - a. Trained and certified by manufacturer in fire-alarm system design.
 - b. NICET-certified, fire-alarm technician; Level III minimum.
 - c. Licensed or certified by authorities having jurisdiction.
- D. Delegated-Design Submittal: For notification appliances and smoke and heat detectors, in addition to submittals listed above, indicate compliance with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
1. Drawings showing the location of each notification appliance and smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the device.
 2. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72. Calculate spacing and intensities for strobe signals and sound-pressure levels for audible appliances.
 3. Indicate audible appliances required to produce square wave signal per NFPA 72.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.
1. Include the following and deliver copies to authorities having jurisdiction:
 - a. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - b. Provide "Fire Alarm and Emergency Communications System Record of Completion Documents" according to the "Completion Documents" Article in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
 - c. Complete wiring diagrams showing connections between all devices and equipment. Each conductor shall be numbered at every junction point with indication of origination and termination points.
 - d. Riser diagram.
 - e. Device addresses.
 - f. Record copy of site-specific software.
 - g. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
 - 1) Equipment tested.
 - 2) Frequency of testing of installed components.
 - 3) Frequency of inspection of installed components.
 - 4) Requirements and recommendations related to results of maintenance.
 - 5) Manufacturer's user training manuals.
 - h. Manufacturer's required maintenance related to system warranty requirements.

- i. Abbreviated operating instructions for mounting at fire-alarm control unit and each annunciator unit.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.
- B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level III technician.
- C. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.

1.6 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.
 1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.
 2. Warranty Period: One year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Source Limitations for Fire-Alarm System and Components: Components shall be compatible with, and operate as an extension of, existing system. Provide system manufacturer's certification that all components provided have been tested as, and will operate as, a system.
- B. Noncoded, UL-certified addressable system, with multiplexed signal transmission and horn/strobe evacuation.
- C. Automatic sensitivity control of certain smoke detectors.
- D. All components provided shall be listed for use with the selected system.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

- A. Fire-alarm signal initiation shall be by one or more of the following devices:
 1. Manual stations.
 2. Heat detectors.
 3. Flame detectors.
 4. Smoke detectors.
 5. Duct smoke detectors.
 6. Carbon monoxide detectors.
- B. Fire-alarm signal shall initiate the following actions:
 1. Continuously operate alarm notification appliances, including voice evacuation notices.

2. Identify alarm and specific initiating device at fire-alarm control unit, connected network control panels, off-premises network control panels, and remote annunciators.
 3. Transmit an alarm signal to the remote alarm receiving station.
 4. Unlock electric door locks in designated egress paths.
 5. Activate voice/alarm communication system.
 6. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
 7. Close smoke dampers in air ducts of designated air-conditioning duct systems.
 8. Activate emergency shutoffs for gas and fuel supplies.
 9. Record events in the system memory.
 10. Indicate device in alarm on the graphic annunciator.
- C. Supervisory signal initiation shall be by one or more of the following devices and actions:
1. Valve supervisory switch.
 2. User disabling of zones or individual devices.
 3. Loss of communication with any panel on the network.
- D. System trouble signal initiation shall be by one or more of the following devices and actions:
1. Open circuits, shorts, and grounds in designated circuits.
 2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
 3. Loss of communication with any addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
 4. Loss of primary power at fire-alarm control unit.
 5. Ground or a single break in internal circuits of fire-alarm control unit.
 6. Abnormal ac voltage at fire-alarm control unit.
 7. Break in standby battery circuitry.
 8. Failure of battery charging.
 9. Abnormal position of any switch at fire-alarm control unit or annunciator.
 10. Voice signal amplifier failure.

2.3 FIRE-ALARM CONTROL UNIT

- A. Manufacturer:
1. Fire Alarm Systems shall be 'Desigo' Series by Siemens Industry, Inc. (no substitutions) to allow for compatibility with and extension of existing networked Desigo system, and reporting to Owner's 'Siemens Desigo CC' monitoring workstation located at Camp Dodge.
 2. Fire Safety Managements System (DCC)
 - a. Model 'Siemens Desigo CC'
 - b. Switch Model X204-2LD
 3. Fire Alarm Control Panel (FACP):
 - a. Model FV-2025 for up to 252 points with mass notification.
 - b. Model FN2012-A1 Network Card.
 - 1) Model VN2002-A1 for Multi-Mode Fiber
 - 2) Model VN2003-A1 for Single-Mode Fiber.
- B. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:
1. Pathway Class Designations: NFPA 72, Class B.
 2. Pathway Survivability: Level 0.

- C. Smoke-Alarm Verification:
1. Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.
 2. Activate an approved "alarm-verification" sequence at fire-alarm control unit and detector.
 3. Record events by the system printer.
 4. Sound general alarm if the alarm is verified.
 5. Cancel fire-alarm control unit indication and system reset if the alarm is not verified.
- D. Notification-Appliance Circuit:
1. Audible appliances shall sound in a three-pulse temporal pattern, as defined in NFPA 72.
 2. Where notification appliances provide signals to sleeping areas, the alarm signal shall be a 520-Hz square wave with an intensity 15 dB above the average ambient sound level or 5 dB above the maximum sound level, or at least 75 dBA, whichever is greater, measured at the pillow.
 3. Visual alarm appliances shall flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72.
- E. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.
- F. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory signals supervisory and digital alarm communicator transmitters and digital alarm radio transmitters shall be powered by 24-V dc source.
1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.
- G. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
- H. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.4 MANUAL FIRE-ALARM BOXES

- A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
1. Single-action mechanism, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
 2. Station Reset: Key- or wrench-operated switch.
 3. Weatherproof Protective Shield: Factory-fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm.

2.5 SYSTEM SMOKE DETECTORS

- A. General Requirements for System Smoke Detectors:
1. Comply with UL 268; operating at 24-V dc, nominal.
 2. Detectors shall be four-wire type.

3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.

B. Photoelectric Smoke Detectors:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status.
 - b. Device type.
 - c. Present average value.
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.).

2.6 NOTIFICATION APPLIANCES

- A. General Requirements for Notification Appliances: Individually addressed, connected to a signaling-line circuit, equipped for mounting as indicated, and with screw terminals for system connections.
- B. General Requirements for Notification Appliances: Connected to notification-appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.
 1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.
- C. Visible Notification Appliances: Xenon strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- (25-mm-) high letters on the lens.
 1. Rated Light Output:
 - a. 15/30/75/110 cd, selectable in the field.
 2. Mounting: Wall mounted unless otherwise indicated.
 3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
 4. Flashing shall be in a temporal pattern, synchronized with other units.
 5. Strobe Leads: Factory connected to screw terminals.
 6. Mounting Faceplate: Factory finished, red.
- D. Voice/Tone Notification Appliances:
 1. Comply with UL 1480.
 2. Speakers for Voice Notification: Locate speakers for voice notification to provide the intelligibility requirements of the "Notification Appliances" and "Emergency Communications Systems" chapters in NFPA 72.
 3. High-Range Units: Rated 2 to 15 W.

4. Low-Range Units: Rated 1 to 2 W.
5. Mounting: Flush.
6. Matching Transformers: Tap range matched to acoustical environment of speaker location.

E. Exit Marking Audible Notification Appliance:

1. Exit marking audible notification appliances shall meet the audibility requirements in NFPA 72.
2. Provide exit marking audible notification appliances at the entrance to all building exits.
3. Provide exit marking audible notification appliances at the entrance to areas of refuge with audible signals distinct from those used for building exit marking.

2.7 NETWORK COMMUNICATIONS

- A. Provide network communications for fire-alarm system according to fire-alarm manufacturer's written requirements.
- B. Provide network communications pathway per manufacturer's written requirements and requirements in NFPA 72 and NFPA 70.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.
 1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.
- B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EQUIPMENT INSTALLATION

- A. Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."
 1. Devices placed in service before all other trades have completed cleanup shall be replaced.
 2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.
- B. Install wall-mounted equipment, with tops of cabinets not more than 78 inches (1980 mm) above the finished floor.

C. Manual Fire-Alarm Boxes:

1. Install manual fire-alarm box in the normal path of egress within 60 inches (1520 mm) of the exit doorway.
2. Mount manual fire-alarm box on a background of a contrasting color.
3. The operable part of manual fire-alarm box shall be between 42 inches (1060 mm) and 48 inches (1220 mm) above floor level. All devices shall be mounted at the same height unless otherwise indicated.

D. Smoke- or Heat-Detector Spacing:

1. Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
2. Comply with the "Heat-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.
3. Smooth ceiling spacing shall not exceed 30 feet (9 m).
4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Annex A in NFPA 72.
5. HVAC: Locate detectors not closer than 36 inches (910 mm) from air-supply diffuser or return-air opening.
6. Lighting Fixtures: Locate detectors not closer than 12 inches (300 mm) from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.

E. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.

F. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct. Tubes more than 36 inches (9100 mm) long shall be supported at both ends.

1. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.

G. Single-Station Smoke Detectors: Where more than one smoke alarm is installed within a dwelling or suite, they shall be connected so that the operation of any smoke alarm causes the alarm in all smoke alarms to sound.

H. Audible Alarm-Indicating Devices: Install not less than 6 inches (150 mm) below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Install all devices at the same height unless otherwise indicated.

I. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches (150 mm) below the ceiling. Install all devices at the same height unless otherwise indicated.

J. Device Location-Indicating Lights: Locate in public space near the device they monitor.

3.3 PATHWAYS

A. Pathways above recessed ceilings and in nonaccessible locations may be routed exposed.

B. Pathways shall be EMT.

C. Exposed EMT shall be painted red enamel.

3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."
- B. Install framed instructions in a location visible from fire-alarm control unit.

3.5 GROUNDING

- A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.
- B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.6 FIELD QUALITY CONTROL

- A. Field tests shall be witnessed by authorities having jurisdiction.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
- D. Perform the following tests and inspections:
 - 1. Visual Inspection: Conduct visual inspection prior to testing.
 - a. Inspection shall be based on completed record Drawings and system documentation that is required by the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
 - b. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
 - 2. System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - 3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
 - 4. Test audible appliances for the private operating mode according to manufacturer's written instructions.
 - 5. Test visible appliances for the public operating mode according to manufacturer's written instructions.
 - 6. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
- E. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
- F. Fire-alarm system will be considered defective if it does not pass tests and inspections.
- G. Prepare test and inspection reports.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION

SECTION 31 10 00
SITE CLEARING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this Section.

1.02 SUMMARY:

- A. This section includes the following:
 - 1. Protection of existing trees.
 - 2. Removal of Trees and other Vegetation.
 - 3. Clearing and Grubbing.
 - 4. Removing above-grade improvement.
 - 5. Removing below grade improvements.

1.03 RELATED WORK SPECIFIED ELSEWHERE:

- A. Section 31 20 00 Earthwork

1.04 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of the Contract and Division 1 Specifications Section.
- B. Schedule indicating proposed sequence of operations for selective demolition work to Owner's Representative for review prior to start of work.

1.05 PROJECT CONDITIONS:

- A. Traffic: Conduct site demolition operations to ensure minimum interference with roads, streets, walks, and other adjacent occupied or used facilities. Do not close or obstruct streets, walks, or other occupied or used facilities without permission from authorities having jurisdiction. Coordinate all work with the District.
- B. Protection of Existing Trees and Vegetation: Protect existing trees and other vegetation indicated to remain in place, against unnecessary cutting, breaking or skinning of roots, skinning or bruising of bark, smothering trees by stockpiling construction materials or excavated materials with drip line, excess foot or vehicular traffic, or parking of vehicles within drip line. Provide temporary fencing to protect trees and vegetation.
- C. Utility Services: Maintain existing utilities indicated to remain in service and protect them against damage during demolition operations.
- D. Environmental Controls: Comply with governing regulations pertaining to environmental protection.
 - 1. Do not use water when it may create hazardous or objectionable conditions such as ice, flooding, and pollution.
 - 2. If unanticipated mechanical, electrical, or structural elements are encountered, investigate and measure both nature and extent of conflict. Submit report to Owner's Representative, rearrange selective demolition schedule as necessary to continue overall job progress without undue delay.
 - 3. Salvageable Improvements: Carefully remove items indicated to be salvaged, and store on owner's premises where indicated or directed.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.01 DEMOLITION:

- A. General: Perform selective demolition work in a systematic manner. Use such methods as required to complete work indicated on Drawings in accordance with demolition schedule and governing regulations.
- B. Demolition work shall include the demolition, removal and legal disposal of existing construction debris as required to accommodate the new construction. The Contractor shall take care to prevent damages to existing utilities, construction and materials not scheduled for demolition, repair or replacement, and shall repair damages to the construction and materials to the satisfaction of the Architect and at no additional cost to the Owner.
- C. Provide services for effective air and water pollution controls as required by local authorities having jurisdiction. Do not use water for dust control if it results in hazardous or objectionable conditions such as, but not limited to, ice, flooding, or pollution. Sweep pavements as often as necessary to control the spread of debris.
- D. Whenever possible, all features demolished shall be salvaged or recycled in lieu of being disposed of as waste in a landfill. Existing features to be demolished which are not salvageable or reused, shall become the property of the Contractor and shall be removed from project site.
- E. Where pedestrian and driver safety is endangered in the area of removal work, use traffic barricades with flashing lights. Provide temporary traffic control in accordance with MUTCD.
- F. Protect existing work that is to remain in place, be reused, or remain the property of the Owner. At no additional expense to the Owner, repair all items that are damaged during performance of the work to their original condition, or replace with new. Do not overload pavements to remain.
- G. Make the maximum use of low-noise emission products, as certified by the EPA.
- H. Saw cut full depth along perimeter of pavement to be removed. Remove to nearby existing pavement joints when possible. Do not leave panel of parking lot and drive panels less than six feet wide. Do not leave panels of sidewalk pavement less than four feet wide.

3.02 SITE CLEARING:

- A. General: Remove trees, shrubs, grass, and other vegetation, improvements or obstructions as required to permit installation of new construction. Remove similar items elsewhere on site or premises as specifically indicated.
 - 1. Removal includes digging out and off-site disposing of stumps and roots.
 - 2. Cut minor roots and branches of trees indicated to remain in a clean and careful manner, where such roots and branches obstruct installation of new construction.
- B. Clearing and Grubbing: Clear sites of trees, shrubs and other vegetation, except those indicated to be left standing.
- C. Completely remove stumps, roots, and other debris protruding through ground surface.
 - 1. Use only hand methods for grubbing inside drip line of trees indicated to remain.
 - 2. Fill depressions caused by clearing and grubbing operations with satisfactory soil materials, unless further excavation of earthwork is indicated.
 - a. Compact fill material in accordance with requirements of Section 31 20 00 - Earthwork.
- D. Removal of Improvements: Remove existing above-grade and below-grade improvements as indicated on drawings.

3.03 DISPOSAL OF DEMOLISHED MATERIALS

- A. Remove from site debris, rubbish, and other materials resulting from demolition operations. Transport and legally dispose of off site.
 - 1. If hazardous materials are encountered during demolition operations, comply with applicable regulations, laws, and ordinances concerning removal, handling, and protection against exposure or environmental pollution.
 - 2. Burning of removed materials is not permitted on project site.

3.04 CLEAN UP AND REPAIR:

- A. General: Upon completion of demolition work, remove tools, equipment, and demolished materials from site. Remove protections:
 - 1. Repair demolition performed in excess of that required. Return elements of construction and surfaces to remain to condition existing prior to start of operations. Repair adjacent construction or surfaces soiled or damaged by selective demolition work.

END OF SECTION 31 10 00

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SECTION 31 23 00
EXCAVATION AND FILL

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. This section includes excavation and earthwork for all site work including pavement earth subgrade.

1.02 DESCRIPTION OF WORK

- A. Work includes stockpiling topsoil, excavating, loading, hauling, depositing, compacting, grading, pavement subgrade preparation, topsoil respreading, finish grading, and restoring surfaces as necessary to conform to lines, grades, and slopes as shown on plans.
- B. Related work covered by other sections:
 - 1. Section 31 23 43: Excavation and Fill for Pipes and Structures
 - 2. Section 31 10 00: Site Clearing
 - 3. Section 31 23 13: Building Pad Preparation

1.03 DEFINITIONS

- A. Reference to percent maximum density shall mean a soil density not less than the stated percentage of maximum density for soil as determined by ASTM D698, "Moisture Density Relations of Soils", using 5.5-lb. rammer and 12 inch drop. (Standard Proctor Method).

1.04 TESTING

- A. The Iowa National Guard is responsible for providing services of an independent testing laboratory. Testing services are typically provided by CMT. Contractor shall be responsible for coordinating with CMT to perform tests required to show compliance with specifications.
- B. Contractor to provide equipment and materials as required for de-watering site areas for excavation operations.

- C. Contractor to plan work and provide temporary means for routing storm water drainage as necessary during construction.

1.05 CONSTRUCTION LAYOUT STAKING

- A. The Contractor shall supply all construction layout staking for this project, including for exterior improvements and utilities. Engineer will supply geometric information for purposes of staking upon request. Contractor shall give Engineer 48-hour notice per request for said information.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Earth: All materials not classified as rock or rubble including loam, silt, gumbo, peat, clay, soft shale, sand, gravel, and fragmentary rock or boulders which can be handled by normal earth moving equipment.
- B. Rock: Boulders so large that they cannot be handled by normal earth moving equipment or solid deposits so firmly cemented together that they cannot be removed without continuous use of pneumatic tools or blasting.
- C. Rubble: Buried concrete foundations, beams, walls, and other materials which cannot be removed without continuous use of pneumatic tools or blasting.
- D. Topsoil: Organic well draining soil free from clay lumps, rocks, stones, concrete, toxic minerals, roots over 1/4" in diameter or other material which will not provide good turf growth. Secure from stripping operations as required or provide as necessary for finish grading.
- E. Contractor shall notify the Owner if unsuitable soils are encountered during construction. Acceptable materials for construction shall include:
 - 1. Fill used for site construction shall be free of organic matter and debris. The soils shall have a liquid limit less than 45 and a plasticity index less than 23.
 - 2. All backfill and subgrade for pavements shall be compacted to 95% of standard proctor and shall be within a range of -1% to 4% of the materials optimum moisture content.

PART 3 - EXECUTION

3.01 EROSION PROTECTION

- A. Code Compliance: The Contractor shall comply with soil erosion control requirements of the Iowa Code, the construction drawings and local ordinances. The Contractor

shall take all necessary measurements to protect against erosion and dust pollution on this project site and all off-site borrow or deposit areas, during performance or as a result of performance.

- B. Damage claims: The Contractor will hold the Owner harmless from any and all claims of any type whatsoever resulting from damages to adjoining public or private property, including reasonable attorney's fees incurred to Owner. Further, if the Contractor fails to take necessary steps to promptly remove earth sedimentation or debris which comes onto adjoining public or private property, the Owner may, but need not, remove such items and deduct the cost thereof from amounts due the Contractor.
- C. The Contractor shall be responsible for erosion control measures in accordance with the contract documents.

3.02 Protection of existing utilities: The contractor shall protect existing gas, electric, water, fiber optic, subdrain lines, storm and sanitary service lines encountered during construction. Any damage shall be repaired by the Contractor to the Owners specifications at the Contractor's expense.

3.03 EXCAVATION

- A. Excavate, load, transport and place excavated materials as necessary to conform to lines, grades and slopes as shown on plans.
- B. Roll and compact cut areas to density not less than specified for fill area.
- C. If soft or yielding materials are encountered near finished grade in cut areas, remove unstable materials at a depth specified by Owner and replace with suitable materials and compact.
- D. Excavate in manner to avoid construction of lenses, pockets, streaks or layers of material differing from surrounding materials in fill areas.
- E. Cooperate with Owner in selection of locations for placement of excavated materials which differ appreciably from surrounding materials.
- F. Maintain excavation in free draining condition; provide drainage for any water or springs which may be encountered.
- G. The Contractor shall notify the Owner should existing drain tile be encountered during excavation and earthwork activities. Contractor is to connect all existing tiles encountered during construction to the storm sewer system.
- H. Provide temporary drainage facilities to prevent damage when necessary to interrupt natural drainage or flow of storm sewers, culverts or subdrains.
- I. Maximum height of vertical cut shall be three (3) feet.

3.04 FILL

- A. Prepare areas for fill by discing, plowing and scarifying to depth of 4 to 6 inches following topsoil removal under building pad or proposed paved areas.
- B. If soft or yielding materials at existing grade are encountered, remove unstable materials and replace with suitable materials and compact prior to fill operations.
- C. When fill meets natural grade of slope, cut bench in existing slope to connect existing grade with new fill.
- D. Step or bench all existing slopes greater than 5 horizontal to 1 vertical to connect existing grade with new fill.
- E. Place no roots, brush, grass or other organic material in fill under buildings, pavement, and pond areas. Place no material on fill when material or foundation is frozen.
- F. Select material for each portion of fill with approval of the Engineer; select materials to avoid sharp change in texture.
- G. Use fill material free of lenses, pockets, streaks or layers of materials differing from surrounding materials.
- H. Construct fill in horizontal layers not more than 9 inches in loose thickness.
- I. Deposit each layer over full width of fill as separate and distinct operation.
- J. After layer is deposited, smooth to uniform depth by means of suitable motor patrol or bulldozer.
- K. Maintain fill in free draining condition, provide drainage for any water or springs which may be encountered, except in the pond areas.
- L. If soft or yielding materials are encountered within fill areas due to trapped water, remove unstable materials and replace with suitable materials and compact.

3.05 COMPACTION

- A. Contractor is responsible for all required compaction tests. Contractor will engage a qualified independent geotechnical engineering testing agency to perform field quality control testing.
 - 1. Allow testing agency to inspect and test subgrades and fill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.
 - 2. Perform soil density and moisture tests on earthwork at locations selected by Owner to show compliance of compaction with specifications. Provide one test every 1,000 square yards of subgrade preparation, 1,800 square yards of fill

placement, or as may be required by geotechnical engineer. Intent is to provide sufficient test to adequately control and represent the compaction procedures.

3. If compaction fails density and moisture tests, rework fill by mechanical means until specified density and moisture is obtained; Contractor shall pay all costs for testing and retesting.
- B. Compact all materials placed in fill.
 - C. Compact selected materials in horizontal layers with tamping or sheepsfoot roller; use roller designed to provide at least 200 psi distributed on one row of knobs; tamping feet must project not less than 6½ inches from face of drum.
 - D. Compact layer by rolling with tamping type roller until full weight of roller is supported by tamping feet.
 - E. Roller will be considered to be supported entirely on its tamping feet when feet do not penetrate more than 3 inches into material being compacted.
 - F. If soil is wet so that it will not sufficiently compact by one passage of roller per inch of loose thickness, provide one discing per 2 inches of loose thickness.
 1. Cut and stir full depth of layer.
 2. Allow interval of not longer than 2 hours between successive discings, or as directed by Geotechnical Engineer.
 3. After discing is completed, compact layer by specified rolling.
 - G. If soil is dry so that it will not satisfactorily compact by rolling, moisten material before compaction; manipulate material to secure proper distribution of moisture before compaction.
 - H. Compact fill slopes progressively until slopes are stable.
 - I. Place fill and compact on all sides of structures to same level as fill operation progresses to protect structures against displacement or other damage.
 - J. Areas adjacent to structures which cannot be tamped with rollers: hand tamp with mechanical tamper to same degree of compaction as specified for other parts of fill.
 - K. Place fill material in maximum of 8 inch lifts.
 - L. Whenever operations are suspended during period, when rain is likely to occur, smooth and compact surface to shed water readily.
 - M. Compact all fill material in non-paved areas to not less than 85% maximum density as determined by ASTM D698 (Standard Proctor Method) with moisture content within -1% to plus 4% points optimum moisture.

- N. Compact all fill material in the upper 12 inches below paved areas, proposed building area, and below footing elevations to not less than 95% maximum density as determined by ASTM D 698 (Standard Proctor Method) with moisture content within - 1% to plus 4% points of optimum.

3.06 SUBGRADE PREPARATION

- A. Shape and consolidate subgrade for placement of pavements.
- B. Prepare subgrade as separate and distinct construction operation just prior to pavement placement.
- C. Provide a uniform composition below top of subgrade of at least 12 inch depth under new paving plus 2 feet outside pavement limits.
- D. Compact upper 12 inches with moisture and density control (95% MD). Moisture content to be -1% to 4% points of optimum.
- E. Excavate top 6 inches of subgrade, scarify, pulverize, mix and recompact with moisture and density control. Pulverize, mix and replace top 6 inches of subgrade and compact with moisture and density control (95% MD).
- F. Other methods for construction of subgrade preparation may be considered for use if uniform composition of finished subgrade is obtained and moisture and density tests taken at top of final subgrade and at 6 inches below top of final subgrade meet specified requirements as approved by Owner.
- G. Remove stones over 3 inches in size from subgrade and stockpile as directed by Owner.
- H. If ruts or other objectionable irregularities form in subgrade during construction, reshape and reroll subgrade before placing pavement; fill ruts or other depressions with material similar to other subgrade material and compact. No extra payment will be made for subsequent subgrade re-compaction.
- I. Construct to elevation and cross section such that, after rolling, surface will be above required subgrade elevation.
- J. Proof roll subgrade with loaded tandem axle truck to determine uniformity and stability of subgrade.
- K. If soft or yielding areas are located, remove unstable materials and replace with suitable materials and compact as specified.
- L. Complete final subgrade within drive areas by excavation to grade by use of steel-shod template supported on side forms or support rollers or by use of automatically controlled subgrade excavating machine.

- M. Check subgrade elevation and grade within drives and parking areas by method approved by Owner prior to paving. No additional payment will be made for rework of subgrade after rain or snow events. The Contractor is responsible for scheduling subgrade operations with pavement installations to ensure proper timing of construction.
- N. Maintain subgrade prior to and during paving operations; repair any damaged or disturbed areas prior to paving. No additional payment will be allowed for the re-compaction of subgrade area if work is not protected.

3.07 FINISH GRADING

- A. Finish excavating and fill areas to conform to lines, grades and slopes as shown on plans or as directed by Owner.
- B. Maximum allowable variation in finished earth grade from design grade outside of paved areas is 0.2 feet. Grade and slope all earth surfaces to drain.
- C. Smooth and finish all earth surfaces disturbed by construction operations.
- D. Provide continuous use of blade grader, dozer or similar equipment of adequate size and power to handle materials encountered during finishing of excavation and fill.
- E. Respread stockpiled topsoil as required for finish grading to a minimum 6 inch depth.
- F. Disc earth surfaces to depth of 3 inches and place topsoil 6 inches deep on finished earth surfaces; smooth and grade ready for turf bed preparation.
- G. Schedule and coordinate topsoil resspreading with seeding, sodding, and planting operations.

END OF SECTION 31 23 00

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SECTION 31 23 16
TRENCH AND BACKFILL

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Trench excavation for pipe systems, manholes, intakes and other structures.
- B. Trench bedding and foundation stabilization.
- C. Pipe and structure placement and backfill.

1.02 DESCRIPTION OF WORK

- A. Perform all excavations required to complete the work shown on the plans.
- B. Prepare trench excavations and shoring for new work, and install the utility lines, structures, and system components, including bedding and foundation stabilization.
- C. Complete specified backfill operation.
- D. Reference is made to the Iowa Department of Transportation Standard Specifications for Highway and Bridge Construction, Series 2001, and all current General Supplemental Specifications and Materials Instructional Memorandum by the term "Iowa DOT Specifications" and/or "Iowa DOT I.M."

1.03 SUBMITTALS

- A. Submit under provisions of Division 1.
- B. Samples, granular bedding material: submit 10-pound samples of each type, if required.
- C. Samples, granular backfill material: submit 10-pound samples, if required.
- D. Gradation reports for fill materials and bedding materials.
- E. Results of Proctor and In-Place Density Tests on backfill.
- F. Contractor will provide Material Certifications to the Engineer.
- G. Contractor's dewatering plan.

1.04 SUBSTITUTIONS

- A. Use only materials conforming to these specifications unless permitted otherwise by Engineer.
- B. Obtain approval of Engineer for all substitutions prior to use.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver only materials that fully conform to these specifications or for which submittals have been provided to Engineer and approved for use.
- B. Store delivered materials and excavated materials in locations that will not interfere with operations and minimize environmental damage.
- C. Grade and shape stockpiles for drainage and protect adjacent areas from runoff. Provide erosion control around stockpiles.
- D. Remove unsuitable and excess materials from the site.

1.06 SCHEDULING AND CONFLICTS

- A. Construction Sequence:
 - 1. Attend a preconstruction meeting if required by Engineer.
 - 2. Submit plan for construction sequence and schedule prior to commencing construction.
- B. Conflict Avoidance:
 - 1. Expose possible conflicts in advance of construction, such as utility lines and drainage structures. Verify elevations and locations of each and verify clearance for proposed construction.
 - 2. Complete other elements of the work that can affect line and grade in advance of other open cut construction unless noted on the plans.
 - 3. Notify Engineer of conflicts discovered or changes needed to accommodate unknown or changed conditions.

1.07 SPECIAL REQUIREMENTS

- A. Stop Work: Stop work and notify Owner immediately if contaminated soils, historical artifacts, or other environmental or historic items are encountered.

- B. Use of Explosives: Not allowed.
- C. Conform to local, state, and federal requirements.
- D. Abandoned Utilities: Remove and dispose of abandoned utility lines including gas mains, water mains, sewer mains, telephone conduits, service lines, etc. required to complete the work. Said work shall be incidental to the project unless otherwise specified.

PART 2 - PRODUCTS

2.01 EXCAVATED MATERIALS

- A. Unclassified Excavation: Excavation of all materials encountered, except rock and over-excavation.
- B. Rock Excavation: Boulders or sedimentary deposits that cannot be removed without continuous use of pneumatic tools or blasting.
- C. Over-excavation: Excavation of soil or rock in trenches below the pipe zone, see Section 31 23 43.
- D. Suitable Excavated Materials for Backfill:
 - 1. Soil, clay, silt, sand, and gravel with moisture content suitable to achieve required compaction. ASTM D 2321, Class II through IVA.
 - 2. Fine-grained soils according to ASTM D 2321 Class IVB (inorganic) may be used in the final backfill upon approval of the Engineer.
 - 3. Adjust moisture content of excessively wet, but otherwise acceptable, material by spreading, turning, aerating, and otherwise working material as necessary to achieve required moisture range.
 - 4. Adjust moisture content of excessively dry, but otherwise acceptable material by adding water, then turning, mixing, and otherwise blending the water uniformly throughout the material until the required moisture range is achieved.
 - 5. Lime or fly ash may be added to soils to produce a suitable backfill material. Uniformly mix soil and additive. Determine Standard Proctor maximum density and optimum moisture content of the modified material. Amount of additive applied is subject to Engineer's approval.
- E. Non-Manufactured (Excavated) Backfill Materials: See SUDAS Section 3010. Also applies for manufactured backfill.

- F. Unsuitable Material: Remove unsuitable materials from the site, including, but not limited to, the following:
1. Rock with gradation not meeting the stated gradation for stabilization material.
 2. Individual stones or concrete chunks larger than 6 inches, and averaging more than one per each cubic foot of soil.
 3. Frozen materials.
 4. Stumps, logs, branches, and brush.
 5. Trash, metal, or construction waste.
 6. Soil in clumps or clods larger than 6 inches, and without sufficient fine materials to fill voids during placement.
 7. Class V Material (ASTM D 2321), as defined in Section 31 23 16, 2.8.
 8. Environmentally-contaminated soils.
 9. Soils deemed unsuitable by the geotechnical engineer.
- G. Replacement of Unsuitable Soils:
1. If the excavated material is determined by the Engineer to be unsuitable and cannot be conditioned so that it becomes suitable, furnish all necessary backfill material.
 2. Remove and dispose of unsuitable material from the site.

2.02 STABILIZATION (FOUNDATION) MATERIALS

- A. Clean 2-1/2 inch crushed stone or crushed portland cement concrete (PCC) material, with the following gradation:

Sieve	Percent Passing
2-1/2"	100
2"	90 to 100
1-1/2"	35 to 70
1"	0 to 20
1/2"	0 to 5

- B. Engineer may authorize a change in gradation subject to materials available locally at time of construction. Subject to the Engineer's approval, crushed concrete may be used if it is within plus or minus 5% of the gradation for each size of material.

2.03 CLASS I GRANULAR BEDDING AND BACKFILL MATERIAL (Storm Sewers and Sanitary Sewers)

- A. Use gravel or crushed stone for granular bedding, complying with the following gradation:

Sieve	Percent Passing
1-1/2"	100
1"	95 to 100
1/2"	25 to 60
No. 4	0 to 10
No. 8	0 to 5

Note: Engineer may authorize the use of crushed PCC, for pipe sizes up to 12 inches, or a change in gradation subject to materials available locally at time of construction.

- B. Use aggregates having a percentage of wear, Grading A or B, not exceeding 50%, determined according to AASHTO T 96.
- C. Compaction: See Section 31 23 16, 3.6.

2.04 CLASS II BACKFILL MATERIAL (Storm Sewers, Sanitary Sewers, and Water Mains)

- A. Class II material is manufactured and non-manufactured open graded (clean) or dense graded (clean) processed aggregate, clean sand, or coarse-grained natural soils (clean) with little or no fines.

- B. Class II material is non-plastic soil less than 1-1/2 inches in size and consists of the following:

SOIL TYPE	DESCRIPTION OF MATERIAL CLASSIFICATION	REMARKS SECTION
GW	Well-graded gravels and gravel-sand mixtures, little or no fines. 50% or more retained on No. 4 sieve. More than 95% retained on No. 200 sieve. Clean.	Where hydraulic gradient exists check gradation to minimize migration. Clean groups suitable for use as drainage blanket and underdrain.
GP	Poorly graded gravels and gravel sand mixtures, little or no fines. 50% or more retained on No. 4 sieve. More than 95% retained on No. 200 sieve. Clean.	
SW	Well-graded sands and gravelly sands, little or no fines. More than 50% passes No. 4 sieve. More than 95% retained on No. 200 sieve. Clean.	
SP	Poorly graded sands and gravelly sands, little or no fines. More than 50% passes No. 4 sieve. More than 95% retained on No. 200 sieve. Clean.	

- C. Compaction: See Section 31 23 16, 3.6.
- D. Class II material may be specified in the contract documents by the Engineer between the pipe embedment zone and the top 2 feet of final backfill when the trench is under the pavement.

2.05 CLASS III BACKFILL MATERIAL (Storm Sewer, Sanitary Sewer, and Water Mains)

- A. Class III material is natural coarse-grained soils with fines.

- B. Class III material consists of the following:

SOIL TYPE	DESCRIPTION OF MATERIAL CLASSIFICATION	REMARKS SECTION
GM	Silty gravels, gravel-sand-silt mixtures. 50% or more retained on No. 4 sieve. More than 50% retained on No. 200 sieve.	Do not use where water condition in trench may cause instability.
GC	Clayey gravels, gravel-sand-clay mixtures. 50% or more retained on No. 4 sieve. More than 50% retained on No. 200 sieve.	
SM	Silty sands, sand-silt mixtures. More than 50% passes No. 4 sieve. More than 50% retained on No. 200 sieve.	
SC	Clayey sands, sand-clay mixtures. More than 50% passes No. 4 sieve. More than 50% retained on No. 200 sieve.	

- C. Compaction: See Section 31 23 16, 3.6.

2.06 CLASS IVA BACKFILL MATERIAL (Storm Sewer, Sanitary Sewer, and Water Mains)

- A. Class IVA material is natural fine grained inorganic soils.
- B. Class IVA material consists of the following:

SOIL TYPE	DESCRIPTION OF MATERIAL CLASSIFICATION	REMARKS SECTION
ML	Inorganic silts, very fine sands, rockflous, silty or clayey fine sands. Liquid limit 50% or less. 50% or more passes No. 200 sieve.	Obtain geotechnical evaluation of proposed material. May not be suitable under deep fills, surface applied wheel loads, and under heavy vibratory compactors and tampers. Do not use where water conditions in trench may cause instability.
CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. Liquid limit 50% or less. 50% or more passes No. 200 sieve.	

- C. Compaction: See Section 31 23 16, 3.6.
- D. Suitable only in dry trench conditions.

2.07 CLASS IVB BACKFILL MATERIAL (Storm Sewer, Sanitary Sewer and Water Mains)

- A. Class IVB material is natural fine-grained inorganic (high elastic silts and plastic clays - fat clay) with a liquid limit greater than 50%.
- B. Class IVB material consists of the following:

SOIL TYPE	DESCRIPTION OF MATERIAL CLASSIFICATION	REMARKS SECTION
MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts. Liquid limit greater than 50%. 50% or more passes No. 200 sieve.	Not to be used in pipe embedment zone.
CH	Inorganic clays of high plasticity, fat clays. Liquid limit greater than 50%. 50% or more passes No. 200 sieve.	

- C. Compaction: See Section 31 23 16, 3.6.
- D. When approved by the Engineer, Class IVB material may be used as final trench backfill in a dry trench.
- E. Do not use in the pipe embedment zone.

2.08 CLASS V BACKFILL MATERIAL (Topsoil)

- A. Class V Material is natural highly organic soils with a liquid limit greater than 50%. See Section 31 23 16, 2.1.
- B. Use Class V Material only as topsoil outside of the pavement, unless otherwise specified or allowed by the Engineer.
- C. Do not use Class V Material in the pipe embedment zone.

2.09 BEDDING AND BACKFILL MATERIALS FOR PIPE CULVERTS

- A. Bedding:
 - 1. Use minimum Type C embedment (see plan details).
 - 2. Install water stop or curtain wall at culvert inlet, as specified in the contract documents.

B. Backfill Material:

1. Use all suitable material excavated for pipe culvert work, as specified in Section 31 23 16, 2.1, for backfill material.
2. Dry suitable material that has excessive moisture prior to placement.
3. Remove unsuitable material, as specified in Section 31 23 16, 2.1, from the project site.

2.10 BEDDING AND BACKFILL MATERIALS FOR SUBDRAINS

A. Drainable Bedding and Backfill Materials Include:

1. Porous backfill material.
2. Pea gravel.
3. Use as shown on the plans or on the detailed drawings.

B. Porous Backfill Material: Crushed stone or gravel with the following gradation.

Sieve	Percent Passing
3/4"	100
1/2"	95 to 100
3/8"	50 to 100
No. 4	0 to 50
No. 8	0 to 8

Iowa DOT Gradation No. 29.

- C. Coarse Aggregate: Use Stabilization Materials, per Section 31 23 16.
- D. Pea Gravel: Use commercially available pea gravel.
- E. Impervious Bedding: Use least permeable on-site materials.
- F. Engineering Fabric: Use Iowa DOT 4196.

2.11 SPECIAL PIPE EMBEDMENT MATERIAL

- A. Concrete Supports: Where specified in the contract documents, construct concrete support systems according to SUDAS Section 3010.
- B. Concrete Bedding, Arch, or Encasement:
1. Concrete: commercial, 4,000 psi compressive strength.

2. Unreinforced, unless otherwise shown on the plans.
 3. Minimum concrete thickness: 6 inches or as shown on the plans.
- C. Flowable Mortar:
1. Approximate quantities per cubic yard:
 - a. Cement 100 pounds
 - b. Fly ash 300 pounds
 - c. Fine aggregate 2,600 pounds
 - d. Water, approximate 70 gallons
 2. Compressive strength at 28 days; 100 psi to 200 psi.
- D. Controlled Low Strength Material (CLSM):
1. Approximate quantities per cubic yard:
 - a. Cement 50 pounds
 - b. Fly ash 250 pounds
 - c. Fine aggregate 2910 pounds
 - d. Water, approximate 60 gallons
 2. Compressive strength at 28 days 50 psi.

PART 3 - EXECUTION

3.01 PREPARATION

- A. When natural soils for Class II, III, and IV backfill material is required as specified in plan details, provide written certification from a testing laboratory that the material meets the class specified if so requested by the Engineer.
- B. Locate, mark, and protect existing utilities and facilities in the work area.
- C. Provide access to utility service locations, such as valves, manholes, and utility poles.
- D. Identify owners of utilities on or near the site, and notify them of operations to occur.

- E. Protect existing facilities and landscaping features, or replace as shown on the plans.
- F. Protect bench marks, control points and land survey monumentation, or replace at Contractor's expense.

3.02 TRENCH EXCAVATION

- A. Notify the Engineer prior to the start of excavation activities.
- B. Remove and stockpile the top 8 inches of topsoil for subsequent reuse.
- C. Place excavated material away from trench. Grade spoil piles to drain. Do not allow spoil piles to obstruct drainage.
- D. Remove rock, rubbish, boulders, debris, and other unsuitable materials at least 6 inches below, and on each side of the pipe. Restore grade using soil suitable for backfill.
- E. Correct unauthorized excavation at no cost to Owner, using bedding or stabilization materials.
- F. Provide protective fences and barricades around open excavations, appropriate to the surrounding area.
- G. Provide weight tickets for stabilization material to the Owner at the time of delivery.
- H. Trench Excavation for Sanitary Sewers, Storm Sewers, Water Mains, and Pipe Culverts:
 - 1. Maximum and minimum pipe trench width: See plan details.
 - 2. Flat trench bottom, conduit bearing directly on trench bottom (not applicable for rock excavation) for water main pipe only with bell hole shaping:
 - a. Shape trench bottom to support pipe around 1/4 of perimeter for the full length of the pipe barrel.
 - b. Provide bell holes.
 - 3. Trench bottom, conduit supported by bedding material:
 - a. Excavate trench as shown on the detailed drawings.
 - b. Install bedding material to support the full length of the pipe barrel.
 - 4. Trench depth:
 - a. See plan details.

- b. For those material types not shown in the plan details, the maximum height of bury will be 20 feet. Installations greater than 20 feet require submittal of licensed professional engineer trench design and certification.
- 5. Conform all trench operations to current OSHA regulations.
- I. Structure Excavation:
 - 1. For concrete structures and parts of structures without footings, 18 inches outside the horizontal projection of the structure.
 - 2. For concrete structures with footings, 18 inches outside the footings.
 - 3. For anchor rods, 12 inches on each side of the rod.
 - 4. For buried anchors, the face of the buried anchor on one side and 24 inches outside the buried anchor on the other face.

3.03 ROCK OR UNSTABLE SOILS IN TRENCH BOTTOM

- A. Notify the Engineer prior to over-excavation.
- B. Contractor will determine the need for trench bottom stabilization prior to installation of pipes and structures.
- C. See plan details for over-excavation of rock and wet or soft foundations.
- D. Provide weight tickets for the stabilization material to the Owner at the time of delivery.

3.04 SHEETING, SHORING, AND BRACING

- A. Conform sheeting and bracing of all excavations to the latest state and federal regulations governing safety of workers in the construction industry.
- B. Leave in place all temporary sheeting below 2 feet over top of pipe unless sheeting removal plan is approved by Engineer. Conform all trench operations to current OSHA regulations.
- C. Move trench boxes carefully to avoid excavated wall displacement or damage.
- D. When necessary or required, install adequate sheeting and bracing to prevent ground movement that may cause damage or settlement to adjacent structures, pipelines, and utilities.
- E. Any damage due to settlement because of failure to use sheeting or because of inadequate bracing, or through negligence or fault of the Contractor in any other manner, shall be repaired at the Contractor's expense.

- F. For sides of trenches in unsuitable, loose, or soft material, shore, sheet, brace, slope, or otherwise support by means of sufficient strength to protect employees working within them.
- G. Where excavations are made with vertical sides that require supporting, use sufficient strength for sheeting and bracing to sustain the sides of the excavations and to prevent movement that could in any way injure the work or adjacent structures, or diminish the working space sufficiently to delay the work.
- H. Select sheeting and bracing material of sufficient dimensions and strength to adequately support the sides of trenches and excavations, which will not split when driving and will be free of imperfections that may impair its strength or durability.
- I. Drive sheeting to true alignment and ensure contact of adjacent pieces.
- J. In wet excavation, use grooved sheeting to prevent passage of soil. Fill any voids between sheeting and face of excavation with suitable material.
- K. Do not remove sheeting and bracing before the completion of the work, unless otherwise directed by the Engineer.
- L. For sheeting left in place, cut off 18 inches for clearance below the bottom of the pavement in streets/highways and 18 inches below the original ground surface, unless otherwise required by the contract documents or the Engineer. Leave in place all temporary sheeting below 2 feet over top of pipe, unless a sheeting removal plan is approved by Engineer.

3.05 DEWATERING

- A. Do all work in dry conditions; do not install pipes on excessively wet soil.
- B. Perform the dewatering operation according to the dewatering plan submitted to the Engineer. Dewatering operations may be modified from the plan for actual field conditions, with approval of the Engineer.
- C. Adequate dewatering is the Contractor's responsibility unless otherwise stated in the contract documents.
- D. Install dewatering system appropriate for the soil conditions.
- E. Maintain water levels sufficiently below the bottom of trench excavation, (typically 2 feet) to prevent upward seepage.
- F. Provide for handling water encountered during construction:
 - 1. Prevent surface water from flowing into excavation. Remove water as it accumulates.

2. Do not use sanitary sewers for disposal of trench water. Discharging water into storm sewers requires Engineer's approval.
 3. Do not discharge water onto adjacent property without property owner's approval.
 4. Maintain and control water discharge as necessary to prevent a safety hazard for vehicular and pedestrian traffic.
 5. Direct water discharge away from electrical facilities or equipment and intersections.
 6. Use noise and fume reducing dewatering equipment to minimize disturbance.
 7. Provide at least two operating pumps for each trench opened in wet ground, and at the same time have one pump in reserve.
- G. Place backfill in trenches prior to stopping dewatering operations.
- H. Protect trench water discharge points from erosion.
- I. Operate dewatering systems to prevent damage to adjoining structures and facilities.
- J. Monitor adjoining structures and facilities during dewatering operations. Cease dewatering operations and notify the Engineer if damage is observed.

3.06 PIPE INSTALLATION

Refer to SUDAS Section 3010, as appropriate, for the installation. Use only the types of materials shown for each position within the trench, for the given groundwater conditions, for the compaction to be provided, and for the type of pipe being installed.

- A. Pipe Bedding:
1. Shape pipe bed to evenly support pipe at the proper line and grade, with full contact under the bottom of the pipe.
 2. Install pipe and system components.
 3. Place bedding simultaneously on both sides of the pipe. Correct any pipe displacements before proceeding.
 4. Place bedding in lifts no greater than 6 inches thick, consolidate, and moderately compact.
 5. Concrete encasement: Install where shown on the plans.

6. If required in the contract documents or if approved by the Engineer, flowable mortar or controlled low strength material may be used in lieu of other bedding material types.
7. Secure pipe against displacement or flotation prior to placing flowable mortar or concrete encasement.

B. Haunch Support:

1. Place granular haunch material in lifts no greater than 6 inches thick, consolidate, and moderately compact by slicing with a shovel or using other approved techniques.
2. If required in the contract documents, or if approved by the Engineer, concrete, flowable mortar, or controlled low strength material may be used instead of other haunch material types. Secure pipe against displacement or flotation prior to placing flowable mortar, controlled low strength material, or concrete encasement.

C. Primary and Secondary Backfill (Pipe Cover):

1. Place pipe cover material in 6-inch lifts. Compact Class I and II (cohesionless) materials to a minimum of 65% Relative Density. Compact Class III and IVA (cohesive) materials to a minimum of 95% of maximum Standard Proctor Density.
2. If required in the contract documents or if approved by the Engineer, flowable mortar or controlled low strength material may be used in lieu of other cover material types. Secure pipe against displacement or flotation prior to placing flowable mortar or concrete encasement.
3. Special pipe support: If required, provide special pipe support as shown on the plans (See SUDAS Section 3010).

D. Final Trench Backfill:

1. Place backfill in the trench immediately after recording locations of connections and appurtenances or at Engineer's direction.
2. Place backfill adjacent to structures immediately after concrete has reached design strength and connecting work has been completed.
3. Allow no more than 100 feet of trench to be open overnight or when work is not in progress except as provided on the plans.

4. Place suitable excavated backfill:
 - a. Carefully place backfill over top of pipe and around structures.
 - b. Compact as required.
5. Compaction:
 - a. Within pavement influence area, compact each lift to a minimum of 65% Relative Density for Class I and II (cohesionless) materials and a minimum of 95% of maximum Standard Proctor Density for Class III and IVA (cohesive) materials.
 - b. Outside of the pavement influence area, compact to a minimum of 50% Relative Density for Class I and II (cohesionless) materials and a minimum of 90% of maximum Standard Proctor Density for Class III and IVA (cohesive) materials.
 - c. In areas more than 3 feet below pavement structure, place backfill in lifts no thicker than 8 inches.
 - d. In areas less than 3 feet below pavement structure, place backfill in lifts no thicker than 6 inches. Terminate backfill at 8 inches below finish grade in areas to remain unpaved, and to subgrade elevation in areas to be paved. Place 8 inches of topsoil in unpaved areas.
 - e. When crossing under levees, railroads, and State or Federal highways, comply with the compaction requirements of these jurisdictions, if more stringent than these requirements.
 - f. For Vitrified Clay Pipe (VCP), keep all heavy compaction equipment 5 feet above the top of the pipe. In the area less than 5 feet, use hand held compactors. Do not allow the compactor to come in contact with the pipe.
6. Moisture Range: Obtain required compaction within a soil moisture range of -1% above optimum moisture content.
7. Dispose of surplus and unsuitable materials.
8. Hydraulic compaction (flooding with water) is not allowed.
- E. Casing Pipe: Place bedding and backfill materials for casing pipe the same as for a rigid gravity flow pipe.

3.07 PIPE INSTALLATION IN CONSTRUCTED EMBANKMENTS

Install all pipes in trenches according to SUDAS Section 3010. When allowed by the contract documents, pipes may be constructed in embankments as follows:

A. Placing Pipe Sections: See Division 31 and 33.

B. Placing Backfill for Pipes:

1. Thoroughly tamp backfill under and around the pipe and in layers not to exceed 8 inches for the full length and width of the pipe.
2. Place backfill and thoroughly tamp around and over the pipe for its full length.
3. Extend the completed embankment on both sides of the pipe from the original ground line to at least 1 foot above the top of the pipe with a slope as shown in the contract documents. Construct the embankment over the pipe with a width no less than the outside diameter of the pipe and centered over the pipe. If necessary to accommodate construction traffic, increase the height of fill to the nominal diameter of the pipe or 3 feet, whichever is greater.
4. When pipe are laid wholly or partly in a trench, granular backfill material may be required for backfill. Compact the remainder of the fill to at least 1 foot above the top of the pipe with slopes as outlined above.
5. If the trench has been cut wide enough to permit use of a roller, after the pipe is bedded, thoroughly tamp the backfill material under and alongside the pipe with a mechanical tamper to the mid-height elevation of the pipe.
6. The contract documents may require placement of pipe with moisture control. When not required, place roadway pipe after construction of an embankment by methods that will produce results equivalent to those required for construction of the embankment, except that moisture determinations will be waived for placing backfill completed within 48 hours after excavation.
7. In addition to the normal backfill material requirements, when directed by the Engineer, build such approach fills to provide a roadway 10 feet in width over the pipe with grades no steeper than 10%.

3.08 STRUCTURE BEDDING

A. Bedding for Structures Bearing on Undisturbed Soils:

1. Shape the bottom to accurate grade and size.
2. Remove loose material, large clods, stones, and foreign materials.
3. In unstable soils or rock conditions, see Section 31 23 16, 3.3 for stabilization requirements.

B. Bedding for Structures Bearing on Bedding Material:

1. Over excavate to minimum of 8 inches or as specified in the contract documents.

2. Place bedding material for structures according to the contract documents and with the material and control specified.

3.09 STRUCTURE BACKFILL

- A. Removal of Forms and Falsework: See Section 33 39 00.
- B. Placement of Backfill: Place backfill after structure concrete has reached at least 80% of the design strength and connecting work has been completed, unless otherwise specified. Determine strengths under comparable conditions. If strength is not determined, place backfill after 14 days.
- C. Backfill Against Walls and Around Structures:
 1. Where backfill is required on both sides of a concrete wall and around all sides of monolithic structures, proceed with filling operations simultaneously on all sides of walls and structures so the fill is kept at approximately the same elevation at all times. Consider concrete box, arch, and circular culvert monolithic structures.
 2. Compact the 3 feet closest to all walls or wing faces by pneumatic or hand tampers only.
- D. Placing Backfill with Excavated Material:

Unless otherwise specified, see Section 31 23 16, 3.6, D for suitable excavated materials for backfill.

3.10 OPEN CUT CASING PIPE INSTALLATION

- A. Casing Pipe: Install casing pipe according to Section 31 23 16, 3.1 to 3.7, as appropriate.

3.11 FIELD QUALITY CONTROL

- A. References:
 1. ASTM C 136; Standard Method for Sieve Analysis of Fine and Coarse Aggregates.
 2. ASTM D 698; Standard Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Moisture Using 5.5 pound (4.54 kg) Rammer and 12 inch (305 mm) Drop. (Standard Proctor Method)
 3. ASTM D 1556; Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
 4. ASTM D 2216; Standard Test Method for Laboratory Determination of Water

(Moisture) Content of Soil and Rock by Mass.

5. ASTM D 2922 and D 3017; Test Methods for Density of Soil and Soil-Aggregate in Place and Water Content of Soil and Rock by Nuclear Methods (Shallow Depth).
 6. ASTM D 4253 and D 4254, Test Methods for Maximum Index Density of Soils using a Vibratory Table and Minimum Index Density of Soils and Calculation of Relative Density.
- B. Compaction Testing: Provide compaction testing of backfill, using the services of an independent testing laboratory approved by the Engineer.
- C. Schedule Testing: Notify Engineer when work is prepared for testing.
- D. Soil Testing:
1. Cohesive soils: Determine moisture-density relationships by ASTM D 698 (Standard Proctor). Perform at least one test for each type of cohesive soil used.
 2. Cohesive soils: Determine in-place density and moisture content using ASTM D 1556 (sand-cone method) and D 2216 or ASTM D 2922 and D 3017 (nuclear).
 3. Non-cohesive soils: Determine maximum and minimum index density and calculate relative density using ASTM D 4253 and D 4254 (cohesionless soils).
 4. Gradation: Test according to ASTM C 136.
- E. Testing Frequency and Locations: Perform testing of the final trench backfill, beginning at a depth of 2 feet above the top of the pipe, as follows:
1. Contractor provided:
 - a. Make one test per each 2 vertical feet of consolidated fill at each street crossing.
 - b. one test per each 2 vertical feet of consolidated fill for each 200 horizontal feet of trench.
 - c. Additional testing may be required by Engineer if non-compliance or a change in conditions occur.
 - d. Coordinate the timing of testing with the Engineer.
 - e. The Engineer will determine the location of testing.
 - f. If necessary, excavate to the depth and size as required by the Engineer to allow compaction tests. Place backfill and recompact.
- F. Test Failure: Rework, recompact, and retest as necessary until specific compaction is

achieved in all areas of the trench.

- G. Retesting: In event of failed tests, Engineer may require retesting as deemed necessary. Costs of such retesting shall be paid by the Contractor, at no additional cost to the owner.

END OF SECTION 31 23 16

SECTION 31 23 43
EXCAVATION AND FILL FOR PIPES AND STRUCTURES

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. This part of specification includes excavation and backfill for culverts, storm sewers, water mains, sanitary sewers, services and utility structures.

1.02 DESCRIPTION OF WORK

- A. Excavate all materials encountered to depth indicated or specified; comply with state and federal safety regulations.
- B. Remove, replace and repair fences, signs and other obstructions as necessary for construction.
- C. Pile excavated material suitable for backfill in an orderly manner sufficient distance back from edge of excavation to avoid roll back, slides or cave-ins.
- D. Remove soil not suitable for backfill; waste as directed by Owner.
- E. Where new construction crosses or closely parallels existing utilities or utility services, excavate in advance of piping laying; determine location and crossing arrangement including line and grade.
- F. Excavate in open cut under existing streets, utilities and structures except as shown on plans or as directed by Owner.
- G. Related work covered by other section:
 - 1. Section 31 23 00: Excavation and Fill
 - 2. Section 31 10 00: Site Clearing

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Earth: all materials not classified as rock or rubble; includes clay, silt, sand, gravel, hardpan, disintegrated shale and rock debris, junk brick, loose stones and boulders that can be removed by use of suitable excavating equipment.
- B. Rock: boulders larger than 75% of rated capacity of excavating equipment in use or solid deposits so firmly cemented together that they cannot be removed without continuous use of pneumatic tools or blasting.
- C. Rubble: buried concrete foundations, beams, walls and other materials which require continuous use of pneumatic tools or blasting.
- D. Reference to percent maximum density shall mean a soil density not less than the stated percent of maximum density for soil as determined by ASTM D698, "Moisture Density Relations of Soils", using 5.5-lb. rammer and 12" drop. (Standard Proctor Method).
- E. Contractor is responsible for over excavating and replacing unsuitable material for backfilling and topsoil. Unsuitable material can be defined as:
 - 1. Rock or concrete chunks greater than 6 inches and averaging more than one per cubic feet of earth.
 - 2. Rock not meeting gradation standards as outlined in Part 3.2 of Section 31 23 43 "Excavation And Fill For Pipes And Structures".
 - 3. Frozen materials.
 - 4. Stumps, logs, branches and brush.
 - 5. Trash or construction waste.
 - 6. Clumps of earth material larger than 6-inches and without adequate fine materials to fill voids.
 - 7. ASTM D 2321 Class V materials.
 - 8. Low plasticity cohesive fill having a liquid limit less than 45 and a plasticity index less than 23.

PART 3 - EXECUTION

3.01 EXCAVATION FOR STRUCTURES

- A. Includes excavation for culverts, manholes, intakes, and other appurtenances.
- B. Excavate as required to firm, undisturbed soil; if excavation is carried below bottom of foundations as shown on plans, fill with granular pipe bedding and compact at no additional cost to Owner.
- C. When unstable material which may not provide suitable foundation is encountered, notify Owner.
 - 1. If material is considered unsuitable for foundations, Owner will specify and authorize remedial measures.
 - 2. If removal of unstable material is authorized, overexcavate and replace with stabilizing material at a depth determined by the Owner.
- D. Provide sheeting, shoring, and bracing where required to hold walls of excavation to protect existing structures or utilities or to provide for safety of workmen.
- E. Stabilizing material: sharp, clean crushed stone; comply with following gradation:

Sieve	% Passing
2 1/2"	100
2"	90-100
1 1/2"	35-70
1"	0-15
1/2"	0-5

3.02 TRENCH EXCAVATION

- A. Keep width of trench as narrow as possible and still provide adequate room for backfill, jointing, and compaction.
- B. Keep sides of trench as nearly vertical as practicable; maintain vertical walls below top of pipe.
- C. Excavate to required grade to provide proper bedding; if trench is overexcavated, fill with stabilizing material.
- D. When unstable material which may not provide suitable foundation for pipe is encountered, notify Owner.
 - 1. If material is considered unsuitable for pipe foundation, Owner will specify and authorize remedial measures.

2. If removal of unstable material is authorized, overexcavate and replace with stabilizing material. Place pipe bedding on top of stabilizing material.

E. Stabilizing material: sharp, clean crushed stone; comply with following gradation:

Sieve	% Passing
2 1/2"	100
2"	90-100
1 1/2"	35-70
1"	0-15
1/2"	0-5

F. Remove large clods, stones, and other foreign material from bottom of trench.

G. Bottom of storm sewer or sanitary sewer service trench:

1. Provide pipe bedding as shown on plans.
2. Granular pipe bedding: sharp, clean crushed stone; comply with following gradation, dependent upon pipe diameter

Sieve	(8" - 18" pipe drain) % Passing	(Over 18" pipe drain) % Passing
1 1/2"	----	100
1"	100	95-100
3/4"	80-95	35-70
1/2"	50-60	25-50
3/8"	20-40	10-30
No. 4	0-5	0-5

3. Owner may authorize change in gradation subject to materials available locally at time of construction.
4. Provide suitable bell holes at each pipe joint so bells provide no point bearing; provide access around circumference of pipe for proper jointing.
5. Compact pipe bedding by rodding or slicing with shovel. No lift shall have a depth greater than 6 inches.

H. Bottom of water main trench:

1. Provide firm, stable and uniform support for full length of pipe.
2. In normal soils, lay pipe on layer of loose material normally left by excavator after leveling trench bottom. If no loose material is left, shave soft material from trench walls.

3. If trench bottom is rocky or hard, overexcavate trench 6 inches and replace with 6 inches of select foundation material, as approved by the Owner, on each side of and below all pipe and accessories.
4. If trench bottom is unstable, overexcavate to depth required by Owner and replace with like depth of select foundation material.
5. Provide granular bedding at hydrants as shown on plans.

3.03 ROCK AND RUBBLE EXCAVATION

- A. If trench bottom is extremely hard or is in rock or rubble where there is a possibility of pipe being subjected to point bearing:
 1. Overexcavate trench bottom 6" minimum below grade.
 2. Backfill overexcavation with suitable material; place pipe bedding material on top of resulting bottom of trench.
- B. Use of explosives: Not permitted.
- C. Dispose of excavated rock and rubble not suitable for backfill.

3.04 SHEETING, SHORING AND BRACING

- A. Where required on plans or when the material to be excavated is unstable, or the bottom of the trench will not hold its form when excavated, install tight sheeting/shoring to a depth necessary to control the action of the bottom.
- B. This support shall prevent any movement which would in any way injure the sewer or adjacent property, private or public utilities, diminish the width necessary for proper construction procedures, or otherwise injure or delay the work.
- C. Contractor shall assume all liability for any and all damages to property, or injury to workmen and other persons, which may occur if sheeting is or is not used.
- D. Contractor shall furnish and place such sheeting/shoring, sheet piling, planking, and bracing as may be required to support both sides of excavation. Cost of sheeting, shoring and related support is incidental to sewer line construction.
- E. Contractor shall install sheeting/shoring in a manner to minimize vibration in adjacent buildings and structures.
- F. Leave in place all sheeting below a level 2' over top of pipe.
- G. Leave sheeting and shoring in place 2' over top of pipe when removal might damage new pipe.

- H. All trench operations shall conform to current OSHA regulations.

3.05 DEWATERING

- A. Do all work in dry conditions; provide for handling water encountered during construction.
- B. Lay no pipe in or pour no concrete on excessively wet soil.
- C. Maintain water levels adequately below the bottom of the trench excavation to prevent upward seepage.
- D. Prevent surface water from flowing into excavation; remove water as it accumulates.
- E. Divert stream flow away from areas of construction.
- F. Do not pump water onto adjacent property without approval of property owner.
- G. Do not use sanitary sewers for disposal of trench water.

3.06 BACKFILL FOR STRUCTURES

- A. Contractor is responsible for all required compaction tests. Contractor will engage a qualified independent geotechnical engineering testing agency to perform field quality control testing.
 - 1. Allow testing agency to inspect and test each backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.
 - 2. Perform soil density and moisture tests on earthwork at each compacted initial and final backfill layer, at least one test for each 150 feet or less of trench length, but no fewer than two tests.
 - 3. If trench backfill or subgrade fails density tests, rework backfill or subgrade and retest until specified density is obtained. Contractor shall pay all costs for testing and retesting.
- B. Backfill after concrete or masonry has cured.
- C. Backfill with suitable material removed from excavation except where other backfill is specified; use no debris, frozen earth, large clods or stones.
- D. Backfill simultaneously on all sides of structure; save structure from damage at all times.

- E. Compact backfill at structures to 95% minimum density.

3.07 TRENCH BACKFILL

- A. Backfill trench immediately after location of connections and appurtenances have been recorded.
- B. Construct manholes, intakes and appurtenances and backfill as work progresses. Allow no more than 100 feet of trench to be open at one time.
- C. Backfill with suitable excavated material or borrow materials. Use no large stones, large clods, organic matter, rubbish or frozen material.
- D. If excavated materials have excessive soil moisture and cannot be compacted to specified density, dry material by discing or mixing with dry soils or remove and replace with suitable borrow materials.
- E. If sufficient suitable excavated material is not available, remove and dispose of unsuitable excavated material. Furnish suitable borrow materials to complete trench backfill.
- F. Backfill simultaneously on both sides of pipe.
- G. Hand place and compact granular pipe bedding adjacent to pipes as shown in details on plans (RCP). Hand place and compact granular pipe bedding adjacent to pipe and to 1' over top of pipe (PVC). Compaction: minimum density of 90% standard proctor or 45% relative density.
- H. Hand place and compact suitable excavated material adjacent to pipe and to 1' over top of pipe (RCP). Backfill in layers not exceeding 6" and compact to 95% minimum density.
- I. Backfill trenches within pavement area with suitable material in 12" lifts and compact to not less than 95% minimum density.
- J. Backfill trenches in other areas with suitable material in 12" lifts and compact to not less than 90% maximum density. Fill upper 12" of trench with topsoil.
- K. Compact backfill with pneumatic or mechanical tampers adjacent to or within 12" over pipe. Rollers or vibrating plate compactors may be used after sufficient backfill has been placed to assure that such equipment will not damage or disturb the pipe.
- L. Do not use drop hammers, backhoe bucket, flooding or jetting for compaction of trench backfill.

3.08 SURFACE RESTORATION

- A. Grade tops of trenches to smooth, uniform lines without large clumps, clods or debris.
- B. Dispose of all brush and rubbish off the owners property.

END OF SECTION 31 23 43

SECTION 31 25 00
EROSION AND SEDIMENT CONTROL

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Erosion Control Measures
- B. Velocity and Flow Control Measures
- C. Sediment Control Measures
- D. Application/Installation of Measures
- E. Removal/Replacement of Measures

1.02 DESCRIPTION OF WORK

- A. Furnish all materials; install, construct, maintain, and remove specified erosion control devices; at locations shown on the plans, or where specified by the Engineer, in accordance with the contract documents.
- B. Complete the required construction work on this project, while minimizing soil erosion and controlling water pollution. Maintain these features as specified, from initial construction stages to final completion of the project.
- C. Reference is made to the Iowa Department of Transportation Standard Specifications for Highway and Bridge Construction, Series 2001, and all current General Supplemental Specifications and Materials Instructional Memorandum by the term "Iowa DOT Specifications" and/or "Iowa DOT I.M."

1.03 SUBSTITUTIONS

Follow the General Provisions.

1.04 DELIVERY, STORAGE, AND HANDLING

Follow the General Provisions.

1.05 SCHEDULING AND CONFLICTS

Follow the General Provisions, as well as the following:

- A. Implement erosion and sediment control measures at the appropriate time(s).
- B. Coordinate construction to minimize damage to erosion and sediment control devices.

1.06 SPECIAL REQUIREMENTS

- A. Protection of Property: Prevent accumulation of earth, sediment, or debris from project site onto adjoining public or private property. Remove any accumulation of earth or debris immediately, and take remedial actions for prevention.

PART 2 - PRODUCTS

2.01 FILTER MATERIAL

- A. Material for use in filter socks, filter berms, and other areas, as specified.
- B. Use material derived from wood, bark, or other, non-toxic vegetative feedstocks.
- C. Use material with no visible admixture of refuse or other physical contaminants, nor any material toxic to plant growth.
- D. Use material meeting the following particle sizes:

Sieve Size	Percent Passing ¹
2"	100
1"	90-100
3/8"	0-30
¹ The target flow rate of in-place material is 10 gal/min/lf. The Engineer may approve use of alternate materials meeting the target flow rate.	

2.02 FILTER SOCK

- A. For slope and sediment control applications, use a continuous, tubular, knitted, mesh netting with 3/8 inch openings, constructed of 5-mil thickness, photodegradable HDPE.
- B. For inlet protection, use a continuous, tubular, knitted, mesh netting with 3/8 inch openings, constructed of 500-denier polypropylene.
- C. Use 1 inch by 2 inch (minimum) hardwood stakes or stakes of equivalent strength.

2.03 SILT FENCE

Use silt fence that meets the following requirements:

- A. Fabric: Conform to Iowa DOT Article 4196.01.
- B. Posts: 4 foot minimum steel (T-section) weighing at least 1.25 pounds per foot, exclusive of anchor plate. Painted posts are not required.
- C. Fastener: Wire or plastic ties with a minimum tensile strength of 50 pounds.

2.04 DUST CONTROL

- A. Water: Use potable water or water from a source approved by the engineer.
- B. Calcium Chloride: Conform to Iowa DOT Article 4194.01.
- C. Lignosulfonate (Tree Sap): Use a commercially-available product with known lignin content.
- D. Soapstock (Soybean Oil):
 - 1. Use a commercially-available, undiluted, soybean oil soapstock emulsion.
 - 2. Conform to specific storage, transportation, temperature, and application equipment requirements, as recommended by the manufacturer.

2.05 EROSION CONTROL MULCH

- A. Conventional Mulch:
 - 1. Use dry straw (oats, wheat barley, or rye) or hay (bromegrass, timothy, orchard grass, alfalfa, or clover).
 - 2. Use material that is free of noxious weed, seed-bearing stalks, or roots and will be inspected and approved by the Engineer prior to use.
 - 3. Other materials, subject to the approval of the Engineer may be used.
- B. Hydromulch:
 - 1. Wood Cellulose:
 - a. Use material that is a natural or cooked cellulose fiber processed from whole wood chips, or a combination of up to 50% of cellulose fiber produced from whole wood chips, recycled fiber from sawdust, or recycled paper (by volume).

- b. Product contains a colloidal polysaccharide tackifier adhered to the fiber to prevent separation during shipment and avoid chemical co-agglomeration during mixing.
 - c. Form a homogeneous slurry of material, tackifier, and water.
 - d. Use a slurry that can be applied with standard hydraulic mulching equipment.
 - e. Dye the slurry green to facilitate visual metering during application.
 - f. Do not use materials that have growth or germination-inhibiting factors or any toxic effect on plant or animal life when combined with seed or fertilizer.
2. Bonded Fiber Matrix (BFM):
- a. Produced from long-strand wood fibers, held together by organic tackifiers and bonding agents that, when dry, become insoluble and non-dispersible.
 - b. Upon curing 24 to 48 hours, form a continuous, 100% coverage, flexible, absorbent, erosion-resistant blanket that encourages seed germination.
 - c. Manufactured to be applied hydraulically.
 - d. Physical Properties:
 - 1) Fibers: Virgin wood, greater than 88% of total volume.
 - 2) Organic Material: Greater than 96% of total volume.
 - 3) Tackifier: 8-10%.
 - 4) pH: 4.8 minimum.
 - 5) Moisture Content: 12% +/- 3%.
 - 6) Water-holding Capacity: 1.2 gal/lb.
 - e. Dyed green to facilitate visual metering.
3. Mechanically-Bonded Fiber Matrix (MBFM):
- a. Produced from long-strand wood fibers and crimped, interlocking synthetic fibers.

- b. Within two hours of application, form a continuous, 100% coverage, flexible, absorbent, porous, erosion-resistant blanket that encourages seed germination.
- c. Manufactured to be applied hydraulically.
- d. Physical Properties:
 - 1) Wood Fibers: 73% minimum.
 - 2) Tackifier: 10% +/- 1%.
 - 3) Crimped, Interlocking Synthetic Fibers: 5% +/- 1%.
 - 4) Moisture Content: 12% +/- 3%.
 - 5) Water holding capacity: 1.2 gal/lb.
 - 6) Minimum pH: 4.8.
- e. Dyed green to facilitate visual metering.

2.06 TEMPORARY ROLLED EROSION CONTROL PRODUCTS (RECP)

Use temporary rolled erosion control products that are classified and have material properties according to the Erosion Control Technology Council's (ECTC) guidelines as follows:

A. Material Classification:

- 1. RECP Type 1 (Ultra Short-Term): Functional longevity of three months or less and classified as follows:
 - a. RECP Type 1.A: Mulch control net, consisting of a photodegradable synthetic mesh or woven biodegradable natural fiber netting.
 - b. RECP Type 1.B: Netless rolled erosion control blankets, consisting of natural and/or polymer fibers, mechanically interlocked and/or chemically adhered together to form a RECP.
 - c. RECP Type 1.C: Single-net erosion control blankets and open weave textiles, consisting of processed degradable natural and/or polymer fibers, mechanically bound together by a single rapidly-degrading, synthetic or natural fiber netting, or an open weave textile of processed rapidly-degrading natural or polymer yarns or twines woven into a continuous matrix.
 - d. RECP Type 1.D: Double-net erosion control blankets, consisting of

processed degradable natural and/or polymer fibers, mechanically bound together between two rapidly-degrading, synthetic or natural fiber nettings.

2. RECP Type 2 (Short-Term): Functional longevity between 3 and 12 months and classified as follows:
 - a. RECP Type 2.A: Mulch control net, consisting of a photodegradable synthetic mesh or woven biodegradable natural fiber netting.
 - b. RECP Type 2.B: Netless rolled erosion control blankets, consisting of natural and/or polymer fibers, mechanically interlocked and/or chemically adhered together to form a RECP.
 - c. RECP Type 2.C: Single-net erosion control blankets and open weave textiles, consisting of an erosion control blanket composed of processed degradable natural or polymer fibers, mechanically bound together by a single degradable synthetic or natural fiber netting to form a continuous matrix, or an open weave textile composed of processed degradable natural or polymer yarns or twines woven into a continuous matrix.
 - d. RECP Type 2.D: Double-net erosion control blanket, consisting of processed degradable natural and/or polymer fibers, mechanically bound together between two degradable synthetic or natural fiber nettings.
3. RECP Type 3 (Extended Term): Functional longevity between 12 and 24 months and classified as follows:
 - a. RECP Type 3.A: Mulch control nets, consisting of a slow-degrading synthetic mesh or woven natural fiber netting.
 - b. RECP Type 3.B: Erosion control blankets and open weave textiles, consisting of processed slow-degrading natural or polymer fibers, mechanically bound together between two slow-degrading synthetic or natural fiber nettings to form a continuous matrix, or an open weave textile composed of processed slow-degrading natural or polymer yarns or twines woven into a continuous matrix.
4. RECP Type 4 (Long Term): Functional longevity of 36 months and classified as follows: Erosion control blankets and open weave textiles, consisting of processed slow-degrading natural or polymer fibers, mechanically bound together between two slow degrading synthetic or natural fiber nettings to form a continuous matrix, or an open weave textile composed of processed slow-degrading natural or polymer yarns or twines woven into a continuous matrix.

B. Properties and Performance:

1. Testing performed according to the ECTC's Testing Procedures for Rolled Erosion Control Products. Verify manufacturer's test results by independent testing.
2. Material properties meeting the Erosion Control Technology Council's (ECTC) Standard Specifications for Rolled Erosion Control Products as follows:

Classification	Slope Application	Channel Application	Min. Tensile Strength
	Max. Grade*	Permissible Shear Stress	
RECP Type 1.A	5:1 (H:V)	0.25 lb/ft ²	5 lb/ft
RECP Type 1.B	4:1 (H:V)	0.50 lb/ft ²	5 lb/ft
RECP Type 1.C	3:1 (H:V)	1.50 lb/ft ²	50 lb/ft
RECP Type 1.D	2:1 (H:V)	1.75 lb/ft ²	75 lb/ft
RECP Type 2.A	5:1 (H:V)	0.25 lb/ft ²	5 lb/ft
RECP Type 2.B	4:1 (H:V)	0.50 lb/ft ²	5 lb/ft
RECP Type 2.C	3:1 (H:V)	1.50 lb/ft ²	50 lb/ft
RECP Type 2.D	2:1 (H:V)	1.75 lb/ft ²	75 lb/ft
RECP Type 3.A	5:1 (H:V)	0.25 lb/ft ²	25 lb/ft
RECP Type 3.B	1.5:1 (H:V)	2.00 lb/ft ²	100 lb/ft
RECP Type 4	1:1 (H:V)	2.25 lb/ft ²	125 lb/ft
*Product tested according to ECTC Test Method No. 2 and meeting the ECTC Standard Specifications for "C" factor.			

- C. RECP Anchors: Stakes or staples as recommended by manufacturer, with a minimum length of 6 inches.

2.07 TURF REINFORCEMENT MATS (TRM)

A. Material Classification:

1. TRM Type 1: Use a TRM that is constructed of a web of mechanically or melt-bonded polymer netting, or monofilaments fibers that are entangled to form a strong and dimensionally stable mat. Bonding methods include polymer welding, thermal or polymer fusion, or the placement of synthetic fibers between two high-strength, biaxially-oriented nets, mechanically bound by parallel stitching with polyolefin thread. Products may contain a degradable component.
2. TRM Type 2: Use a TRM that is constructed of a web of mechanically or melt-bonded polymer netting, monofilaments, or fibers that are entangled or woven to form a strong and dimensionally stable mat. Non-woven bonding methods include polymer welding, thermal or polymer fusion, or the placement of fibers between two high-strength, biaxially oriented nets, mechanically bound by parallel stitching with polyolefin thread. Use only components that are 100% synthetic and resistant to biological, chemical, and ultraviolet degradation.
3. TRM Type 3: Use a high performance/survivability TRM that is composed of monofilament yarns woven into a resilient uniform configuration. Use a mat that has a matrix that exhibits very high interlock and reinforcement capacities with

both soil and root systems and demonstrate a high tensile modulus. TRMs manufactured from discontinuous or loosely held together by stitched or glued, netting, or composites are not allowed in this category. Use only components that are 100% synthetic and resistant to biological, chemical, and ultraviolet degradation. Use this category when field conditions exist with high loading and/or high survivability requirements. These requirements consist of maintenance, structural backfills protecting critical structures, potential traffic areas, abrasion, higher factors of safety, and/or general durability concerns.

- B. Properties and Performance: Meet the minimum material and performance requirements contained in the following table:

Property ¹		Test Method	Type 1	Type 2	Type 3	Type 4
Material	Thickness	ASTM D 6525	0.25 in	0.25 in	0.25 in	0.25 in
	Tensile Strength ²	ASTM D 6818	125 lb/ft	240 lb/ft	750 lb/ft	3,000 lb/ft
	UV Resistance ³	ASTM D 4355	80% @ 500 hrs	80% @ 1,000 hrs	80% @ 1,000 hrs	90% @ 3,000 hrs
Performance	Maximum Shear Stress ⁴ (Channel Applications)	ASTM D 4640	7 lb/ft ²	10 lb/ft ²	12 lb/ft ²	15 lb/ft ²
	Maximum Slope Gradient (Slope Applications)	N/A	1:1 (H:V) or flatter	1:1 (H:V) or flatter	1:1 (H:V) or greater	1:1 (H:V) or greater

1 For TRMs containing degradable components, all values must be obtained on the non-degradable portion of the matting.

2 Minimum Average Roll Values, machine direction only. Tensile strength from ASTM D5035 may be substituted upon approval.

3 Tensile strength of structural components retained after exposure.

4 Minimum shear stress that fully-vegetated TRM can sustain without physical damage or excess erosion (0.5 in soil loss) during a 30-minute flow event in large scale testing. Acceptable large scale testing protocol includes ASTM D6460 or independent testing conducted by the Texas Transportation Institute, Colorado State University, Utah State University, or other approved testing facility.

2.08 FLOW TRANSITION MATS

Use flow transition mats that meet the following requirements:

- A. UV-stabilized HDPE plastic sheet with openings for vegetation growth and energy dissipation.
- B. Use a nominal sheet size of 4 feet by 4 feet by 1/2 inch.
- C. Use duckbill style anchors, as specified by the mat manufacturer.

2.09 INLET PROTECTION

A. Drop-In Intake Protection:

1. Use a manufactured device that is inserted into the intake, and is capable of trapping or filtering sediment from runoff prior to entering the storm sewer.
2. All components must be contained entirely below the surface of the intake grate.
3. Incorporate means of emergency outflow to prevent flooding if plugged with sediment.

B. Surface-Applied Intake Protection:

1. Use devices or filter socks, placed around or over the intake, that are capable of trapping or filtering sediment from runoff prior to entering the storm sewer.
2. Do not allow the device to completely block or plug the intake, preventing inflow.

2.10 ENGINEERING FABRIC

Comply with Iowa DOT Article 4196.01, C (Embankment Erosion Control).

2.11 REVETMENT AND EROSION STONE

- A. Class A Revetment: Conform to Iowa DOT Section 4130.
- B. Class B Revetment: Conform to Iowa DOT Section 4130.
- C. Class D and E Revetment: Conform to Iowa DOT Section 4130.
- D. Erosion Stone: Conform to Iowa DOT Section 4130.

2.12 REVETMENT AND EROSION STONE

- A. Class A Revetment: Conform to Iowa DOT Section 4130.
- B. Class B Revetment: Conform to Iowa DOT Section 4130.
- C. Class D and E Revetment: Conform to Iowa DOT Section 4130.
- D. Erosion Stone: Conform to Iowa DOT Section 4130.

2.13 STABILIZED CONSTRUCTION ENTRANCE

- A. Entrance Stone: Use Iowa DOT Section 4122, Gradation 13, Macadam crushed stone.
- B. Subgrade Stabilization Material:
 - 1. Use woven, UV-stabilized geotextile.
 - 2. Minimum tensile strength of 135 lb/ft.

PART 3 - EXECUTION

3.01 EROSION AND SEDIMENT CONTROL INSPECTION

- A. Schedule necessary maintenance or improvements for items that are included in the contract documents.
- B. Notify the Engineer immediately of situations requiring attention beyond that provided for in the contract documents.

3.02 FILTER BERMS

- A. Construct berm with filter material, unless otherwise specified.
- B. Install filter berm along the contour as specified in the contract documents, or as directed by the Engineer.
- C. Turn the ends of the filter berm uphill to prevent runoff from flowing around the end of the berm.
- D. When a vegetated berm is specified, apply seed to the surface of the berm.
- E. Replace the berm when sediment accumulation reaches one-half of the height of the berm.

3.03 FILTER SOCKS

- A. Installation:
 - 1. Pneumatically fill mesh filter sock of size and length indicated in the contract documents, or as directed by the Engineer. Alternative methods of filling the sock may be allowed upon approval of the Engineer.
 - 2. Fill socks with filter material.
 - 3. Place the filter sock along the contour as specified in the contract documents, or

as directed by the Engineer.

4. Place additional filter material or soil from the site, on the upstream side of the sock, in the seam between the tube and the ground.
5. Construct a "J-hook" at each end of a continuous run of filter sock, by turning the end of the sock uphill, as necessary to prevent runoff from flowing around the ends when water behind the sock ponds up to a level even with the top of the sock.
6. Drive stakes into the ground at a maximum spacing of 10 feet, and as required to secure the sock and prevent movement.

B. Maintenance: Perform the following incidental work.

1. Repair or replace non-functioning filter socks that allow water to flow under the sock, are torn, or are otherwise damaged, due to inadequate installation.
2. Remove filter material from damaged socks that are located along streambanks, around intakes, in ditches, or in other locations where the material may be carried to surface waters.

3.04 SILT FENCES

A. Installation:

1. Install material along the contour of the ground, as specified in the contract documents, or as directed by the Engineer.
2. Install silt fence with a mechanical soil slicing machine that creates a slit in the ground while simultaneously installing the fabric. The trenching method may be used when situations will not allow soil slicing, as determined by the Engineer.
3. Construct a "J-hook" at each end of a continuous run of silt fence, by turning the end of the silt fence uphill, as necessary to prevent runoff from flowing around ends when water behind the fence ponds to a level even with the top of the fence.
4. Insert 12 inches of fabric to a minimum depth of 6 inches (fabric may be folded below the ground line).
5. Compact installation by driving along each side of the silt fence, or by other means, as necessary to adequately anchor the material in the ground, to prevent pullout and water flow under the fence.
6. Drive steel posts into the ground alongside the silt fence, to a minimum depth of 20 inches, unless otherwise specified by the Engineer. Space posts, or as required to adequately support silt fence.

B. Maintenance: At the Contractor's expense, repair or replace non-functioning silt fence

that allows water to flow under the fence, is torn, or is otherwise damaged, due to inadequate installation.

C. Removal:

1. Remove sediment or spread to match finished grade; ensure proper drainage.
2. Stabilize the area disturbed by removal operations.

D. Replacement:

1. When accumulated sediment reaches a level one-half the height of the fence, remove the silt fence as described above, and replace according to the installation instructions above.
2. At the Engineer's option, the existing silt fence and accumulated sediment may be left in place, and a new silt fence installed up-slope from the existing silt fence.
3. When permitted by the Engineer, the existing silt fence may be left in place and the accumulated sediment removed. Carefully inspect the existing silt fence for structural integrity and signs of undermining. Make any necessary repairs.

3.05 DUST CONTROL

A. Water: Apply frequent light watering to ground surface, as required to control dust.

B. Calcium Chloride: Apply according to Iowa DOT Section 2314.

C. Lignosulfonate (Tree Sap):

1. Loosen the top 1 to 2 inches of the roadway surface.
2. Apply solution with a 50% residual concentration, at a rate of 0.50 gal/yd², to deliver a 25% residual. For diluted solutions, increase the application rate, as required, to deliver an equivalent 25% residual.
3. Allow product to penetrate through the loosened material.
4. Tight-blade road surface.

D. Soapstock (Soybean Oil):

1. Loosen the top 1 to 2 inches of the roadway surface.
2. Apply undiluted soapstock at a rate of 0.70 gal/yd².
3. Allow product to penetrate through the loosened material.

4. Tight-blade road surface.

3.06 TEMPORARY EROSION CONTROL SEEDING

A. Temporary Erosion Control Seedmix

Common Name	Application Rate lb/acre
<i>SPRING - March 1 - May 20</i>	
Oats	65
Annual ryegrass	40
<i>SUMMER - May 21 - August 14</i>	
Oats	95
Annual ryegrass	50
<i>FALL - August 15 - September 30</i>	
Oats	65
Annual Ryegrass	40

3.07 EROSION CONTROL MULCHING

A. Conventional Mulching:

1. Use conventional mulching when the surface cannot be stabilized by seeding, due to season or ground conditions.
2. Uniformly distribute mulch over the required areas, at a rate of 2 tons/acre for dry cereal straw, or 2.5 tons/acre for prairie hay.
3. Work the mulch into the soil with a mulch tucker, designed to anchor the mulch into the soil, by means of dull blades or disks.

B. Hydromulching:

1. Place mulch and tackifier (if applicable) in equipment specifically manufactured for hydraulic mulching.
2. Mix materials with fresh, potable water; using a combination of re-circulation through the equipment's pump, and mechanical agitation to form a homogeneous slurry.
3. If necessary, dampen any dry, dusty soil, as required to prevent balling of the material during application.
4. Apply hydromulch in multiple layers from opposing directions, where possible.

5. Apply the slurry evenly over all specified areas, at the minimum component material rates specified:
 - a. Wood Cellulose Mulch:
 - 1) Mulch: 2600 lb/acre dry weight.
 - 2) Tackifier: 50 lb/acre.
 - b. Bonded Fiber Matrix: 3600 lb/acre dry weight.
 - c. Mechanically Bonded Fiber Matrix: 3600 lb/acre dry weight.
6. Retain and count empty bags of mulch to ensure final application rate.

3.10 SURFACE ROUGHENING

A. Directional Tracking:

1. Do not use on slopes steeper than 3:1.
2. Operate tracked equipment up and down exposed slope, to create ridges perpendicular to the slope.
3. Continue operation until the entire surface has been tracked.

B. Grooving/Furrowing:

1. May be used on all slopes.
2. Use rippers, disks, harrows, chisel plows, or other equipment, capable of operating on the slope and creating grooves a maximum of 15 inches apart and 3 inches deep.
3. Operate equipment along the contour of the slope, to create grooves that are perpendicular to the slope.
4. Perform over all exposed slopes as specified.

3.11 TEMPORARY ROLLED EROSION CONTROL PRODUCTS

Install temporary RECPs according to the manufacturer's published installation recommendations, subject to the following minimum requirements:

A. Slope Application:

1. Grade and smooth surface. Remove all rocks, clods, vegetation, or other obstructions that will prevent direct contact between the RECP and the soil surface.

2. When specified, prepare seedbed and place seed and fertilizer according to Section 32 92 00 prior to placing RECP.
3. Installation:
 - a. Install anchor trench at top of slope. Seed and fertilize trench after backfill and compaction, if seeding is specified.
 - b. Unroll the RECP down or horizontally across the slope.
 - c. Place consecutive blankets down the slope end-over-end, shingle style.
 - d. Overlap ends of consecutive rolls a minimum of 3 inches, and install anchors at a maximum spacing of 18 inches along all overlaps.
 - e. Overlap edges of adjacent rolls a minimum of 2 inches.
 - f. Install anchors at edge seams between rows.

B. Channel/Ditch Application:

1. When specified, prepare seedbed and place seed and fertilizer according to Section 32 92 00, prior to placing RECP.

3.12 TURF REINFORCEMENT MATS

Install according to the manufacturer's published installation literature, for the product specified and application (slope or channel).

3.13 TEMPORARY EARTH DIVERSION STRUCTURES

- A. Construct at the location shown in the contract documents.
- B. Construct to the dimensions specified in the contract documents.
- C. Ensure positive drainage along the diversion toward the outlet area.
- D. Adequately compact fill to prevent failures or seepage.
- E. Outlet the diversion to undisturbed and/or stabilized areas only.
- F. Stabilize the surface of the earth diversion with temporary erosion control seeding.

3.14 FLOW TRANSITION MATS

Install according to the manufacturer's published recommendations.

3.15 SEDIMENT TRAPS

- A. Construct the storage area to the size and elevations indicated in the contract documents.
- B. Construct the rock outlet to the dimensions indicated in the contract documents.

3.16 INLET PROTECTION

- A. Install inlet protection devices according to the manufacturer's recommendations.
- B. Remove the accumulated sediment, as required to maintain the inlet protection device in working order. Remove any accumulated sediment from streets open to traffic if it encroaches into the traveled roadway.

3.17 ROCK OUTLET PROTECTION

- A. Install the quantity of revetment stone or erosion stone, as specified in the contract documents.

3.18 STABILIZED CONSTRUCTION ENTRANCE

- A. Install a stabilized construction entrance at all locations where construction traffic leaving the site presents the potential for sediment track-out.
- B. Remove the accumulated sediment and install new stone, as required to prevent track-out.
- C. Remove construction entrance near completion of project, coordinate with construction schedule.

3.19 MAINTENANCE

- A. If temporary erosion and pollution control measures are required due to the Contractor's negligence, carelessness, or failure to install permanent controls as a part of the work as scheduled, and are ordered by the Engineer; perform such work at the Contractor's expense.
- B. Prevent the accumulation of soil sediment or debris onto streets adjacent to project site. Remove any accumulation of earth or soil immediately, and take remedial actions for prevention.
- C. In case of repeated failures on the part of the Contractor to control erosion, pollution, and/or siltation, the Engineer reserves the right to employ outside assistance, or to use

the Jurisdiction's own forces to provide the necessary corrective measures. Such incurred direct costs, plus project engineering costs, will be at the Contractor's expense, and appropriate deductions will be made from the Contractor's monthly progress estimate and final payment.

END OF SECTION 31 25 00

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SECTION 32 13 13
CONCRETE PAVING

PART 1- GENERAL

1.01 SECTION INCLUDES

- A. Includes construction of concrete drives, parking lots, curbs, slabs and sidewalks.

1.02 DESCRIPTION OF WORK

- A. Furnish all materials and labor to construct portland cement pavements, curbs, and sidewalks on prepared subgrade.
- B. See Section 31 23 00 Excavation and Fill.
- C. Reference is made to the Iowa Department of Transportation Standard Specifications for Highway and Bridge Construction, Series 2001, and all current General Supplemental Specifications and Materials Instructional Memorandum by the term "Iowa DOT Specifications" and/or "Iowa DOT I.M."

1.03 SUBMITTALS

- A. Submit under provisions of Division 1.
- B. Concrete mix including material components and origins.
- C. Jointing plan for Engineer's review and approval prior to construction, if anticipated jointing varies significantly from jointing plan provided as part of the plans.

1.04 STORAGE AND PROTECTION OF MATERIALS

- A. Aggregates: store and handle aggregates to avoid contamination and frequent variations in specific gravity, gradation or moisture content of materials used.
 - 1. Store fine and coarse aggregates in separate piles or bins.
 - 2. Minimize changes in aggregates with different specific gravities or gradations in working day.
 - 3. Handle aggregates to prevent variations of more than 0.5 percent in moisture content of successive batches.
 - 4. Thoroughly wet and allow to drain for at least one hour coarse aggregate having an absorption greater than 0.5 percent.

- 5. Drain fine aggregate at least 24 hours after washing and before batching.
- B. Cement: store in suitable weathertight enclosures and handle to prevent loss.
 - 1. If lumps develop in cement, it must be reprocessed, re-tested and re-approved prior to use.
 - 2. Cement in storage at site or local warehouses for more than 60 days must be re-tested prior to use.
- C. Admixtures: store in suitable weathertight enclosures that will preserve quality.
- D. Reinforcing steel: store off ground on timbers or other supports.

PART 2 PRODUCTS

2.01 PORTLAND CEMENT: ASTM C150, Type I.

2.02 ADMIXTURES

- A. Air entraining: ASTM C260; no admixtures containing chlorides will be permitted.
- B. Retarding: a suitable retarding admixture may be used during hot weather, with approval of Owner.
- C. Calcium chloride shall not be used except as directed by the Owner.
- D. Fly ash: Iowa DOT Section 4108. Use only as approved by Owner.
- E. Other admixtures may be used subject to approval of Owner.

2.03 FINE AGGREGATE

- A. Clean, hard, durable particles of natural sand, free from injurious amounts of silt, shale, coal, organic matter or other deleterious substances.
- B. Deleterious substances: not more than 2.0% shale and coal by weight retained on No. 16 sieve.
- C. Organic matter: other than coal, not more than standard reference color; ASTM C40.
- D. Conform to the following sieve analysis:

Sieve Size	% Passing
3/8"	100
No. 4	90-100
No. 8	70-100
No. 200	0.-1.5

- E. Percent passing one sieve and retained on next higher number sieve not more than 40% when sieved through 4, 8, 16, 30, 50 and 100 numbered sieves.
- F. Mortar strength at 7 days not less than 1.5 times standard sand strength when tested in accordance with Iowa DOT Laboratory Test Method 212.

2.04 COARSE AGGREGATE

- A. Clean, hard, durable particles of crushed limestone free from injurious amounts of objectionable materials; Class 2 durability limestone; Iowa DOT 4115.04.
- B. Objectionable materials not more than:

	<u>Percent</u>
Clay lumps	0.5
Coal and carbonaceous shale	0.5
Sticks (wet weight)	0.1
Total of all shale and coal combined	1.0
Organic material other than coal and sticks	0.0
Unsound chert particles* retained on 3/8" sieve	3.0

*Chert particles breaking into three or more pieces in freezing and thawing test, Iowa DOT Laboratory Test Method 211, Method A, are considered unsound.

- C. Conform to the following sieve analysis:

Sieve Size	% Passing
1 1/2"	100
1"	50-100
3/4"	30-100
1/2"	20-75
3/8"	5-55
No. 4	0-10
No. 8	0-5
No. 200	0-1.5

- D. Percent of wear, AASHTO T96, Grading A or B, shall not exceed 35% for gravel, 50% for crushed stone.

- E. Particle durability: aggregate considered durable when it has no adverse affect upon durability of concrete in which used; minimum percent of durable particles in aggregate: 95; durability based on the following:
 - 1. That loss in freezing and thawing test, Iowa DOT Laboratory Test Method 211, Method A, does not exceed 6%.
 - 2. Behavior of existing air-entrained concrete pavement over 10 years of age containing aggregate of similar geological origin or chemical and mineral composition.
- F. Water: clean and clear, free from salt, oil, acid, strong alkalis, vegetable matter, or other substances injurious to concrete.
- G. Water may be heated for cold weather paving operations; anti-freezing agents not permitted.

2.05 REINFORCING STEEL

- A. Deformed bars: ASTM A615, Grade 40, epoxy coated.
- B. Plain and smooth dowel bars: ASTM A615; Grade 40, epoxy coated.
- C. Epoxy coated reinforcement: AASHTO M284 and Iowa DOT 4151.03C.
- D. Metal expansion tubes: fabricated steel tubes; provide tubes with internal diameter 1/16" larger than dowel bar; bar stop capable of withstanding 20 lbs. push, minimum.
- E. Metal keyways: fabricated 24 gauge sheet steel; conform to details shown on plans; provide lengths in multiples of tie bar spacing; punch to receive tie bars.

2.06 SUPPORTS FOR REINFORCING STEEL

- A. Support tie bars as required to place and maintain correct location during construction.
- B. Support dowel bars at expansion and contraction joints as shown on plans.
- C. Epoxy coated reinforcement: support with metal chairs and supports coated with epoxy or other inert material reviewed by Engineer; tie with plastic coated tie wires.

2.07 PAVEMENT JOINTS

- A. Joint Sealers: Comply with Iowa DOT Section 4136.02, see specification.
- B. Preformed Expansion Joint Fillers and Sealers:

1. Use the following types of preformed materials for filling expansion joints that comply with Iowa DOT Article 4136.03. Use resilient filler.
2. Expansion joint filler material with “tear-off” strips where joint is intended to be filled with sealant. These strips help ensure a consistent, correct joint depth. Joints must be primed as required by the sealant manufacturer. Acceptable products:
 - a. Expansion Strips by “Reflectix” <http://www.reflectixinc.com/>
 - b. Cellu-Cushion EXP 200 by “Sealed Air” <https://sealedair.com/>
 - c. 1000 Series Expansion Board Caps by “BoMetals, Inc.” <http://bometals.com/>
- C. Joint Caps: Provide preformed, removable joint caps to assure that the top of the joint filler is at the proper depth for installation of sealant.
- D. Liquid curing compound: white pigmented curing compound: Iowa DOT 4105.
- E. Adjacent to proposed building: Use expansion joint filler with “tear-off” strips.

2.08 PROPORTIONS FOR MIX

- A. Mix No. C-4 in accordance with Iowa DOT 2301.04; proportions as follows:
 1. Basic absolute volumes of materials per unit volume of concrete:

Cement Minimum	0.118
Water	0.159
Entrained Air	0.060
Fine Aggregate	0.331
Coarse Aggregate	0.332
 2. Approximate quantity of dry materials per cubic yard of concrete: cement: 624 lbs.; fine aggregate: 0.739 tons; coarse aggregate: 0.741 tons.
 3. Above quantities based on specific gravity of cement: 3.14; specific gravity of aggregates: 2.65; water-cement ratio: 0.430 pound of water per pound of cement; air voids: 6.0%.
 4. Maximum water-cement ratio: 0.488 pound of water per pound of cement including free water in aggregate.
 5. Air entraining admixture: produce $7\% \pm 1.5\%$ air voids in fresh concrete measured by pressure method.
- B. Adjustments:

1. Basis: when actual quantity of concrete is more than 101% or less than 99% of calculated quantity or if combination of materials does not produce quality of concrete specified.
 - a. Fine aggregate shall not exceed 50% of total aggregate in any adjustment.
 - b. Do not exceed maximum water-cement ratio specified.

2.09 WATER QUANTITY AND CONCRETE CONSISTENCY

- A. Use proper amount of mixing water to produce concrete of uniform consistency; adapt to mix, characteristics of materials used, methods of consolidation, weather conditions and slope of finished surface.
- B. Modify proportions if maximum water-cement ratio does not produce workability; increase cement to aggregate proportion to produce specified degree of workability without exceeding maximum water-cement ratio.

2.10 CONCRETE PROPORTIONING AND MIXING EQUIPMENT

- A. Plant batching and mixing equipment shall be Iowa DOT calibrated and approved. Provide copy of current certification.
- B. Equipment may be either stationary central plant mixer or central plant-proportioned, truck mounted transit mixer.
- C. If concrete is centrally mixed; it may be transported in agitating or non-agitating units.
 1. Concrete must be placed on grade within 30 minutes after mixing if transported in non-agitating units.
 2. Concrete must be placed on grade within 90 minutes after mixing if transported in agitating units.
- D. When concrete is mixed on truck mounted transit mixers and agitated thereafter, it must be placed on grade within 90 minutes after materials added to mixer.
- E. Truck Mounted Transit Mixers: capacities and mixing capability as defined in ASTM C94 with attached plate containing required information.
 1. Equipment shall include reliable reset-revolution counter that will register the number of revolutions at mixing speed.
 2. Unit must have signed certification that concrete producer or authorized representative has inspected unit within previous 30 day period and that interior of mixing drum is clean and reasonably free of hardened concrete, that fins or paddles are not broken or worn excessively and that other parts are in proper working order.

- F. Plant or transit mixers must produce concrete with consistent quality; if uniformity entrained air or slump varies, concrete producer must take corrective action.
- G. Each truck load of concrete must be identified by an acceptable plant charge ticket showing plant name, contractor, project name, date, quantity, class and time batched.

2.11 PLACEMENT EQUIPMENT

- A. Subgrade finishing equipment: use mechanical excavating equipment designed for purpose and approved by Owner.
 - 1. Form line or path area for slip-form paving machine constructed to final grade by form-line excavating equipment with automatic grade controls.
 - 2. Subgrade between forms or between path areas for slip-form machines constructed to final grade with steel shod template or automatically controlled subgrade excavating machine.
- B. Side forms: steel, minimum thickness: 5 gage, height at least equal to design thickness of pavement, base width at least 6".
 - 1. Minimum section length: 10', joint connections designed to permit horizontal and vertical adjustment with locking device to hold abutting sections firmly in alignment when set.
 - 2. Bracing, support and staking must prevent deflection or movement of forms from pressure of concrete or weight or thrust of machinery operating on forms.
 - 3. Forms must be free from scale and surface irregularities; coat with form oil prior to concrete placement.
- C. Flexible forms: use steel or wood flexible forms for curves with radius less than 100'.
 - 1. Bracing, support, and staking must prevent deflection or movement of forms from pressure of concrete or weight or thrust of machinery operating on forms.
 - 2. Forms used to form back of curbs at returns shall have height at least equal to design thickness of pavement and curb height.
 - 3. Forms must be free from scale and surface irregularities; coat with form oil prior to concrete placement.
- D. Consolidating and finishing equipment: fixed form or slip form paving machines specifically designed for placing, striking off, consolidating and finishing in single passage to required cross section.
 - 1. Consolidation of concrete by single pass of approved surface, tube or internal vibrator operated in accordance with manufacturer's recommendations.

2. Slip form equipment: automatic horizontal and vertical controls required; equipment must spread concrete to uniform depth prior to striking off.
 3. Air screeds and vibrating screeds are not approved consolidating and finishing equipment.
 4. Equipment subject to approval of Owner.
- E. Hand finishing equipment: Contractor shall provide tools including wood or magnesium floats, wood hand floats, pointing trowels, edgers or other equipment necessary for proper finishing of concrete.
1. Provide two light straightedges, 10' long, with handles not less than 12' long for use in detecting irregularities in surface; provide two heavy straightedges of similar size for use in correcting surface; provide two light straightedges 6' long for checking curb and gutter line.
 2. Provide approved vibrators for consolidating concrete.
 3. Provide metal or wood screed true to crown.
- F. Curing equipment: use pressure sprayer capable of applying a continuous uniform film of curing compound.
- G. Concrete saws: power operated concrete saws capable of cutting hardened concrete neatly to dimensions shown on plans.
- H. Joint sealing equipment: equipment capable of heating and installing sealant in joints in accordance with manufacturer's recommendations.

PART 3 EXECUTION

3.01 GENERAL

- A. Place, strike off, consolidate and finish concrete with fixed form or slip form mechanical paving equipment to cross section shown on plans.
- B. Use paving machine for all uniform width slabs 8 1/2' or more in width and 200' or more in length.
- C. Use hand placing, consolidating, and finishing in areas of irregular dimensions or narrow widths.

3.02 SETTING AND REMOVING FORMS

- A. Use form line excavating machine to establish subgrade for forms used to support mechanical subgrader, mechanical spreader or finisher or other similar equipment.
- B. Set base of forms at or below subgrade elevation with top of forms at pavement surface elevation at edge of slab.
- C. Extra height forms may be used to back up integral curb; set base at or below subgrade elevation with top of form at top of curb elevation.
- D. Set forms accurately to required grade and alignment and secure in place to maintain grade and alignment during concrete placement and finishing.
- E. If voids occur under forms, remove forms and rework subgrade to proper elevation and density.
- F. If soil supporting form is softened by rain or standing water so that form is inadequately supported, remove forms and rework subgrade to proper elevation and density.
- G. Check forms joints with 10 foot straightedge prior to paving; adjust as necessary to proper grade and alignment; maximum deviation of top surface is 1/4" in 10'
- H. Coat forms with form oil before concrete is placed to prevent adherence of concrete.
- I. Leave side forms in place not less than 6 hours after concrete is placed; if form removal damages concrete, Owner may require remaining forms to remain in place more than 6 hours.
- J. Remove forms with care to prevent cracking, spalling or overstressing concrete; remove form stakes prior to raising forms.
- K. Clean forms before resetting.

3.03 CONCRETE AND STEEL PLACEMENT

- A. Place plastic film on prepared subgrade, lap joints 12" or uniformly moisten subgrade just prior to concrete placement.
- B. Adjust manhole castings, valve boxes or other fixtures within pavement to finished surface grade; clean outside of castings.
- C. Place dowel and tie bars as shown on plans or specified; support and secure bars by approved chairs and wire assemblies.
- D. Place concrete to full depth in single operation; do not pile concrete more than 8" above design elevation of surface.
- E. Carefully place concrete on subgrade to prevent segregation of materials and at locations which require minimum rehandling; do not displace reinforcing.

- F. All concrete to be consolidated with mechanical vibration equipment. Vibrate and consolidate to prevent formation of voids; do not displace reinforcing.

3.04 FINISHING

- A. Begin finishing operations promptly after concrete has been placed and consolidated.
- B. Screed surface to grade and crown as shown on plans.
- C. Finish surface with wood or magnesium floats, finish from both sides simultaneously if pavement is placed to full width with one pass of paving machine.
- D. Check surface longitudinally with 10' long straightedge while concrete is still plastic; correct any surface deviations greater than 1/8" in 10'.
- E. Provide finish as designated.
 - 1. Uniformly gritty surface with astroturf drag; round edges of pavement to 1/8" radius.
- F. Check pavement surface longitudinally after concrete has hardened with 10' long straightedge; grind high spots over 1/8" with approved grinding device or device consisting of multiple saw blades.

3.05 CURBS

- A. Construct integral curb or rolled curb, as shown on plans, along with pavement or immediately following finishing of pavement.
- B. Use paving machine with integral slip-form for curb, curb mule or similar mechanical where possible.
- C. Construct depressed curb where sidewalks intersect street; use templates to form faces of such curbs.
- D. Form and construct curb by hand only where barrier or depressed curb is required and where small radii or other special sections preclude use of mechanical equipment.
- E. Construct curb as rapidly as finishing operations on pavement permit; maximum distance behind paving machine: 100'.
- F. Remove free water, laitance, dust, leaves or other foreign matter prior to placing concrete for curb.
- G. Use freshly mixed concrete; do not store concrete in receptacles at side of pavement for use in curb at a later time; do not use concrete require retempering.
- H. Vibrate or puddle concrete to secure bond with paving slab and eliminate rock pockets.

- I. Secure final finish on curbs by hand method, including 6' straightedge or 6' slipform.
- J. Edge, protect and cure curb in same manner as pavement.
- K. Check surfaces of curb and gutter with 10' straightedge; correct variations greater than 1/8"; remove and replace curbs having varying cross section.

3.06 CURING AND PROTECTION

- A. Apply liquid curing compound in fine spray to form continuous, uniform film on surface and vertical edges of pavement and curbs.
- B. Apply compound with power sprayer; rate of application not less than 0.067 gal. per square yard (15 square yards per gallon); do not dilute compound.
- C. Apply to pavement surface after finishing and after surface moisture has disappeared; apply to pavement edges within 30 minutes after forms are removed.
- D. Protect concrete pavement during cold weather for at least 36 hours after placement as follows:

Forecast or Actual Temperature	Protection
35 to 32 F.	One layer of burlap for concrete. Plastic top layer is required if burlap is exposed to rain or heavy winds.
31 to 25 F.	Two layers burlap or one layer plastic film on one layer burlap
Below 25 F.	Four layers of burlap between layers of four mil plastic or equivalent commercial insulating material.

- 1. Burlap: AASHTO M182, Class 3.
- 2. Use of straw shall not be allowed for temperature protection
- 3. Protect insulation from disturbance by wind; leave in place for 5 days, minimum, or until pavement is opened to traffic.
- 4. Lap plastic film 18" at junctions.
- E. Provide cold weather protection as specified for temperature below 25 degrees F. for all concrete placed after November 15.
- F. Provide burlap, paper, or plastic film and planks and stakes at or near job site to cover and protect fresh concrete and to construct temporary forms for protection against rain.

- G. Contractor responsible for pavement protection against effects of rain; failure to properly protect may result in removal and replacement of defective pavement.
- H. Curing of concrete containing calcium chloride shall be in accordance with IDOT Supplemental Specifications SS-1091, Section 1091.09A.

3.07 CONSTRUCTION OF JOINTS

A. General:

1. Longitudinal and transverse joints shall be constructed of the type, dimensions, and at the locations required, as described by these specifications, or as detailed by the plans or special provisions.
2. Longitudinal joints shall be coincident with or parallel to the pavement center line unless shown otherwise on the plans.
3. All transverse joints shall be at right angles to the center line and shall extend the full width of the pavement unless otherwise specified.
4. All joints shall be perpendicular to the finished grade of the pavement and the alignment across the joint shall not vary from a straight line by more than 1 inch.
5. All joint fillers shall be installed as shown in the contract documents.
6. The Contractor shall exercise care in placing, consolidating, and finishing the concrete at and about all joints.
7. The edges of the pavement at tooled joints shall be rounded, where required, as specified on the standard detailed plates.
8. Wet sawing shall be used when required by the contract documents for dust control.

B. Expansion Joint:

1. Install expansion joints where pavement meets building slabs, footings or other frost-protected items.
2. Prevent movement of or damage to joint assembly when placing concrete; set joint material low enough to clear the finish machine.
3. Construct double width expansion joint in curb over expansion joint in pavement. The backside of the joint must be clear of concrete.
4. The expansion joint shall be aligned straight and true.
5. If joint fillers are assembled in sections, or if joints as a whole are constructed in sections, then no offsets shall be between adjacent units.

6. Where more than one section is used in a joint, the sections shall be securely laced or clipped together. Damaged basket assemblies shall not be used.

C. Saw Joints:

1. Joint locations shall be chalked with a string line before sawing.
2. Joint dimensions:
 - a. All transverse contraction joints shall be sawed at a maximum spacing of $21T$, where T is the thickness of the pavement in feet.
 - b. All joints shall be sawed to a depth shown below and on the detail plate.

	Minimum Sawcut Depth	
	Conventional Saw	Early "Green" Saw
Transverse "C" Joint	$T/3$	1 1/4"
All other Transverse	$T/3$	1 1/4"
Contraction joints	$T/3$	1 1/2"
Longitudinal Joint	$T/3$	Not Allowed

- c. The Contractor shall closely monitor joint sawing for both longitudinal and transverse joints for depth and spacing and immediately report any deviations from the specifications. The Contractor shall take immediate steps to correct any deviations.
3. In order to prevent shrinkage cracks, sawing shall be commenced promptly after the pavement has obtained sufficient strength to resist tearing of the concrete adjacent to the joint during the process of sawing.
4. Pavement pours shall be scheduled to allow transverse joints to be sawn within 24 hours of the concrete being placed.
5. Longitudinal joints shall be sawn within 24 hours of the concrete being placed.
6. If necessary, the sawing operations shall be carried on both day and night.
7. Joints sawed with an early "green" concrete saw shall be washed out prior to sealing. The concrete must be capable of supporting the sawing operations to allow the use of an early green concrete saw.

D. Construction Joints:

1. Longitudinal or transverse construction joints shall be placed between adjacent lanes of concrete and at end-of-day header runs.
2. Manhole boxouts shall be located and placed on grade prior to paving. Manhole boxouts are required for two piece castings for sanitary/storm manholes.

3. The longitudinal construction joints shall be an approved key type joint with legs unless machine placed.
4. Transverse construction joints shall employ load transfer devices (Header) and shall be placed whenever concrete placement is delayed for more than 30 minutes.

3.08 RESTRICTIONS ON OPERATIONS

A. Weather

1. Do not place concrete when stormy or inclement weather prevents good workmanship.
2. Use no aggregates containing frozen lumps and do not place concrete on frozen subgrade.
3. With favorable weather conditions, begin concrete mixing and placement when temperature is at least 34 degrees F. and rising.
4. Concrete delivered to subgrade must have temperature of at least 40 degrees F.
5. Stop concrete mixing and placement when air temperature is 38 degrees F. and falling.
6. Stop concrete mixing and placement when air temperature exceeds 95°F.

B. Night operation:

1. Place no concrete when darkness prevents good workmanship in placing and finishing.
2. Do not place or finish concrete under artificial light.

C. Use of pavement:

1. Time for opening pavement for use will be determined by results of tests on cylinders taken during concrete placement.
2. Pavement may be opened to Contractor's forces after 7 days for purpose of removing coverings and building shoulders if tests of cylinders from section show compressive strength of 3,000 psi or higher.
3. Open pavement to general traffic when authorized by Owner.

4. Concrete placed in cold weather may require additional curing time, as directed by Owner; keep all vehicles off pavement until such curing time has been completed.

3.09 TESTS ON TRIAL BATCHES AND CONCRETE PLACED AT PROJECT SITE

- A. Provide slump test: ASTM C143; 1-1/2" to 3" for machine finished concrete; 4", maximum, for hand finished concrete.
- B. Air voids of fresh concrete, by pressure method: ASTM C231; 6.5% $\pm$ 1.5% without CaCl and 5.0% $\pm$ 2% with CaCl.
- C. Minimum compressive strength: ASTM C39; 3,000 psi when tested at 7 days and 4,000 psi when tested at 28 days.
- D. Provide a minimum of two 28 day compressive strength test cylinders for every 100 cubic yards of concrete placed for purpose of demonstrating compressive strength. Minimum of 1 test each day substantial pavement is placed, (25 CY).

3.10 DEFECTS OR DEFICIENCIES

- A. Pavement containing excessive cracks, fractures, spalls or other defects shall be removed and replaced at no cost to Owner.
- B. Pavement thickness: determined by random cores; one 4" diameter core taken for each section of approximately 2,000 square yards.
- C. Restore core holes by tamping non shrink cement grout into hole, finishing and texturing surface.
- D. If the concrete cores taken are less than the specified thickness, the following adjustments in payment will be made:

Pavement Deficiency	Payment
0 - 0.25"	100% of Lump Sum for PCC Paving
0.25" 0 - 0.50"	90% of Lump Sum for PCC Paving
0.50" - 0.75"	83% of Lump Sum for PCC Paving
0.75" - 1.00"	77% of Lump Sum for PCC Paving

- E. Pavement with thickness deficient by more than 1":
 1. Remove and replace at Contractor's expense.
 2. Leave in place and paid for at 10% of Lump Sum for PCC Paving.
- F. Area represented by each core is one-half of distance to next core or to end of pavement.

- G. Additional core samples may be made and measured at Contractor's expense to determine the extent and severity of pavement deficiency; minimum distance between core samples: 100'. A maximum of 1 additional core may be taken for each deficient core.

3.11 DRIVES, PARKING LOTS, CURBS, SLABS AND SIDEWALKS

- A. Construct drives, parking lots, curbs, slabs and sidewalks as shown on plans.
- B. Use concrete with air entrainment and other materials as specified in Section 2.15 Proportions for Mix.
- C. Forms: use wood or steel forms adequately staked and braced to maintain grade and alignment while concrete is placed and finished.
 - 1. Set base of forms at or below subgrade elevation with top of forms at surface elevation at edge of slab.
 - 2. Coat forms with form oil before concrete is placed to prevent adherence of concrete.
 - 3. Leave forms in place not less than 24 hours after concrete is placed.
 - 4. Remove forms with care to prevent cracking, spalling or overstressing concrete.
- D. Concrete placement: place plastic film on prepared subgrade or uniformly moisten subgrade just prior to concrete placement.
- E. Vibrate and consolidate to prevent formation of voids.
- F. Screed concrete flush with forms; finish surface with wood or cork float.
- G. Saw cut and seal joints in driveways and curb and gutter as shown on plans or as directed by Owner.
- H. Cure and protect drives, curbs, slabs and sidewalks as specified for concrete pavement.
- I. Restrictions on operations for drives, curbs, slabs and sidewalks as specified for concrete pavement.

END OF SECTION 32 13 13

SECTION 32 13 73
CONCRETE PAVING JOINT SEALANTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Cold-applied joint sealants.
 - 2. Hot-applied joint sealants.
- B. Reference is made to the Iowa Department of Transportation Standard Specifications for Highway and Bridge Construction, Series 2001, and all current General Supplemental Specifications and Materials Instructional Memorandum by the term "Iowa DOT Specifications" and/or Iowa DOT I.M."

1.02 SUBMITTALS

- A. Product Data: For each type of product.
- B. Material Certificates: For each type of product.
- C. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch wide joints formed between two 6-inch long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

PART 2 - PRODUCTS

2.01 MATERIALS, GENERAL

- A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

2.02 JOINT SEALERS

- A. Hot Applied: Use sealers composed of petropolymers supplied in a solid form and meeting the requirements of ASTM D 6690, Type IV.
- B. Cold Applied: Use sealer that meets the physical requirements of ASTM D 6690, Type IV.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine joints to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 JOINT SEALING EQUIPMENT

- A. Use equipment capable of cleaning the joint and heating and installing sealant in joints according to manufacturer's recommendations.

3.03 INSTALLATION OF JOINT SEALANTS

- A. Within 3 hours after a joint has been wet sawed to the finished dimension, flush the wet sawing residue away from the sawed faces using a high pressure water blast operating with a minimum pressure of 1,000 pounds per square inch. Within 3 hours after a joint has been dry sawed to the finished dimension, blow the dry sawing residue from the joint using air compressors that provide moisture and oil free compressed air.
- B. Immediately prior to installation of sealant, clean joints with an air blast. Do not perform sealing until visual examination verifies the joint surfaces appear dry, in addition to being clear of dust and contamination.
- C. Prepare and install joint sealer in the joint and to the proper level specified in the contract documents and as recommended by the manufacturer.
- D. Heat hot-poured sealers in a thermostatically controlled heating kettle; heat the material to the temperature required for use, but not above that recommended by the manufacturer. After sealing, remove excess sealer from the pavement surface.
- E. Seal joints the same day they are cleaned. Apply sealant only when the joint surfaces appear dry by visual examination.
- F. Place joint sealer only when the pavement and ambient air temperatures are 40°F or above. When near this minimum, additional air blasting or drying time, or both, may be necessary to ensure a satisfactory bond to the joint faces. When this sealer cannot be properly placed due to late fall work, submit a joint construction plan and sealing details to the Engineer for approval before commencing paving. Delay the cleaning, sealing, and, if required, resawing of joints until the following spring. This delay requires the Engineer's approval.
- G. When surface correction is required, repair seals damaged from the corrective work. Joint preparation, cleaning, and sealing may be delayed until after corrective work, provided the pavement is not opened to traffic before corrective work is performed.

END OF SECTION 32 13 73

SECTION 32 92 00
SEEDING AND SOIL SUPPLEMENTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Description of Work
- B. Warranty
- C. Seeding Dates
- D. Seedbed Preparation
- E. Seed Preparation
- F. Application of Seed
- G. Watering
- H. Reseeding
- I. Cleanup
- J. Acceptance

1.02 DESCRIPTION OF WORK

- A. Drawings and general provisions of contract, including general and supplementary conditions apply to this section.
- B. This section shall include materials, equipment, and labor for the preparation of the seedbed, furnishing and installing seed, fertilizer and mulch, maintenance, and guarantee for completed seeded areas, as shown on plans. Seed all areas disturbed by construction, unless otherwise noted.
- C. The Contractor has the option of using either hydraulic or conventional seeding methods; unless specified otherwise in the contract documents.
- D. Provide permanent seed at the earliest possible date following grading and topsoil re-spreading and/or irrigation installation operations, as approved by Engineer.

1.03 PROTECTION OF PROPERTY

- A. Protect existing conditions at the site against damage including the following:
1. Take precautions to insure that equipment, vehicles, and seeding operations do not disturb or damage existing grades, walls, drives, pavement, utilities, plants, lawns, irrigation systems, and other facilities.
 2. Verify locations and depths of all underground utilities prior to excavation and report conflicts with new seeding operations.
 3. Any damage to existing trees or shrubs, including branches and root systems shall be repaired and/or pruned by an experienced tree surgeon or arborist.
 4. Contractor shall replace plantings damaged due to watering of newly seeded areas with same species, size, 1-year warranty, and planted as approved by Engineer without additional compensation.
 5. All existing lawn areas undisturbed by construction within the construction limits shall be mown by the Contractor until the project is accepted.
 6. New seeding installed adjacent to existing lawns shall be installed to provide a smooth matching grade transition in a straight, neat alignment as approved by the Engineer.
 7. Repair, replace, and/or return to original condition any damaged item, without additional compensation.

1.04 SUBMITTALS

- A. Submit a laboratory analysis showing the seed provided meets or exceeds the minimum requirements of purity and germination stated on an independent certificate of seed analysis document in accordance with the AOSA (Association of Official Seed Analysts) rules. The seed certification tag and seed analysis document provided must be from the same lot number as shown on the seed tag. The date of test results shall be no greater than 9 months from seed application date. The following information shall be included on the seed laboratory analysis:
1. Name of company responsible for analysis,
 2. Lot number of seed being provided and tested,
 3. Kind - Species or common name of seed. Include cultivar or variety name if applicable,
 4. Seed origin,
 5. Percentage of purity and germination,

6. Percentage of dormant seed,
 7. Percentage of inert matter, other crop seed and weed seeds,
 8. Restricted and prohibited noxious seed. Provide name of and number per pound of seed.
- B. Submit from an established seed dealer or certified seed grower the applicable Association of Official Seed Certifying Agencies (AOSCA) certified Blue, Gold or Yellow Tag, from each container seed mixture dated within 9 months of delivery, indicating bulk weight of bag or container, percentage by weight and percentage of purity, germination and weed seed for each grass, forb, legume, and cereal crop stating botanical and common name of each species as specified in contract documents.
- C. Submit certificates of inspection as required by governmental authorities and manufacturer's or vendor's certified analysis for soil amendments.
1. Certification of the fertilizer analysis with scale weight and statement of guaranteed analysis.
 2. Certification of the tackifier ingredients, recommended rates of application, and expiration date.
 3. Certification of the inoculant ingredient for legumes and the specific seed to be inoculated with the application rate and expiration date.
 4. Certification of the fungicide ingredients and applicable fungus disease control and recommended application rate of manufacturer.
 5. Certification on the sticking agent ingredients with applicable use and rate by manufacturer.
 6. Certification in the degradable wood cellulose fiber mulch ingredients with applicable use and rate, and the water retention capacity by manufacturer or supplier.
- D. Submit written maintenance instructions recommending procedures for maintenance of seeded areas for one year, prior to final acceptance of the seeded areas.
- E. Upon request the Contractor will provide additional Material Certifications to the Owner.
- 1.05 QUALITY ASSURANCE
- A. All seed shall be certified and provided by an established seed dealer or certified seed grower.
- B. All materials to be in accordance with Iowa Seed Law and Iowa Department of Agricultural Regulations and shall be labeled accordingly.

- C. All materials and method of operation shall be subject to inspection and approval by Engineer.
- D. Material not meeting requirements specified will be rejected.

1.06 DELIVERY, HANDLING, AND STORAGE

- A. Packaged materials shall be delivered in original, unopened, and undamaged containers.
- B. Deliver, handle and store all materials according to product recommendations and protect them from loss, damage and deterioration.
- C. Deliver all seed in original containers. Seed shall not be mixed or blended except in the presence of the Engineer.

1.07 SCHEDULING

- A. Coordinate the seeding schedule with all other work on the project. Notify the Engineer at least three working days prior to the start of seeding operations.
- B. After all land-disturbing activities are complete and the seedbed has been approved by the Engineer, perform seeding operations.

1.08 WARRANTY

The seeding shall be installed as specified to germinate and provide a uniformly dense stand of the seed mix specified, free of weeds and undesirable species, debris, and free of eroded areas and bare spots. Re-rake areas failing to show a good dense stand within 60 days and reseed as originally specified.

- A. A warranty is to be provided for completed seeded areas, starting upon the date of initial acceptance. The warranty is to guarantee completed seeded areas to provide a uniformly dense, live, and healthy stand of seed mix specified, free of weeds and undesirable species, debris, and free of eroded areas, bare spots, diseases, and insects at the end of the warranty period of 60 days for domestic/lawn grasses and a 12-month period for native prairie and wetlands species from date of project acceptance.
- B. During warranty period, any defects in the seeded area and grass stand such as weedy areas, eroded areas and bare spots shall be corrected and reseeded as originally specified until all affected areas are accepted by the Engineer, without additional compensation.

- C. Repair and replace to original condition all damages to property resultant from the seeding operation and all damages as a resultant from the remedying of these defects, without additional compensation.

PART 2 - PRODUCTS

2.01 SEED

- A. Provide fresh, clean, new crop, certified seed complying with tolerance for germination and purity and free of poa annua, bent grass, and noxious weed seed. Furnish all seeds, including grass, legume, forbs, and cereal crop seeds, from an established seed dealer or certified seed grower. All materials and suppliers are to follow Iowa Seed Law and Iowa Department of Agriculture and Land Stewardship regulations, and be labeled accordingly.
- B. Type 1 –Permanent Lawn Seed Mix: choose equal portions of three different cultivars of Kentucky Bluegrass and two different cultivars of Turf-Type Perennial Ryegrass at 20 pounds/acre each. Selected seed to be Blue or Gold Tag certified. Seed Rate: See table below.

<u>Variety & Kind</u>	<u>Purity</u>	<u>Germination</u>	<u>Application Rate</u> <u>lb/acre</u>
Turf-Type Perennial Ryegrass cultivar blend	95%	90%	40
Creeping Red Fescue	98%	85%	25
Kentucky Bluegrass cultivar blend	95%	85%	195

2.02 FERTILIZER

- A. Fertilizer shall comply with the rules of the Iowa Department of Agriculture and Land Stewardship as follows:
1. The grade of fertilizer will be identified according to the percent nitrogen (N), percent of available phosphoric acid (P_2O_5), and percent water soluble potassium (K_2O), in that order, and approval will be based on that identification.
 2. All fertilizer shall be furnished from an established fertilizer dealer and guaranteed percentage analysis shall be provided by the fertilizer supplier on each container with the proper scale weight records.
 3. Fertilizer shall be of a type that can be uniformly distributed by the application equipment. Fertilizer may be furnished in a dry or liquid form.
 4. When applied dry, the fertilizer shall be a granular, non-burning chemically combined product composed of not less than 50% organic slow acting, guaranteed analysis professional fertilizer. Granular or pellet form shall be

uniform in composition, dry, and free flowing without caking or other damage not suitable for use.

5. When applied in a liquid form, fertilizer may be chemically combined or may be furnished as separate ingredients.
6. Upon request of the Engineer, the Contractor shall provide a test of the fertilizer for conformance with the required analysis at no additional compensation; a tolerance of 1.0 percentage point plus or minus of that specified will be considered to be in substantial compliance.

2.03 WATER

- A. Water shall be free of any substance harmful to seed growth.
- B. The Contractor shall provide water, equipment, methods of transportation, water tanker, hoses, sprinklers, and labor necessary for the application of water.

2.04 MULCH

- A. Hydraulic Seeding:
 1. The material shall be a natural or cooked cellulose fiber processed from whole wood chips (no recycled material) which will disperse readily in water to form a homogeneous slurry and remain in such state when agitated in the hydraulic mulching unit. Material shall be completely photo-degradable or biodegradable.
 2. The homogeneous slurry of material and water shall be capable of being applied with standard hydraulic mulching equipment.
 3. The slurry shall be dyed green to facilitate visual metering during application with said material or homogeneous slurry having no growth or germination-inhibiting factors, being completely non-injurious to plant or animal life and having no toxic effect when combined with seed, fertilizer, and water.
 4. When applied, the wood cellulose fiber slurry shall be free from weeds or other foreign matter toxic to seed, consisting of a classification of fibers with a minimum of 30 percent having an average length of 0.15 inches or passing a Clarke Classifier 24 mesh screen, will form an absorptive mat, but not a plant-inhibiting membrane, which will allow moisture to percolate into the underlying soil.
 5. Mulch shall have a water-holding capacity of not less than 9 pounds of water per pound of fiber.
 6. The wood cellulose fiber shall have an equilibrium air dry moisture content of 12 percent or less at time of manufacture, as defined by the pulp and paper industry standards, and shall have a pH range of 4.0 – 5.5.

7. It shall be packaged in new labeled containers and be applied at a rate of 1,800 pounds per acre (41.3 lb/1,000 sf).
8. The mulch shall include a colloidal polysaccharide tackifier which shall be adhered to the fiber to prevent separation during shipment and avoid chemical co-agglomeration during mixing within the hydraulic mulching equipment.
9. The material shall be homogeneous within the slurry and shall have no growth or germination-inhibiting factors nor any toxic effect on plant or animal life when combined with seed or fertilizer. The material shall not form a water-resistant crust that can inhibit plant growth.
10. The tackifier shall be applied at a minimum rate of 50 pounds per acre (0.11lb/sq) and shall be packaged in new labeled containers.
11. All components pre-packaged by manufacturer to ensure material performance and compliance. Field mixing of additives or any components will not be allowed.

B. Conventional Seeding:

1. Material used as mulch may consist of straw (oats, wheat, barley, or rye).
2. Hay (bromegrass, timothy, orchard grass, alfalfa, or clover) shall not be used to mulch areas where lawn mixtures are seeded but may be used to mulch areas where erosion control and perennial ground covers are seeded.
3. All material used as mulch will be free from all noxious weed, seed-bearing stalks, or roots and shall be inspected and approved by the Engineer prior to its use.
4. Other materials, subject to the approval of the Engineer, may be used.

2.05 INOCULANT FOR LEGUMES

- A. An inoculant is a culture of bacteria specifically formulated for legume seeds (alfalfa, clovers, lespedesa, birdsfoot trefoil, hairy vetch, and crown vetch).
- B. The manufacturer's container shall indicate the specific legume seed to be inoculated, rate of application, and the expiration date.
- C. All inoculant shall meet requirements of the Iowa Seed Law. Follow the safety precautions specified on the product label.

2.06 FUNGICIDE

- A. A fungicide shall be a noncommercial protectant formulation to provide protection from soil-born fungus diseases of seeds.

- B. The application shall be made at the rate of 5 1/2 ounces of a 75 percent concentrate or equivalent per 100 pounds of seed.

2.07 STICKING AGENT

- A. A sticking agent shall be a commercial material recommended by the manufacturer to improve adhesion of inoculant and fungicide to the seed.
- B. For small quantities, less than 50 pounds, the sticking agent need not be a commercial agent, but it must be approved by the Engineer and must be applied separately prior to application of inoculant and fungicide.

PART 3 - PART 3 EXECUTION

3.01 AREA OF SEEDING

- A. Areas to be seeded include all areas disturbed by construction unless otherwise noted.
- B. Temporary Erosion Control: Contractor to provide and seed temporary seeding as may be required to fulfill NPDES Permit requirements.

3.02 SEEDING DATES

- A. Seeding dates Turf Type 1 seed shall be between March 1 to May 31 and between August 10 and September 30. Commence only when ground temperatures are 55 degrees Fahrenheit or greater.
- B. Dormant seeding for domestic lawn seed, if approved by Owner, shall be completed when air temperatures are consistently below 40°F and prior to December 25 of a given year, unless otherwise approved. Dormant seeding is not allowed on snow. Prepare the seedbed before the ground freezes. To ensure protection of the seed, apply on a frosty morning or before a predicted snow.
- C. At the option and at the full responsibility of the Contractor, seeding operations may be conducted under unseasonable conditions. The final results shall be as specified and guaranteed without additional compensation should the seeded areas require reseeding.

3.03 SEEDBED PREPARATION

- A. Limit preparation of seedbed to areas which will be seeded immediately upon completion.
- B. Remove all straw-mulch, weeds and weed debris where weed growth has developed, in the opinion of the Engineer. Straw-mulch, weed growth and weed debris removal

process shall be approved by the Engineer and shall be done without additional compensation.

- C. Use crawler type or dual-wheeled tractors for seedbed preparation. Operate equipment in a manner to minimize displacement of soil and disturbance of the design cross-section. Harrow ridging in excess of 4 inches due to operation of tillage equipment prior to rolling with the cultipacker. Roll the area with no less than one pass of the cultipacker prior to permanent seeding.
- D. The Contractor shall shape and fine grade to remove washes or gullies, water pockets, and irregularities to provide a smooth, firm, and even surface true to grade and cross-section.
- E. Disk or rototill and cultivate seedbed to a minimum 3 inch depth to a fine texture and without soil lumps. Where the area is inaccessible to machinery, it shall be prepared by hand to a minimum depth of 2 inches after the fertilizer has been applied. For lawn seeding areas, prepare to a fine texture and without soil lumps. Coordinate preparation of all ditches designated for special ditch control with the seedbed preparation. Till parallel to the contours.
- F. Smooth the seedbed with a cultivator-type tillage tool having a rake bar or a rock rake. Pick up and remove all debris, such as rocks, stones, concrete larger than 2 inches (1/2 inch maximum for lawn seeding areas), or roots and other objectionable material that will interfere with the seeding operation. A spring tooth cultivator may be used in lieu of a rock picker. Remove the rock by hand after each use of the cultivator; repeat the process until the soil is relatively free of rock as determined by the Engineer.
- G. Choose equipment to minimize soil compaction. Operate equipment in a manner to minimize displacement of soil and disturbance of the design cross-section. Roll the area with at least one pass of the cultipacker. Remove ruts that develop during the sequence of operations before subsequent operations are performed. This must be completed just prior to seeding and the work approved by the Engineer before the seeding application.
- H. Application of Fertilizer:
 - 1. Do not apply fertilizer with native grass and forb mixes.
 - 2. Apply fertilizer after shaping and fine grading and prior to the combined tillage and rock-removal operations. On areas inaccessible to machinery, the fertilizer may be spread prior to tillage and cultivated seedbed preparation and uniformly mixed into the top 1 1/2 inches of soil.
 - 3. Fertilizer shall be spread with a mechanical spreader or sprayer uniformly to all areas to be seeded at the minimum rate specified herein. The fertilizer shall be tilled into the soil to a minimum depth of 3 inches.
 - 4. The Contractor shall be permitted to substitute other fertilizer containing analysis percentages different from those specified, provided that the minimum amounts of actual nitrogen (N), phosphate (P), and potash (K) per acre are supplied and

that in no case shall the total amount per acre of the three fertilizer elements (N), (P), or (K) be exceeded by 30 percent of the following minimum amounts.

5. Conventional Seeding (Lawn Seed Mixes Only):
 - a. Apply 6-24-12 commercial fertilizer or the equivalent units of nitrogen (N), phosphate (P), and potash (K) at the rate of 200 pounds per acre. A minimum of 40 percent of the total nitrogen (N) shall be water insoluble nitrogen.
6. Hydraulic Seeding (Lawn Seed Mixes Only):
 - a. Apply 6-24-12 commercial fertilizer or the equivalent units of nitrogen (N), phosphate (P), and potash (K) at the rate of 200 pounds per acre prior to seeding.
 - b. In addition to the above, a minimum of 100 pounds per acre of a 20-26-6 fertilizer in which a minimum of 50 percent of the total nitrogen is water insoluble nitrogen shall be applied as part of the seed, fertilizer, mulch, and water slurry.
7. Tilling:
 - a. After fertilizer has been applied, a mechanical rock picker shall be used on areas accessible to machinery to mix fertilizer in the soil to a depth of 3 inches and to remove all rocks, debris, and solid non-soil material larger than 1 inch in diameter from the upper 3 inches of the soil. A spring tooth cultivator may be used in lieu of a rock picker. The rock shall then be removed by hand after each use of the cultivator--the process to be repeated until the soil is relatively free of rock as determined by the Engineer.
 - b. Remove all rock remnants from rock piles used on project smaller than 1 inch.
 - c. The seedbed shall then be smoothed with a cultivator-type tillage tool having a rake bar-such as the Roseman rake-or a rock rake-such as the York-gauged by rear gauge wheels or by a blade gauged by a landscape roller-such as the Viking roller blade.
 - d. Tilling shall be parallel to the contours.
 - e. Ruts and wheel tracks in the seedbed from seedbed preparation are to be removed prior to seeding. This must be completed just prior to seeding and the work approved by the Engineer before the seeding application.

3.04 SEED PREPARATION

- A. Treat all legume seed with a commercial sticking agent to be applied prior to application of inoculant, or as a mixture when the sticking agent is compatible with other materials. A sticking agent is not required if a liquid formulation of inoculant is used. Use mechanical mixing equipment to apply sticking agent and inoculant on seed quantities over 50 pounds.
- B. Inoculate all legumes with a standard product humus culture before being mixed with other seeds for sowing.
- C. Inoculate all legumes with a standard culture at the rate specified by the manufacturer of the inoculant according to Iowa DOT Article 4169.04. Do not expose inoculated seed to direct sunlight for more than 30 minutes. Re-inoculate seed that is not sown within 8 hours after inoculation prior to use. Pre-inoculated seed with manufacturer's recommended protective coating may be used in lieu of seed with Contractor-applied inoculant.
- D. When the gravity or cyclone seeder is used for application of seed, inoculate legume seed according to the manufacturer's recommended procedures, before mixing with other grass seeds for sowing. Furnish and apply inoculant.

3.05 APPLICATION OF SEED

- A. Prior to seeding, the seedbed shall be inspected and approved by the Engineer and Owner.
- B. Conventional Seeding:
 - 1. Sowing:
 - a. Domestic Grasses - On all areas accessible to machinery, all grasses shall be sown with a drop-type seeder attached to a landscape roller in such a manner that the seed is applied and then covered by rolling which firms the soil. Seeding to be completed with a minimum of two passes in different directions.
 - b. On areas inaccessible to field machinery, the use of cyclone seeders will be permitted, but no other hand-seeding methods will be accepted.
 - 2. Mulching:
 - a. All seeded areas shall be mulched within 24 hours after the seed is sown. The mulch shall be uniformly distributed over the required areas at a rate of 2 tons of dry mulch per acre.
 - b. The mulch shall then be worked into the soil with a mulch tucker which shall be designed to anchor the mulch into the soil. The tucker shall be designed to anchor mulch into soil by means of dull blades or disks with a

minimum of two passes. Operate equipment in a manner to minimize displacement of the soil and disturbance of the design cross-section.

- c. Do not tuck mulch over native prairie, wetland, and forbes mixtures.

C. Hydraulic Seeding:

1. If approved by Engineer, hydraulic seeding shall be applied as specified.
2. All material, seed, fertilizer, mulch, tackifier, and fungicide shall be placed in hydraulic-mulching equipment specifically manufactured for hydraulic seeding and mulching.
3. Ensure the hydraulic equipment, pump, and application process do not damage or crack seeds.
4. Materials shall be mixed with fresh potable water using a combination of both recirculation through the equipment's pump and mechanical agitation to form a homogeneous slurry.
5. It shall be applied evenly over all specified areas in a workmanlike manner at component material rates specified.
6. Apply mixture within one hour after seed and fertilizer are placed in the hydraulic seeder.
7. If necessary, dampen dry, dusty soil, to prevent balling of the material during application.
8. Site cleanup shall be considered part of application and shall include the removal of hydraulic mulch slurry from buildings, landscaping, sidewalks, and any other areas not specified for application. All debris resulting from this application shall be removed from the site.

3.06 WATERING

- A. All seeded areas shall be kept moist at all times. The areas shall be artificially watered a minimum of twice a day (early morning and evening) every day for the first week after seeding is completed.
- B. For the second and third weeks after seeding, the seeded areas shall be artificially watered once a day (early morning or evening).
- C. The quantity of water used shall be adequate to keep the soil and mulch moist to a depth of 1 inch and ensure growth of the seed. If natural rainfall is adequate to keep the soil and mulch moist as stated above, artificial watering may be deleted.

- D. Any area seeded in the month of May shall be maintained for an additional 3 weeks. The seeded areas shall receive a minimum of 1 inch of water each week (either natural, artificial, or combination) for the fourth, fifth, and sixth week after seeding.

3.07 MAINTENANCE

- A. Domestic Grasses - Maintenance shall begin immediately following the installation of seed and mulch and continue for a minimum 60 day period or until seed has been accepted.
- B. Maintenance of seeded areas shall include protection against traffic, repairing of areas damaged, watering, rolling, and mowing when grasses are at an approximate 3-inch height.
 - 1. If areas are seeded in the fall and not given a full maintenance period, or if seeding establishment is not acceptable at that time, continue maintenance the following spring until acceptable lawn is established.

3.08 RE-SEEDING

- A. When all work related to seeding on an area has been completed but is washed out or damaged prior to final acceptance of the seeding area and that area involves seeding in combination with mulching or fertilizing or both, the area shall be reseeded, refertilized, and remulched at the contract unit price or prices when so ordered by the Owner.
- B. Fertilized or seeded areas damaged by rain prior to required mulching or areas where the mulch is not tacked shall be refertilized or reseeded or both at a rate not to exceed the specified rate, as designated by the Engineer, without additional compensation.

3.09 CLEANUP

- A. Perform cleanup operations during installation of work and upon completion.
- B. Remove from site all excess materials, debris, and equipment.
- C. Hose down and/or broom clean all paved surfaces.
- D. Repair any damage resulting from seeding operations.
- E. Remove hydraulic slurry from buildings landscaping and plantings, mulch, sidewalks, pavement, and any other areas not specified for application.

3.10 FINAL ACCEPTANCE

- A. The areas seeded shall be given acceptance based upon the following criteria:
 - 1. All requirements for the completed installation and a minimum of 60 days maintenance have been provided for domestic grasses.
 - 2. Seeded areas shall be in a live, healthy, growing, and well-established condition without eroded areas, bare spots, free of weeds, undesirable grasses, disease, or insects.
 - 3. Re-seeding operations are completed, as per original specifications.
- B. Final acceptance may be given by the Owner upon fulfillment of all items completed as required.

END OF SECTION 32 92 00

SECTION 33 05 00
COMMON WORK RESULTS FOR UTILITIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Piping joining materials.
 - 2. Transition fittings.
 - 3. Dielectric fittings.
 - 4. Sleeves.
 - 5. Identification devices.
 - 6. Grout.
 - 7. Flowable fill.
 - 8. Piped utility demolition.
 - 9. Piping system common requirements.
 - 10. Equipment installation common requirements.
 - 11. Painting.
 - 12. Concrete bases.
 - 13. Metal supports and anchorages.

1.03 DEFINITIONS

- A. Exposed Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions.
- B. Concealed Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- C. ABS: Acrylonitrile-butadiene-styrene plastic.
- D. CPVC: Chlorinated polyvinyl chloride plastic.
- E. PE: Polyethylene plastic.
- F. PVC: Polyvinyl chloride plastic.

1.04 ACTION SUBMITTALS

A. Product Data: For the following:

1. Dielectric fittings.
2. Identification devices.

1.05 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.06 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Steel Piping Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- C. Comply with ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.08 COORDINATION

- A. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- B. Coordinate installation of identifying devices after completing covering and painting if devices are applied to surfaces.
- C. Coordinate size and location of concrete bases. Formwork, reinforcement, and concrete requirements.

PART 2 - PRODUCTS

2.01 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
- B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
- F. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- G. Solvent Cements for Joining Plastic Piping:
- H. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.02 TRANSITION FITTINGS

- A. Transition Fittings, General: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
- B. Transition Couplings NPS 1-1/2 (DN 40) and Smaller:
- C. AWWA Transition Couplings NPS 2 (DN 50) and Larger:
- D. Plastic-to-Metal Transition Fittings:
- E. Plastic-to-Metal Transition Unions:
- F. Flexible Transition Couplings for Underground Nonpressure Drainage Piping:

2.03 DIELECTRIC FITTINGS

- A. Dielectric Fittings, General: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.

2.04 SLEEVES

- A. Mechanical sleeve seals for pipe penetrations see mechanical specifications.
- B. Galvanized-Steel Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
- C. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized, plain ends.
- D. Cast-Iron Sleeves: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- E. Molded PVC Sleeves: Permanent, with nailing flange for attaching to wooden forms.
- F. PVC Pipe Sleeves: ASTM D 1785, Schedule 40.
- G. Molded PE Sleeves: Reusable, PE, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

2.05 IDENTIFICATION DEVICES

- A. General: Products specified are for applications referenced in other utilities Sections. If more than single type is specified for listed applications, selection is Installer's option.
- B. Equipment Nameplates: Metal permanently fastened to equipment with data engraved or stamped.
- C. Stencils: Standard stencils prepared with letter sizes complying with recommendations in ASME A13.1. Minimum letter height is 1-1/4 inches (30 mm) for ducts, and 3/4 inch (20 mm) for access door signs and similar operational instructions.
- D. Snap-on Plastic Pipe Markers: Manufacturer's standard preprinted, semirigid, snap-on type. Include color-coding according to ASME A13.1, unless otherwise indicated.
- E. Pressure-Sensitive Pipe Markers: Manufacturer's standard preprinted, color-coded, pressure-sensitive-vinyl type with permanent adhesive.
- F. Pipes with OD, Including Insulation, Less Than 6 Inches (150 mm): Full-band pipe markers, extending 360 degrees around pipe at each location.
- G. Pipes with OD, Including Insulation, 6 Inches (150 mm) and Larger: Either full-band or strip-type pipe markers, at least three times letter height and of length required for label.
- H. Lettering: Manufacturer's standard preprinted captions as selected by Architect.
- I. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.

- J. Plastic Tape: Manufacturer's standard color-coded, pressure-sensitive, self-adhesive vinyl tape, at least 3 mils (0.08 mm) thick.
- K. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) sequenced numbers. Include 5/32-inch (4-mm) hole for fastener.
- L. Valve Tag Fasteners: Brass, wire-link or beaded chain; or brass S-hooks.
- M. Engraved Plastic-Laminate Signs: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.
- N. Plastic Equipment Markers: Manufacturer's standard laminated plastic, in color codes:
- O. Plasticized Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with mat finish suitable for writing.
- P. Lettering and Graphics: Coordinate names, abbreviations, and other designations used in piped utility identification with corresponding designations indicated. Use numbers, letters, and terms indicated for proper identification, operation, and maintenance of piped utility systems and equipment.

2.06 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

2.07 FLOWABLE FILL

- A. Description: Low-strength-concrete, flowable-slurry mix.

PART 3 - EXECUTION

3.01 PIPED UTILITY DEMOLITION

- A. Disconnect, demolish, and remove piped utility systems, equipment, and components indicated to be removed.
- B. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.02 DIELECTRIC FITTING APPLICATIONS

- A. Dry Piping Systems: Connect piping of dissimilar metals.
- B. Wet Piping Systems: Connect piping of dissimilar metals.

3.03 PIPING INSTALLATION

- A. Install piping according to the following requirements and utilities Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on the Coordination Drawings.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping to permit valve servicing.
- E. Install piping at indicated slopes.
- F. Install piping free of sags and bends.
- G. Install fittings for changes in direction and branch connections.
- H. Select system components with pressure rating equal to or greater than system operating pressure.
- I. Sleeves are not required for core-drilled holes.
- J. Permanent sleeves are not required for holes formed by removable PE sleeves.
- K. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
- L. Verify final equipment locations for roughing-in.
- M. Refer to equipment specifications in other Sections for roughing-in requirements.

3.04 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and utilities Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves.
- E. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- G. Grooved Joints: Assemble joints with grooved-end pipe coupling with coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.
- H. Soldered Joints: Apply ASTM B 813 water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy (0.20 percent maximum lead content) complying with ASTM B 32.
- I. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- J. Pressure-Sealed Joints: Assemble joints for plain-end copper tube and mechanical pressure seal fitting with proprietary crimping tool to according to fitting manufacturer's written instructions.
- K. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings.
- L. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.
- M. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.
- N. Plastic Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
- O. Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.05 EQUIPMENT INSTALLATION

- A. Install equipment level and plumb, unless otherwise indicated.

- B. Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference with other installations. Extend grease fittings to an accessible location.
- C. Install equipment to allow right of way to piping systems installed at required slope.

3.06 PAINTING

- A. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.07 IDENTIFICATION

- A. Piping Systems: Install pipe markers on each system. Include arrows showing normal direction of flow.
 - 1. Stenciled Markers: According to ASME A13.1.
 - 2. Plastic markers, with application systems. Install on insulation segment if required for hot noninsulated piping.
 - 3. Locate pipe markers on exposed piping.
- B. Equipment: Install engraved plastic-laminate sign or equipment marker on or near each major item of equipment.
- C. Adjusting: Relocate identifying devices that become visually blocked by work of this or other Divisions.

3.08 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

3.09 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor piped utility materials and equipment.
- B. Field Welding: Comply with AWS D1.1/D1.1M.

3.10 GROUTING

- A. Mix and install grout for equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.

- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

END OF SECTION 33 05 00

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SECTION 33 11 00
WATER UTILITY DISTRIBUTION PIPING

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Pipe
- B. Fittings
- C. Special Fittings
- D. Pipeline Accessories

1.02 DESCRIPTION OF WORK

Construct water mains and building service pipes.

1.03 SUBMITTALS

Follow the General Provisions (Requirements) and Covenants as well as the following:

Submit product information sheet for joint restraint system to be used.

1.04 SUBSTITUTIONS

Follow the General Provisions (Requirements) and Covenants.

1.05 DELIVERY, STORAGE, AND HANDLING

Follow the General Provisions (Requirements) and Covenants as well as the following:

Remove pipe and fittings contaminated with mud and surface water from the site; do not use in construction unless thoroughly cleaned, inspected, and approved by the Engineer.

1.06 SCHEDULING AND CONFLICTS

Follow the General Provisions (Requirements) and Covenants.

1.07 SPECIAL REQUIREMENTS

None.

PART 2 - PRODUCTS

2.01 WATER MAIN

A. Polyvinyl Chloride (PVC) Pipe:

1. Comply with AWWA C900 or AWWA C905 with gray iron pipe equivalent outside diameters.

2. Minimum Wall Thickness:
 - a. 4-inch through 24-inch sizes: DR 18.
 - b. Sizes over 24-inch: As specified in the contract documents.
3. Joint Type: Use push-on joint type, except as otherwise required in the contract documents or as authorized by the Engineer.
 - a. Push-on: Per AWWA C900 or AWWA C905.
 - b. Integral Restrained Joint: AWWA C900 or AWWA C905 pipe with restraining system manufactured integrally into pipe end.
 - c. Mechanical Restrained Joint: Ductile iron mechanical device designed for joint restraint of AWWA C900 or AWWA C905 pipe complying with the requirements of ASTM F 1674.
4. Markings on Pipe:
 - a. Name of manufacturer.
 - b. Size and class.
 - c. Spigot insertion depth gauge.
 - d. National Sanitation Foundation (NSF) seal.

B. Ductile Iron Pipe:

1. Minimum Thickness Class:
 - a. 4-inch through 24-inch sizes: Special thickness Class 52 per AWWA C151.
 - b. Sizes over 24 inches: As specified in the contract documents.
2. Cement-mortar lined, per AWWA C104 with asphaltic seal coat.
3. External Coating: Asphaltic per AWWA C151.
4. Joint Type: Use push-on type, except as otherwise required in the contract documents or as authorized by the Engineer.
 - a. Push-on: Per AWWA C111.
 - b. Mechanical: Per AWWA C111.
 - c. Restrained, Buried: Pipe manufacturer's standard field removable system.
 - d. Restrained, in Structures: Restraining gland, flanged or grooved.
 - e. Flanged: AWWA C111.
 - f. Grooved: AWWA C606.
 - g. Gaskets: AWWA C111.
5. Markings on Pipe:
 - a. Name of manufacturer.
 - b. Size and class.
 - c. Spigot insertion depth gauge.

C. Prestressed Concrete Cylinder Pipe:

1. Design and manufacture according to AWWA C301 and AWWA C304 to meet the following minimum conditions:
 - a. Internal Pressure: 150 psi.
 - b. Earth Loads: Actual trench depth, but not less than 6 feet.
 - c. Live Loads: HS 20 vehicle over trench.
 - d. Surge Pressure: Allowance 60 psi.
 - e. Bedding: Type R2, AWWA C304, Figure 9.
 - f. Safety Factor: 2.5.

2. Joints:
 - a. Steel joint rings with rubber gaskets per AWWA C301.
 - b. External Joint Filler: Cement mortar with diaphragms.
 - c. Outlets: Flanged, per ANSI B16.1, Class 125, with 1/8 inch minimum thickness rubber gaskets.
- D. Taper-Tite 250 Piping Systems : Fiberglass Reinforced Plastic (FRP) Green Thread with PVC Casing Pipe
 1. To be used for only the hot water and chilled water piping systems.
 2. Joined with adhesive using matching tapered bell and spigot ends.
 3. All pipe, fittings, valves and accessories shall conform to ANSI B31.1
 4. Contractor to confirm compliance with specified pressure and temperature of system.
 5. FRP shall be filament wound using epoxy resins and shall have resin rich reinforced liner and comply with ASTM D2310, D2996 and D5686.
 6. PVC casing pipe shall meet ASTM D1784.

2.02 BOLTS FOR WATER MAIN AND FITTINGS

Use corrosion resistant bolts.

A. Tee-bolts and Hexagonal Nuts for Mechanical Joints:

1. High-strength, low-alloy steel manufactured according to AWWA C111.
2. Provide ceramic-filled, baked-on, fluorocarbon resin coating for bolts and nuts.
3. Include factory-applied lubricant that produces low coefficient of friction for ease of installation.

B. Other Bolts and Nuts:

1. Stainless steel.
2. Ductile iron.
3. Zinc, zinc chromate, or cadmium plated.

2.03 FITTINGS

A. For Ductile Iron and PVC Pipe:

1. Comply with AWWA C110 or AWWA C153.
2. Joint Type:
 - a. For pipe sizes 16 inches and less, use mechanical joint complying with AWWA C111.
 - b. For pipe sizes greater than 16 inches, use restrained mechanical joint system. Provide follower gland using breakaway torque bolts to engage thrust restraint.
 - 1) Minimum pressure rating same as connecting pipe. For fittings between dissimilar pipes, the minimum pressure rating is the lesser of the two pipes.
 - 2) Suitable for buried service.
 - 3) Joint restraint system to be field installable, field removable, and re-installable.
 - c. Use of alternate restraint systems must be approved by the Engineer.

3. Cement-mortar lined per AWWA C104 with asphaltic coating.
 4. Wall Thickness: AWWA C153.
 5. Gaskets: AWWA C111.
- B. Fittings for Prestressed Concrete Cylinder Pipe: As required for prestressed concrete cylinder pipe.
- C. Flange Adapter:
1. Body: Ductile iron complying with ASTM A 536.
 2. End Rings (Follower Rings): Ductile iron complying with ASTM A 536.
 3. Gaskets: New rubber compounded for water service and resistant to permanent set.
 4. Bolts and Nuts: High strength, low alloy corrosion resistant steel or carbon steel bolts complying with ASTM A 307.
- D. Pipe Coupling:
1. Center Sleeve (Center Ring): Steel pipe or tubing complying with ASTM A 53 or ASTM A 512; or formed carbon steel with a minimum yield of 30,000 psi.
 2. End Ring (Follower Ring): Ductile iron complying with ASTM A 536, or steel meeting or exceeding the requirements of ASTM A 576, grade 1010-1020.
 3. Gaskets: New rubber compounded for water service and resistant to permanent set.
 4. Bolts and Nuts: High strength, low alloy corrosion resistant steel.

2.04 CONCRETE THRUST BLOCKS

- A. Use concrete with a compressive strength of 4000 psi at 28 days.
- B. Comply with the contract documents for dimensions and installation of thrust blocks. Comply with plan detail.
- C. Use for all pipe sizes 16 inches in diameter or smaller or when specified.

2.05 PIPELINE ACCESSORIES

- A. Polyethylene Wrap:
1. Use on all ductile iron pipe and fittings in buried service.
 2. Comply with AWWA C105.
 3. 8 mil minimum thickness.
- B. Tracer System: Comply with plan detail.
1. Ground Rod: 3/8 inch diameter, 60-inch steel rod uniformly coated with metallically bonded electrolytic copper.

2. Ground-rod Clamp: High-strength, corrosion-resistant copper alloy.
3. Splice Kit: Inline resin splice kit with split bolt for 1kV and 5kV. Insulates and seals single conductor and unshielded cable splices for direct bury and submersible applications.
4. Tracer Wire Station: Contact the Jurisdiction for requirements.
5. Tracer wire: Solid, AWG #12, blue insulated, direct bury, Type TWHN. Install in trench attached directly to, parallel with, and centered above or below the utility.
6. Underground splices: Use Scotchcast splicing kits, 3M Company or approved equal.
7. In addition to tracer wire, Contractor shall install underground pipe markers: bright colored continuously printed plastic ribbon tape, 6" wide by 3.5 mils thick, manufactured for direct burial, with aluminum foil core for location by non-ferric metal detectors and bold lettering identifying buried item. Install 8" to 10" below grade directly above buried utilities.

2.06 SPECIAL GASKETS

- A. For soils contaminated with gasoline, use neoprene or nitrile gaskets.
- B. For soils contaminated with volatile organic compounds, use nitrile or fluoro carbon gaskets.
- C. For other soil contaminants, contact the Engineer for the required gasket.

2.07 WATER SERVICE PIPE AND APPURTENANCES

- A. Controlling Standards: Local plumbing and fire codes.
- B. Materials (as allowed by Jurisdiction or specified in contract documents):
 1. Copper Pipe:
 - a. Comply with ASTM B 88.
 - b. Wall thickness: Type K.
 2. Ductile Iron Pipe: As specified in Section 331100, 2.01. Polyethylene wrap is required.
 3. PVC Pipe: ASTM D 1785, SDR 21, Schedule 80, Type S joints.
 4. Brass Pipe: Red, seamless, per ASTM B 43.
 5. Polyethylene Pipe: Class 200, per AWWA C901.
- C. Corporations and Stop Boxes: Contact the Jurisdiction for requirements.

2.08 NON-SHRINK GROUT

Comply with Iowa DOT I.M. 491.13.

PART 3 - EXECUTION

3.01 PIPE INSTALLATION

A. General:

1. Do not use deformed, defective, gouged, or otherwise damaged pipes or fittings.
2. Keep trench free of water. Clean pipe interior prior to placement in the trench.
3. Install pipe with fittings and valves to the lines and grades specified in the contract documents.
4. Clean joint surfaces thoroughly and apply lubricant approved for use with potable water and recommended by the manufacturer.
5. Push pipe joint to indication line on spigot end of pipe before making any joint deflections.
6. Limit joint deflections to one degree less than pipe manufacturer's recommended maximum limit.
7. Tighten bolts in a joint evenly around the pipe.
8. Install concrete thrust blocks on pipes 16 inches in diameter or smaller (comply with Figure 5010.1). For pipes larger than 16 inches, install restrained joints; when specified in the contract documents, also install concrete thrust blocks.
9. Keep exposed pipe ends closed with rodent-proof end gates at all times when pipe installation is not occurring.
10. Close the ends of the installed pipe with watertight plugs during nights and non-working days.
11. Do not allow any water from the new pipeline to enter the existing distribution system piping until testing and disinfection are successfully completed.

B. Trenched:

1. Excavate trench and place pipe bedding and backfill material as specified in Section 3010.
2. Provide uniform bearing along the full length of the pipe barrel. Provide bell holes.

3.02 ADDITIONAL REQUIREMENTS FOR DUCTILE IRON PIPE INSTALLATION

- A. Utilize full-length gauged pipe for field cuts. Alternatively, field-gauge pipe selected for cutting to verify the outside diameter is within allowable tolerances.
- B. Cut pipe perpendicular to pipe barrel. Do not damage cement lining. Bevel cut ends for push-on joints according to the manufacturer's recommendations.
- D. Encase all pipe, valves, and fittings with polyethylene wrap. Comply with Figure 5010.2.

3.03 ADDITIONAL REQUIREMENTS FOR PVC PIPE INSTALLATION

- A. Cut pipe perpendicular to pipe barrel. Deburr and bevel cut spigot end of pipe barrel to match factory bevel. Re-mark insertion line.
 - B. When connecting to shallow-depth bells, such as on some cast iron fittings or valves, cut spigot end square to remove factory bevel. Deburr end and form partial bevel on end.
- 3.04 ADDITIONAL REQUIREMENTS FOR PRESTRESSED CONCRETE CYLINDER PIPE INSTALLATION
- A. Install according to AWWA M9.
 - B. Relieve gasket tension by inserting a small rod between the gasket and the gasket groove and running the tool around the pipe twice.
 - C. Check gasket position using a metal feeler gauge after the joint has been assembled.
 - D. Complete joint exterior grouting after pipe has been properly positioned using non-shrink grout.
- 3.05 POLYETHYLENE ENCASEMENT INSTALLATION
- A. Apply to all buried iron pipe, fittings, fire hydrants, and appurtenances.
 - B. Wrap material snugly around pipe, but provide sufficient slack to prevent stretching around irregular areas such as fittings and valves. Comply with Figure 5010.2.
 - C. Secure and repair encasement material using polyethylene tape, or replace as necessary.
 - D. The polyethylene encasement is to prevent contact between the pipe and the bedding material, but need not be airtight or watertight.
- 3.06 TRACER SYSTEM INSTALLATION
- A. Install with all buried water main piping.
 - B. Begin and terminate system at all connections to existing mains.
 - C. Install wire continuously along the lower quadrant of the pipe. Do not install wire along the bottom of the pipe. Attach wire to the pipe at the midpoint of each pipe length; use 2-inch wide, 10 mil thickness polyethylene pressure sensitive tape.
 - D. Install splices only as authorized by the Engineer. Allow the Engineer to inspect all below-grade splices of tracer wire prior to backfill.
 - E. Install ground rods adjacent to connections to existing piping and at locations specified in the contract documents or as directed by the Engineer.
 - F. Bring two wires to the surface at each hydrant location and terminate with a tracer wire station (comply with plan detail).
 - G. Final inspection of the tracer system will be conducted at the completion of the project and prior to acceptance by the owner. Verify the electrical continuity of the system. Repair any discontinuities.

- H. After all utilities have been installed but prior to substantial completion, Contractor shall demonstrate, in the presence of the Owner, continuity of all tracer wires from end to end at all underground utilities. Tracer wires which fail a continuity test shall be repaired or replaced and re-tested until a successful continuity test is achieved. Provide Owner 48 hour notice of this activity.

3.07 CONFLICTS

- A. Provide temporary support for existing gas, telephone, power, or other utilities or services that cross the trench.
- B. Compact backfill under existing utility crossing as specified in Section 332343 or construct utility line supports where indicated on plans or as directed by the Engineer.
- C. Separate water mains from gravity sewers by a horizontal distance of at least 10 feet unless:
 - 1. Bottom of the water main is at least 18 inches above the top of the sewer.
 - 2. Sewer is placed in a separate trench or in the same trench on a bench of undisturbed earth at a minimum horizontal separation of 3 feet separation from the water main.
- D. Use water main materials as specified in Section 331100, 2.1 for gravity sewers with less than 10 feet horizontal distance and the bottom of the water main less than 18 inches above top of the sewer; maintain at least 2 feet linear separation.
- E. Where the water main crosses under the gravity sewer, or where the bottom of the water main is less than 18 inches above the top of the sewer:
 - 1. If physical conditions prohibit the separation, the water main may not be placed closer than 6 inches above a sewer or 18 inches below a sewer. Use the maximum feasible separation distance in all cases.
 - 2. Use full length of water main material as specified in Section 331100, 2.1 for gravity sewer centered on the water main.
 - 3. The water main and sewer must be adequately supported and have watertight joints.
 - 4. Place backfill in the trench with low permeability soil for 10 feet centered on the crossing.
- F. Separate water mains from sanitary sewer force mains by a horizontal distance of at least 10 feet, unless the force main is constructed of water main materials meeting a minimum pressure rating of 200 psi and is installed at least 4 feet horizontally from the water main.

3.08 TRANSITIONS IN PIPING SYSTEMS

Where the specified material of piping system entering or exiting a structure changes, change at the outside of the structure wall, beyond any wall pipe or wall fitting required, unless otherwise specified.

3.09 STRUCTURE PENETRATIONS

- A. Wall Pipes:

1. Install where pipes penetrate and terminate at a wall or floor surface of a concrete structure, or where the pipe protrudes through the concrete wall or floor and the protrusion is otherwise unsupported.
 2. Provide a waterstop flange near the center of the embedment length. Waterstop is to be cast integrally with the wall pipe, or fully welded to it around the pipe circumference.
- B. Wall Sleeves:
1. Install where a pipe passes through a structure wall.
 2. Sleeves in concrete walls are to be supplied with a waterstop collar, fully welded, and be cast-in-place.

3.10 WATER SERVICE STUB

- A. Install water service pipe, corporations, stops, and stop boxes according to local Jurisdiction requirements.
- B. Install 1 inch and smaller corporation valves tapped at 45 degrees above horizontal at a minimum distance of 18 inches from pipe bell or other corporation. Install 1 1/2 inch and 2 inch corporation valves tapped horizontal a minimum distance of 24 inches from pipe bell or other corporation.
- C. Construct trench and backfill per Section 312316.

3.11 TESTING AND DISINFECTION

Test and disinfect according to Section 312343

END OF SECTION 33 11 00

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SECTION 33 12 00
WATER UTILITY DISTRIBUTION EQUIPMENT

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Butterfly Valves
- B. Gate Valves
- C. Tapping Valve Assemblies
- D. Fire Hydrant Assemblies
- E. Flushing Devices (Blowoffs)
- F. Valve Boxes

1.02 DESCRIPTION OF WORK

Install valves, fire hydrants, and appurtenances for water mains.

1.03 SUBMITTALS

Follow the General Provisions (Requirements) and Covenants.

1.04 SUBSTITUTIONS

Follow the General Provisions (Requirements) and Covenants.

1.05 DELIVERY, STORAGE, AND HANDLING

Follow the General Provisions (Requirements) and Covenants, as well as the following:

Remove valves, fire hydrants, and appurtenances contaminated with mud and surface water from the site; do not use in construction unless thoroughly cleaned, inspected, and approved by the Contracting Officer.

1.06 SCHEDULING AND CONFLICTS

Follow the General Provisions (Requirements) and Covenants.

1.07 SPECIAL REQUIREMENTS

None

PART 2 - PRODUCTS

2.01 VALVES

A. General:

1. Same size as pipeline in which it is installed, unless noted otherwise on the plans.

2. Manufacturer's name and pressure rating cast on valve body.
 3. Direction of Opening: The opening direction is counterclockwise as viewed from the top, unless otherwise specified in the contract documents or as directed by the Jurisdiction.
 4. Joints:
 - a. For buried installations, use mechanical joints per AWWA C111. Comply with Section 331100 for joint nuts and bolts.
 - b. For installation within structures, flanged with dimensions and drillings per AWWA C110 or ANSI B16.1 class 125.
- B. Gate Valves:
1. Comply with AWWA C509 (gray iron or ductile iron) or AWWA C515 (ductile iron) and NSF 61.
 2. Stem Seals: Double O-rings permanently lubricated between seals. Lubricant certified for use in potable water.
 3. External Bolts and Hex Nuts: Stainless steel per ASTM A 240, Type 304.
- C. Butterfly Valves:
1. Comply with AWWA C504 class 150B (gray iron or ductile iron) and NSF 61.
 2. Disc: Ductile iron or gray iron with plasma applied nickel-chromium edge or stainless steel edge per ASTM A 240, Type 316, and mechanically fixed stainless steel pins.
 3. Stem: Stainless steel per ASTM A 240, Type 304, turned, ground, and polished.
 4. Seat: Synthetic rubber compound bonded or mechanically retained to the body.
 5. External Bolts and Hex Nuts: Stainless steel per ASTM A 240, Type 304.
- D. Tapping Valve Assemblies:
1. Tapping Valve: Gate valve complying with AWWA C509 or AWWA C515.
 2. Sleeve:
 - a. Minimum 14 gauge.
 - b. Stainless steel per ASTM A 240, Type 304.
 - c. Working pressure 150 psi.
 - d. Must fully surround pipe.
 - e. Flanged with dimensions and drillings per AWWA C110 or ANSI B16.1 class 125.

3. Minimum Sleeve Length:

Outlet Flange Size	Minimum Sleeve Length
4" (101.6 mm)	15" (381.0 mm)
6" (152.5 mm)	15" (381.0 mm)
8" (203.2 mm)	20" (508.0 mm)
10" (254.0 mm)	25" (635.0 mm)
12" (304.8 mm)	25" (635.0 mm)
Over 12" (over 304.8 mm)	As approved by the Contracting Officer

4. Gasket:

- To completely surround pipe.
- Minimum thickness 0.125 inch (3.18 mm).
- Use nitrile rubber.

5. Outlet Flange:

- Stainless steel ASTM A 240, Type 304.
- ANSI B16.1, 125 pound pattern.

6. Hex Nuts and Bolts: Stainless steel per ASTM A 240, Type 304.

7. Use tapping valve assemblies only where shown on the plans.

2.02 APPURTENANCES

A. Flushing Device (Blowoff): As specified.

B. Valve Box:

- Applicability: For all buried valves.
- Manufacturer: As allowed by the Jurisdiction or specified in the contract documents.
- Type:
 - In paved areas, use a slide type.
 - In all other areas, use a screw extension type.
- Material: Gray iron.
- Cover: Gray iron, labeled "WATER"
- Wall Thickness: 3/16-inch (4.8 mm), minimum.
- Inside Diameter: 5 inches (127.0 mm), minimum.
- Length: Adequate to bring top to finish grade, including valve box extensions, if necessary.
- Factory Finish: Asphalt coating.
- Valve Box Centering Ring: Include in installation.

C. Valve Stem Extension: For all buried valves, provide as necessary to raise 2-inch (50.8

mm) operating nut to within 3 feet (914.4 mm) of the finish grade. Stem diameter per valve manufacturer's recommendations, but not less than 1 inch (25.4 mm).

PART 3 - EXECUTION

3.01 GENERAL

- A. Install according to the contract documents.
- B. Apply polyethylene wrap to all iron pipe, valves, and fittings.
- C. Set tops of valve boxes to finish grade unless otherwise directed by the Contracting Officer.
- D. Check the working order of all valves by opening and closing through entire range. Before opening the valves, check with the Jurisdiction on operating requirements.
- E. Test and disinfect all valves, and appurtenances as components of the completed water main according to Section 33 1300.

3.02 FLUSHING DEVICE (BLOWOFF)

Install where shown on the plans and construct as specified.

END OF SECTION 33 12 00

SECTION 33 31 13
SANITARY UTILITY PIPING

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Sanitary Sewer Gravity Mains
- B. Sanitary Sewer Force Mains
- C. Sanitary Sewer Services

1.02 DESCRIPTION OF WORK

- A. Construct sanitary sewer gravity and force mains.
- B. Construct or relocate building sanitary sewer services, stubs, and connections.

1.03 SUBMITTALS

Comply with General Provisions.

1.04 SUBSTITUTIONS

Comply with General Provisions.

1.05 DELIVERY, STORAGE, AND HANDLING

Comply with General Provisions.

1.06 SCHEDULING AND CONFLICTS

Comply with General Provisions.

1.07 SPECIAL REQUIREMENTS

None.

PART 2 - PRODUCTS

2.01 SANITARY SEWER (Gravity Mains)

A. Solid Wall Polyvinyl Chloride Pipe (PVC) 8 inch to 15 inch:

1. Comply with ASTM D 3034, SDR 26, unless SDR 35 is specified.
2. Pipe stiffness per ASTM D 2412.
 - a. SDR 26: Minimum pipe stiffness of 115 psi.
 - b. SDR 35: Minimum pipe stiffness of 46 psi.
3. PVC plastic meeting ASTM D 1784, Cell Classification 12454 or 12364.
4. Integral bell and spigot joints with elastomeric seals complying with ASTM D 3212 and ASTM F 477.

B. Solid Wall Polyvinyl Chloride Pipe (PVC) 18 inch to 27 inch:

1. Comply with ASTM F 679.
2. Pipe stiffness per ASTM D 2412, 46 psi.
3. PVC plastic meeting ASTM D 1784, Cell Classification 12454 or 12364.
4. Integral bell and spigot joints with elastomeric seals complying with ASTM D 3212 and ASTM F 477.

C. Corrugated Polyvinyl Chloride Pipe (PVC) 8 inch to 36 inch:

1. Comply with ASTM F 949, smooth interior, corrugated exterior.
2. Pipe stiffness per ASTM D 2412.
 - a. 8 inch to 10 inch: Minimum pipe stiffness of 115 psi, unless 46 psi is specified.
 - b. 12 inch to 36 inch: Minimum pipe stiffness of 46 psi.
3. PVC resin meeting ASTM D 1784, Cell Classification 12454.
4. Integral bell and spigot joints with elastomeric seals complying with ASTM D 3212 and ASTM F 477.

D. Closed Profile Polyvinyl Chloride Pipe (PVC) 21 inch to 36 inch:

1. Comply with ASTM F 1803.
2. Pipe stiffness per ASTM D 2412, 46 psi.
3. PVC plastic meeting ASTM D 1784, Cell Classification 12364.
4. Integral bell and spigot joints with elastomeric seals complying with ASTM D 3212 and ASTM F 477.

E. Polyvinyl Chloride Composite Pipe (truss type PVC) 8 inch to 15 inch:

1. Comply with ASTM D 2680. Pipe constructed with truss-type structure between inner and outer PVC walls with voids filled with lightweight concrete.
2. Pipe stiffness per ASTM D 2412, 200 psi.
3. PVC plastic meeting ASTM D 1784, Cell Classification 12454.
4. Integral bell and spigot joints with elastomeric seals complying with ASTM D 3212 and F 477.

F. Reinforced Concrete Pipe (RCP) 18 inch to 144 inch:

1. **General:**
 - a. Comply with ASTM C 76 (AASHTO M 170).
 - b. Minimum Class IV (3000D), Wall B.
 - c. Tongue and groove joints.
 - d. Rubber O-ring or profile gasket flexible joint complying with ASTM C 443.

2. Pipe Lining:

- a. Epoxy Coal Tar:
 - 1) Coat interior pipe barrel and all joint surfaces with two-component coal-tar epoxy- polyamide black paint or approved equal.
 - 2) Lining Material: Steel Structures Painting Council (SSPC) Specification No. 16, Table 1.
 - a) Minimum epoxy resin content 34% to 35% by dry film weight.
 - b) Minimum sag resistance 40 mils.
 - c) Minimum solids 80% by volume.
 - 3) Apply according to lining material manufacturer's recommendations.
- b. PVC:
 - 1) Minimum thickness of 0.65 inch.
 - 2) Locking extensions extruded from the same material as the liner a minimum of 0.375 inches tall spaced a maximum of 2.5 inches.
 - 3) Liner to cover the entire interior of the concrete pipe.
 - 4) Minimum tensile strength of liner is 2200 psi with a minimum elongation of 200% at breaking.
 - 5) Meet EPA 9090 for chemical resistance.
 - 6) Free of cracks, cleavages, pinholes, or other defects.
 - 7) Joint sealer strip to be from the same material as the liner.
- c. HDPE:
 - 1) Minimum thickness of 0.064 inches according to ASTM D5199.
 - 2) Minimum density of 0.90 g/cm³.
 - 3) Meet EPA 9090 for chemical resistance.
 - 4) Locking extensions made from the same material as the liner with minimum pullout strength of 14,000 pounds per square foot.
 - 5) Free of cracks, cleavages, pinholes, or other defects.
 - 6) Joint sealer strip to be from the same material as the liner.
 - 7) If gasketed joints, comply with ASTM F 477 and ability to withstand a minimum groundwater pressure equal to that of the pipe liner or 20 psi, whichever is greater.

G. Ductile Iron Pipe (DIP) 8 inch to 54 inch:

1. General:

- a. Comply with AWWA C151.
- b. Minimum thickness Class 52.

2. Interior Linings:

- a. Provide interior lining for ductile iron pipe and fittings used for all gravity sewers and drop connections.
- b. Use linings specifically designed for sanitary sewer applications, such as ceramic epoxy. Other lining types may be allowed upon approval of the Engineer.
- c. Apply lining to interior of unlined ductile iron pipe and fittings according to the published specifications from the manufacturer.
- d. Seal all cut ends and repair field damaged areas according to the manufacturer's recommendations.

3. Exterior Coating: Asphalt.

4. Joints: Push-on complying with AWWA C111.

5. Fittings: Mechanical complying with AWWA C110 or AWWA C153.

6. Polyethylene Encasement:

- a. Comply with AWWA C105.
- b. Minimum thickness of 8 mils.
- c. Use for all ductile iron pipe and fittings in buried service.

H. Vitrified Clay Pipe (VCP) 8 inch to 42 inch:

1. Pipe and fittings complying with ASTM C 700.
2. Compression joints complying with ASTM C 425 for plain end pipe or bell and spigot pipe.
3. Test according to ASTM C 301.

I. Double Walled Polypropylene Pipe 12 inch to 30 inch:

1. Comply with ASTM F 2764.
2. Minimum pipe stiffness per ASTM D 2412, 46 psi.
3. Integral bell and spigot joint complying with ASTM D 3212 and ASTM F 477.

J. Triple Walled Polypropylene Pipe 30 inch to 36 inch:

1. Comply with ASTM F 2764.
2. Minimum pipe stiffness per ASTM D 2412, 46 psi.
3. Integral bell and spigot joint complying with ASTM D 3212 and ASTM F 477.

2.02 SANITARY SEWER FORCE MAINS

A. Ductile Iron Pipe (DIP) 4 inch to 54 inch: Comply with the DIP requirements in Section 33 31 13, 2.01. If joint restraints are specified, comply with Section 33 14 16, 2.03.

B. Polyvinyl Chloride Pipe (PVC): Comply with the requirements in Section 33 14 16, 2.01 for PVC pipe. Provide restrained joints when specified.

C. Sewage Air Release Valve:

1. General: Consists of an elongated tapered or conical body and a float to operate (open and close) under pressure without spillage. Provide valves suitable for pressures up to 150 psi. Use a float with a linkage connection to the seal plug assembly to prevent irregular air release and protect the connecting rod. Ensure the bottom of the valve body is sloped or funnel-shaped to encourage the accumulated sewage and solids to drain from the valve. Preserve a volume of air at all times between the liquid sewage and the seal plug assembly. Provide a flushing port with attachments for backwashing.

2. Materials:

a. Body and Cover:

- 1) Stainless Steel: ASTM A 351.
- 2) Cast Iron: ASTM A 126, Grade B.
- 3) Ductile Iron: ASTM A 536, Grade 65-45-12.

- 4) Other corrosion resistant materials.
- b. **Internal Metal Components:** Stainless steel.
- c. **Float:** Stainless steel, ASTM A 240, Type 304 or Type 316, or foamed polypropylene.
- d. **Seal Plug Assembly:** Stainless steel, foamed polypropylene, EPDM rubber, Nitrile (Buna-N) rubber, and reinforced nylon.

3. **Tapping Saddle:** Stainless steel or nylon.

4. **Pit:** Construct according to SUDAS Figure 4010.202.

D. **Tracer Wire:** Comply with Section 33 14 16, 2.05. Tracer wire will be required on all force mains.

E. Tracer Wire Station:

- 1. Two internal terminals with shunt.
- 2. Five to six foot plastic post (color as specified by the Jurisdiction).
- 3. Removable top cap with lock.
- 4. Decals indicating "Sewer Force Main" or similar language.

2.03 CASING PIPE

Comply with Section 31 23 34, 2.02 for casing pipe requirements.

2.04 SANITARY SEWER SERVICES

A. Connection to Main:

- 1. **PVC Main:**
 - a. Preformed wye or tee service fitting with integral bell and spigot joints with elastomeric seals complying with ASTM D 3034 or ASTM F 949.
 - b. Preformed saddle wye or saddle tee for service tap complying with ASTM D 3034 or ASTM F 949.
 - c. PVC plastic meeting ASTM D 1784, Cell Classification 12454.
- 2. **PVC Composite Main:**
 - a. Preformed wye or tee service fitting with integral bell and spigot joints with elastomeric seals complying with ASTM D 3212.
 - b. Preformed saddle wye or saddle tee for service tap complying with ASTM D 2680.
- 3. **RCP Main:** Preformed saddle wye or saddle tee service tap designed for use with RCP.
- 4. **VCP Main:**
 - a. Precast VCP wye or tee service fitting complying with ASTM C 700 for pipe and ASTM C 425 for compression joints.
 - b. Preformed saddle wye or saddle tee service tap designed for use with VCP.
- 5. **DIP Main:**
 - a. Use DIP wye or tee fittings complying with AWWA C110 or AWWA C153.
 - b. Preformed saddle wye or tee services tap designed for use with DIP. Cut the hole for the tap with equipment designed for application.

- B. Wye and Tee Pipe Stop:** All saddle wye or saddle tee fittings must provide integrally molded pipe stop in the branch for positive protection against service pipe insertion beyond the inside of sewer main pipe wall.
- C. Service Pipe:** Use products as required by local plumbing code or regulations, if applicable. Otherwise, use the following:
 - 1. PVC:**
 - a. Comply with ASTM D 3034, minimum thickness SDR 23.5 minimum pipe stiffness of 153 psi as per ASTM D 2412.
 - b. PVC plastic meeting ASTM D 1784, Cell Classification 12454.
 - c. Integral bell and spigot type rubber gasket joint complying with ASTM D 3212.
 - 2. DIP:** As specified for sanitary sewer force main, including polyethylene encasement.

2.05 SANITARY SEWER SERVICE RELOCATIONS

- A. Comply with Section 33 31 13, 2.04 for all materials used for sanitary service relocation.
- B. Use the same nominal size as the existing service being relocated.

2.06 SANITARY SEWER CLEANOUT

Comply with SUDAS [Figure 4010.203](#).

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify measurements at site. Make necessary field measurements to accurately determine pipe makeup lengths or closures.
- B. Examine site conditions to ensure construction operations do not pose hazards to adjacent structures or facilities.

3.02 GRAVITY SEWER INSTALLATION

A. General:

- 1. Install watertight plug to prevent water from entering the existing sewer system.
- 2. Clean pipe interior and joints prior to installation. Keep pipe clean during construction.
- 3. Begin at the lowest point in the line. Lay groove or bell end pointing upstream unless otherwise specified.
- 4. Assemble joints according to Section 33 31 13, 3.04.
- 5. Use a saw to cut ends of pipe flush with inside wall of manholes and structures. Do not use hammer or other means to break pipe.
- 6. Provide manholes as specified in the contract documents.

7. Install cap, plug, or bulkhead at exposed ends of pipe upon completion of construction or whenever pipe installation is not in progress.

B. Trenched:

1. Excavate trench and provide pipe bedding and backfill material as specified in Section 31 23 33.
2. Prepare trench bottom to design line and grade so that only minor movement of the pipe is necessary after installation.
3. Lay pipe to design line and grade. Set field grades to invert of pipes.
4. Provide uniform bearing for full pipe barrel length. Excavate bell holes as necessary for uniform support of pipe barrel on bedding material.
5. Do not lay pipe in water or on saturated soil or bedding, or allow water to rise in trench around pipe prior to placing backfill material.
6. Do not disturb installed pipe and bedding when using movable trench boxes and shields. Block or anchor pipe as necessary to prevent joint displacement.
7. Install wye or tee service fitting at each location specified in the contract documents.

C. Trenchless: Comply with Section 31 23 34.

3.03 SANITARY SEWER INSTALLED WITHIN A CASING PIPE

Comply with Section 31 23 34, 3.04 for installation of sanitary sewer within casing pipe.

3.04 GRAVITY MAIN PIPE JOINTING

A. General:

1. Clean joint surfaces to remove soil or foreign material prior to jointing pipe.
2. Assemble joints according to pipe manufacturer's recommendations. Use equipment that does not apply damaging forces to pipe joints.

B. Polyvinyl Chloride Pipe (PVC) and Polyvinyl Chloride Composite Pipe (truss-type):

1. Coat rubber gasket and joint with soap-based lubricant immediately prior to closing joint.
2. Seal ends of PVC composite and closed profile pipe at manholes with the coating recommended by the manufacturer.

C. Reinforced Concrete Pipe (RCP): Coat rubber gasket and joint with soap-based lubricant immediately prior to closing joint.

D. Ductile Iron Pipe (DIP):

1. Push-on Joint: Coat gasket and joint with soap-based lubricant immediately prior to closing joint.

2. Mechanical Joint: Wash plain end, bell socket, and gasket with soap solution. Press gasket into socket, set gland, and tighten bolts uniformly.

E. Polypropylene Pipe: Coat gasket and bell with lubricant immediately prior to closing joint.

F. Connections between Dissimilar Pipes:

1. Use manufactured adapters or couplings approved by the Engineer.
2. Where adapters or couplings are not available, the Engineer may authorize use of a Type PC-2 concrete collar as shown on SUDAS Figure 4020.211.

3.05 FORCE MAIN INSTALLATION

A. General: Install according to Section 33 14 16.

B. Tracer Wire:

1. Required for all force main installations. Comply with Section 33 14 16.
2. Install tracer wire station at each end of the force main and at additional locations specified in the contract documents.
3. Bury end of tracer wire station 2 feet and compact.

3.06 SANITARY SEWER SERVICE STUBS

A. Provide sanitary sewer service stubs at locations specified in the contract documents.

B. Install wye or tee for each service connection.

1. Connection of sanitary service to new sewer main, except RCP:
 - a. Use only factory wye or tees.
 - b. Install according to manufacturer's requirements and Section 33 31 13, 2.04 and 3.04 for joints.
2. Connection to existing sewer main and new RCP:
 - a. Cut sewer main for service tap with hole saw or sewer tap drill.
 - b. Use preformed saddle wye or saddle tee for service tap. Use a gasketed saddle with rigid pipe mains and a solvent-cemented saddle with PVC mains.
 - c. Install according to the manufacturer's requirements, but always attach with at least two stainless steel band clamps.

C. Install service stub from sewer main to a location 10 feet beyond the right-of-way line or as specified in the contract documents. Comply with SUDAS Figure 4010.201.

1. Install according to Section 33 31 13, 3.02.
 2. Install service stub with a slope between 2% and 5% for 4 inch pipes, and between 1% and 5% for pipes 6 inches and greater.
 3. Terminate end of service stub 10 to 12 feet below finished ground elevation or as specified in the contract documents.
 4. If the depth of the sewer main causes the service to exceed a depth of 12 feet or a

slope of 5%, install a service riser.

5. For undeveloped properties, place watertight stopper, cap, or plug in end of sanitary sewer service. Mark the end of the service line as required by the Jurisdiction or as specified in the contract documents.
6. For reconnection of new service pipe with existing service pipe, comply with the Jurisdiction's plumbing code.

3.07 SANITARY SEWER SERVICE RELOCATION

- A. Relocate existing sanitary sewer services that conflict with new storm or sanitary sewer installations. Existing services located within a conflict zone from 6 inches below the bottom of the proposed sewer pipe to 2 inches above the top of the proposed sewer pipe require relocation.
- B. When a conflicting service is encountered:
 1. Determine grades and elevations of the existing service and proposed main.
 2. Determine the extent of service replacement necessary to relocate the service outside of the conflict zone while maintaining a minimum 1% slope on the sewer service.
 3. If it is not feasible to maintain a minimum slope of 1% on the relocated service, a special design and additional work may be required. Stop work and contact the Engineer. Do not remove sewer service unless directed by the Engineer.
 4. If service relocation with a minimum slope of 1% is feasible, proceed with removal and replacement of the existing sanitary sewer service.
 - a. Length of replacement varies. Remove the existing service to the extent necessary to move the service out of the conflict zone.
 - b. Use all new materials complying with Section 33 31 13, 2.04.
 - c. Re-install the service according to Section 33 31 13, 3.02.
 - d. Maintain a minimum 1% grade on relocated service.

3.08 SANITARY SEWER ABANDONMENT

A. Plug:

5. Prior to placing the sewer plug, the Engineer will verify the sewer line is not in use.
6. Construct sewer plug by completely filling the end of the pipe with concrete. Force concrete into the end of the pipe for a distance of 16 inches, or one-half the pipe diameter, whichever is greater.

B. Fill:

7. Prior to filling the sewer, the Engineer will verify the sewer line is not in use.
8. If specified in the contract documents, fill the line to be abandoned with flowable mortar, foamed cellular concrete, or CLSM (comply with Section 31 23 33) by gravity flow or pumping.
9. Batching, mixing, and placing may be started when temperature is 34°F and rising. Cease mixing and placing when temperature is 38°F or less and falling.

3.09 CONNECTION TO EXISTING MANHOLE

Comply with Section 33 42 31, 3.05.

3.10 SANITARY SEWER CLEANOUT

Provide cleanouts where specified in the contract documents. Comply with SUDAS Figure 4010.203.

3.11 TOLERANCES

Apply the following tolerances to utilities installed by open trench construction. For trenchless construction, comply with Section 31 23 34.

A. Gravity Main:

1. Do not allow horizontal and vertical alignment to vary from design line and grade at any structure by more than 1% of the inside diameter of the pipe or 1/4 inch, whichever is larger.
2. Do not allow the horizontal alignment of the pipe to vary from design line at any point along the pipe by more than 1% of the inside diameter of the pipe.
3. Low spots holding water exceeding the following depths for each pipe size will be considered unacceptable and must be removed and reinstalled to proper grade.

Pipe Diameter	Maximum Low Spot Depth
8"	1/2"
10"	1/2"
12"	3/4"
15"	3/4"
18" and Larger	5% of Pipe Diameter*

* Measured to the nearest 1/2"

B. Force Main: Do not allow horizontal and vertical alignment of trenched force mains to vary from design line and grade by more than 3 inches.

3.12 CONFLICTS

C. Horizontal Separation of Gravity Sanitary and Combined Sewers from Water

Mains: Separate gravity sanitary and combined sewer mains from water mains by a horizontal distance of at least 10 feet unless:

1. The top of a sewer main is at least 18 inches below the bottom of the water main, and
2. The sewer is placed in a separate trench or in the same trench on a bench of undisturbed earth at a minimum horizontal separation of 3 feet from the water main.
3. When it is impossible to obtain the required horizontal clearance of 3 feet and a vertical clearance of 18 inches between sewers and water mains, provide a linear separation of at least 2 feet and one of the following:
 - a. Construct sanitary and combined sewers of water main materials meeting the requirements of Section 33 14 16, 2.01.

- b. Enclose the water main in a watertight casing pipe with an evenly spaced annular gap and watertight end seals.

D. Horizontal Separation of Water Mains from Sanitary and Combined Sewer

Manholes: Ensure water pipes do not pass through or come in contact with any part of a sanitary or combined sewer manhole. Maintain a minimum horizontal separation of 3 feet.

E. Separation of Sanitary Sewer Force Mains from Water Mains: Separate sanitary sewer force mains and water mains by a horizontal distance of at least 10 feet unless:

1. The force main is constructed of water main materials meeting a minimum pressure rating of 150 psi and the requirements of Section 33 14 16, 2.01 and
2. The sewer force main is laid at least 4 linear feet from the water main.

F. Separation of Sanitary and Combined Sewers and Water Main Crossovers:

1. Vertically separate sanitary sewers crossing under any water main by at least 18 inches when measured from the top of the sewer to the bottom of the water main. If physical conditions prohibit the separation, do not place the sewer closer than 6 inches below a water main or 18 inches above a water main. Maintain the maximum feasible separation distance in all cases.
2. Where the sanitary sewer crosses over or is less than 18 inches below a water main, utilize one of the following within 10 feet measured edge-to-edge horizontally, centered on the crossing:
 - a. Construct sewer pipe of water main material.
 - b. Enclose the water main in a watertight casing pipe with an evenly spaced annular gap and watertight end seals.

3.13 CLEANING, INSPECTION, AND TESTING

Clean, inspect, and test sanitary sewer per Section 33 01 12.

END OF SECTION

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SECTION 33 41 00
STORM UTILITY DRAINAGE PIPING

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Storm Sewers.
- B. Culverts.
- C. Storm Sewer Service.

1.02 DESCRIPTION OF WORK

- A. Construct storm sewers, culverts, and footing drain collectors.
- B. Construct storm sewer service and connections.
- C. Reference is made to the Iowa Department of Transportation Standard Specifications for Highway and Bridge Construction, Series 2001, and all current General Supplemental Specifications and Materials Instructional Memorandum by the term "Iowa DOT Specifications" and/or "Iowa DOT I.M."

1.03 SUBMITTALS

- A. Submit under provisions of Division 1.
- B. Manufacturer's instructions for installation of pipe and appurtenances.
- C. Construction sequence.
- D. Catalog cuts, samples, manufacturer's data, and listing of applicable standards for special, unique, or proposed substitute materials if requested by Engineer.
- E. Certification that materials being provided meet the requirements of these specifications or that alternate materials or substitutions have received written approval of the Engineer.
- F. Project Record Documents.
- G. Upon requests the Contractor will provide Material Certifications to the Engineer.

1.04 SUBSTITUTIONS

- A. Use only materials conforming to these specifications unless permitted otherwise by Engineer.
- B. Obtain written approval of Engineer for all substitutions prior to use.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver only materials that fully conform to these specifications or for which submittals have been provided to Engineer and approved for use.
- B. Store materials and handle to avoid damage. Replace any damaged materials. Remove damaged materials from site.

1.06 SCHEDULING AND CONFLICTS

- A. Construction Sequence:
 - 1. Attend a preconstruction meeting if required by Engineer.
 - 2. Submit plan for construction sequence and schedule prior to commencing construction.
- B. Conflict Avoidance:
 - 1. Expose potential conflicts such as utility lines and drainage structures in advance of construction. Verify elevations and locations, and verify clearance for proposed construction.
 - 2. Complete elements of work that can affect line and grade in advance of storm sewer construction unless noted on plans.
 - 3. Notify Engineer of conflicts discovered or changes needed to accommodate unknown conditions.

1.07 SPECIAL REQUIREMENTS

- A. Stop Work: Stop work and notify Engineer immediately if contaminated soils, historical artifacts or other environmental or historic items are encountered.
- B. Conform to local, state and federal requirements.

PART 2 - PRODUCTS

2.01 STORM SEWERS

A. Reinforced Concrete Pipe (RCP):

1. Conform to ASTM C 76.
2. Minimum Class III, Wall B.
3. Tongue and groove joints.
 - a. Use cold applied bituminous or rubber rope gasket jointing materials, unless otherwise specified.
 - b. If specified, use rubber O-ring or profile gasket conforming to ASTM C 443.
4. If specified, wrap exterior of each joint with engineering fabric.

B. Reinforced Concrete Arch Pipe (RCAP):

1. Use only where indicated on plans or approved by Engineer.
2. Conform to ASTM C 506.
3. Minimum Class A III.
4. Tongue and groove joints. Use cold applied bituminous or rubber rope gasket jointing materials, unless otherwise specified.
5. If specified, wrap exterior of each joint with engineering fabric.

C. Reinforced Concrete Elliptical Pipe (RCEP):

1. Use only where indicated on plans or approved by Engineer.
2. Conform to ASTM C 507.
3. Minimum Class HE III or Class VE III
4. Tongue and groove joints. Use cold applied bituminous or rubber rope gasket jointing materials, unless otherwise specified.
5. If specified, wrap exterior of each joint with engineering fabric.

D. Reinforced Concrete Low Head Pressure Pipe (RCPP):

1. Conform to ASTM C 361.

2. Minimum Class C 25.
 3. Tongue and groove joints.
 4. Conform to ASTM C 361 for rubber O-rings or profile gaskets.
- E. Polyvinyl Chloride Pipe (PVC):
1. Use pipe conforming to the following:
 - a. Types of PVC pipes:
 - 1) Corrugated exterior, smooth interior, ASTM F 949
 - 2) Solid wall, ASTM D 3034 or ASTM F 679
 - 3) Closed profile, ASTM F 1803
 - 4) Truss, ASTM D 2680
 - b. PVC plastic meeting ASTM D 1784, Cell Classification 12454. Do not exceed 10 parts by weight per 100 of PVC resin in the compound for additives and fillers, including but not limited to stabilizers, antioxidants, lubricants, colorants, etc.
 - c. Minimum pipe stiffness of 46 psi.
 - d. Gasketed integral bell and spigot joints per ASTM D 3212 and ASTM F 477.
 2. Do not use in right-of-way.
 3. Use only outside of right-of-way in public utility easement areas where no utilities exist or are proposed (running parallel or crossing) or where the trench for the PVC pipe will not be disturbed, and where the Engineer allows.
- F. High Density Polyethylene Pipe (HDPE):
1. Use pipe conforming to the following:
 - a. AASHTO M 294, Type S corrugated exterior and smooth interior.
 - b. ASTM D 3350 minimum resin Cell Classification 33 5420 C.
 - c. Minimum pipe stiffness at 5% deflection per ASTM D 2412.
 - d. Integral bell and spigot joints with O-ring rubber gasket meeting ASTM F 477.
 - e. Maximum 5% deflection of the average inside diameter by testing after

installation.

2. Do not use in right-of-way.
3. Use only outside of right-of-way in public utility easement areas where no utilities exist or are proposed (running parallel or crossing) or where the trench for the HDPE pipe will not be disturbed, and where the Engineer allows.

G. Metal Pipes:

1. Use pipe conforming to Section 33 4100, 2.2.
2. Do not use in right-of-way.
3. Use only outside of right-of-way in public easement areas where no utilities exist or are proposed (running parallel or crossing) or where the trench for the metal pipe will not be disturbed, and where the Engineer allows.

H. Jointing Material for Concrete Pipe:

1. Bituminous jointing material: Use a cold applied mastic sewer joint sealing compound recommended by the manufacturer for the intended use and approved by the Jurisdictional Engineer. Conform to AASHTO M 198.
2. Rubber rope gasket jointing material: Conform to ASTM C 990.
3. Rubber O-ring or profile gasket: Conform to ASTM C 443 (for RCP) or ASTM C 361 (for RCPP).

I. Bituminous Joint Primer: Meet the requirements of ASTM D 41, which is intended for use in priming concrete pipe joints prior to application of bituminous jointing material.

J. Engineering Fabric:

1. Use for wrapping exterior of storm sewer pipe joints where indicated on plans.
2. Iowa DOT 4196.01B fabric for use in subsurface drains.

K. Pipe Apron Section:

1. Use where indicated on plans.
2. Reinforced concrete apron sections conforming to details.
3. Metal pipe aprons conforming to details.
4. Minimum Class III.

L. Apron Guard:

1. Use where indicated on plans.
 2. See plan detail.
- 2.02 CULVERTS

Use the following pipe materials for culverts where indicated on plans or approved by the Engineer.

- A. Pipe materials as specified for storm sewers.
- B. Corrugated Metal Pipe (CMP):
 1. Conform to AASHTO M 36, Type I.
 2. Zinc coating: Conform to AASHTO M 218.
 3. Corrugated steel circular section with annular (circumferential) or helical corrugations.
 4. Minimum thickness: Gauge of pipe conforming to Iowa DOT Standard Road Plans RF-32 and RF-33 or as indicated on the plans.
 5. Coupling bands: Annular corrugations or helical corrugations to match pipe ends.
- C. Spiral Rib Pipe:
 1. Conform to ASTM A 760 Type 1R.
 2. Use a corrugation profile of 3/4 inch by 3/4 inch by 7-1/2 inches.
 3. Aluminized steel Type 2: Conform to ASTM A 929.
 4. Use a minimum thickness of 0.064 inch: Gauge of pipe conforming to manufacturer's requirements or as shown on plans.
 5. Coupling bands conforming to manufacturer's recommendations.
- D. Corrugated Metal Arch Pipe (CMAP):
 1. Conform to AASHTO M 36, Type II.
 2. Zinc coating: Conform to AASHTO M 218.
 3. Corrugated steel Type I pipe reformed into a pipe-arch having an approximately flat bottom.
 4. Coupling bands: Annular corrugations or helical corrugations to match pipe ends.

5. Minimum thickness: Gage of pipe conforming to Iowa DOT Standard Road Plan RF-33.

E. Spiral Rib Pipe Arch:

1. Conform to ASTM A 760 Type IIR.
2. Corrugation profile to be 3/4 inch by 3/4 inch by 7-1/2 inch.
3. Aluminized steel Type 2: Conform to ASTM A 929.
4. Use a minimum thickness of 0.064 inch: Gage of pipe conforming to manufacturer's requirements or as shown on plans.
5. Coupling bands conforming to the manufacturer's recommendations.

F. Structural Plates:

1. Use a galvanized steel structural plate conforming to AASHTO M 167.
2. Use bolts and nuts meeting ASTM A 449 and galvanized per ASTM A 153, Class C.
3. Assemble the structure according to the shop drawings provided by the manufacturer and per the manufacturer's recommendations. Tighten the bolts using an applied torque of between 100 and 300 foot-pounds.
4. Install the structure according to the plans and specifications, the manufacturer's recommendations, and AASHTO Standard Specifications for Highway Bridges, Division II, Section 26.
5. Conform the gage of the structure to Iowa DOT Standard Road Plan RF-33 or as indicated on the plans.

G. Coated Corrugated Metal Pipe:

1. Use in corrosive soil or effluent conditions or where indicated on plans or required by Engineer.
2. Conform to AASHTO M 274 [steel sheet, aluminum-coated (Type 2)], minimum thickness per Section 334100, 2.2.

H. Aluminum Structural Plate

1. Conform to AASHTO M 219
2. Use a corrugation profile of 9 inches by 2-1/2 inches.
3. Aluminum: Conform to ASTM B 209.

4. Use a minimum thickness of 0.100 inch: Gage of structure conforming to manufacturer's requirements or as shown on the plans.
5. Use bolts and nuts meeting ASTM A 307 or ASTM A 449 and galvanize per ASTM A 153
6. Assemble the structure according to the shop drawings provided by the manufacturer and per the manufacturer's recommendations. Tighten the bolts using an applied torque of between 100 and 300 foot-pounds.
7. Install the structure according to the plans and specifications, the manufacturer's recommendations, and AASHTO Standard Specifications for Highway Bridges, Division III, Section 26.
8. Meet or exceed the AASHTO Standard Specifications for Highway Bridges, Section 12.8 for HS 20 loading.

I. Pipe Aprons and Beveled Ends:

1. Use where indicated on plans.
2. Conform to Section 33 4100, 2.1.

2.03 SUBDRAINS, TYPE I (See details)

A. Polyvinyl Chloride Pipe and Fittings (Solid Wall PVC):

1. Conform to ASTM D 3034, minimum thickness SDR 35, 46 psi minimum pipe stiffness.
2. PVC plastic according to ASTM D 1784, Cell Classification 12454.
3. Integral bell and spigot type rubber gasket joint conforming to ASTM D 3212 and ASTM F 477.
4. Fabricated or preformed saddle wye or saddle tee for service tap conforming to AASHTO M 252 or M 294.
5. Slot subdrain pipe according to ASTM F 949 or perforate with four rows of 1/4 inch to 3/8 inch diameter holes along the bottom of the pipe.

B. Polyvinyl Chloride Corrugated Pipe and Fittings (Corrugated PVC):

1. Corrugated exterior, smooth interior, PVC.
2. Conform to ASTM F 949, minimum pipe stiffness, 46 psi.
3. PVC plastic according to ASTM D 1784, Cell Classification 12454.

4. Integral bell and spigot type rubber gasket joint conforming to ASTM D 3212 and ASTM F 477.
5. Slot subdrain pipe according to ASTM F 949.

C. Polyethylene Corrugated Tubing (Corrugated PE):

1. Conform to AASHTO M 252, Type C, corrugated interior and exterior or Type S, corrugated exterior, smooth interior.
2. Use only fittings supplied or recommended by pipe manufacturer for soil tight service.
3. Slotted or perforated, if required, conforming to AASHTO M 252, Type CP, or Type SP.

D. CMP Subdrain Outlet:

1. Use CMP at outlets or connections to intakes or other drainage facilities where specified.
2. Conform to AASHTO M 36, Type 1.
3. Zinc coating: Conform to AASHTO M 218.
4. Corrugated steel circular section with annular (circumferential) or helical corrugation.
5. Minimum thickness: 0.052 inch.
6. Coupling bands: Annular corrugations or helical corrugations to match pipe ends.

E. Engineering Fabric: Use fabric conforming to Iowa DOT 4196.01B.

2.04 FOOTING DRAIN COLLECTOR (Minimum 8-inch, maximum 12-inch diameter)

The following requirements also apply to Type II Subdrains (see details).

A. PVC Pipe:

1. Conform to ASTM D 3034, minimum thickness SDR 35, minimum pipe stiffness 46 psi.
2. PVC plastic according to ASTM D 1784, Cell Classification 12454.
3. Integral bell and spigot type rubber gasket joint conforming to ASTM D 3212 and ASTM F 477.

4. Preformed wye or tee service fitting with gasket joints conforming to ASTM D 3034.
5. Preformed saddle wye or saddle tee for service tap conforming to ASTM D 3034.
6. For Type II Subdrain, slot pipe according to ASTM F 949 or perforate with four rows of 1/4 inch to 3/8 inch diameter holes along the bottom of the pipe.

B. Corrugated PVC Pipe:

1. Corrugated exterior, smooth interior PVC.
2. Conform to ASTM F 949, minimum pipe stiffness 46 psi.
3. PVC plastic according to ASTM D 1784, Cell Classification 12454.
4. Integral bell and spigot type rubber gasket joint conforming to ASTM D 3212 and ASTM F 477.
5. Preformed wye or tee service fitting with gasket joints conforming to ASTM F 949.
6. Preformed saddle wye or saddle tee for service tap conforming to ASTM F 949.
7. For Type II Subdrain, slot pipe according to ASTM F 949.

C. HDPE Pipe:

1. Use pipe conforming to the following:
 - a. AASHTO M 294, Type S corrugated exterior and smooth interior.
 - b. ASTM D 3350, minimum resin Cell Classification 335420 C.
 - c. Minimum pipe stiffness at 5% deflection per ASTM D 2412.
 - d. Integral bell and spigot joints with O-ring rubber gasket meeting ASTM F 477.
 - e. Maximum 5% deflection of the average inside diameter by testing after installation.
2. Fabricated or preformed saddle wye or saddle tee for service tap shall conform to AASHTO M 252 or M 294.
3. For Type II Subdrain, slot or perforate according to AASHTO M 252, Type CP, or Type SP.

D. RCP

1. Conform to Section 334100, 2.1.
 2. If specified for Type II Subdrain, wrap exterior of each joint with engineering fabric and use no joint sealant.
- E. Engineering Fabric: Conform to Iowa DOT 4196.01B.
- 2.05 STORM SEWER SERVICE STUBS (Minimum 4-inch diameter)
- A. Pipe materials specified for footing drain collectors may be used for storm sewer services.
- B. PVC Pipe:
1. Conform to ASTM D 3034, pipe stiffness per ASTM D 2412, minimum thickness solid wall pipe SDR 23.5 (153 psi), 26 (115 psi), 35 (46 psi).
 2. PVC plastic meeting ASTM D 1784, Cell Classification 12454. Do not exceed 10 parts by weight per 100 of PVC resin in the compound for Additives and fillers, including but not limited to stabilizers, antioxidants, lubricants, colorants, etc.
 3. Integral bell and spigot type rubber gasket joint conforming to ASTM D 3212 and ASTM F 477.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify measurements at site; make necessary field measurements to accurately determine pipe makeup lengths or closures.
- B. Examine site conditions to ensure construction operations do not pose hazards to adjacent structures or facilities.

3.02 LINE AND GRADE

- A. Install pipe to line and grade shown on plans. Set field grades to invert of pipes or culverts.
- B. Notify Engineer immediately if discrepancies or irregularities are discovered in line or grade shown by grade stakes.
- C. Make detailed measurements as required to construct work to line and grade

established by line and grade hubs.

D. Batter Boards:

1. Set grade points at intervals of 25 feet at convenient offset from centerline of pipe or culvert.
2. Set batter boards as necessary to construct to design line and grade.
3. Provide at least three batter boards at all pipe laying areas during construction as check on accuracy of grades.
4. Check line and grade of each pipe length with grade rod and plumb bob.

E. Laser Beam:

1. Set laser equipment to proper line and grade from line and grade hubs.
2. Check line and grade of laser at intervals of 25 feet for first 100 feet and then at intervals of 50 feet for each setup.
3. Check line and grade of each pipe length.

F. Correct Misalignment: Correct misalignment, displacement, or otherwise defective pipe by removing, relaying, or replacing pipe at Contractor's expense.

3.03 PIPE INSTALLATION

- A. Provide trench excavation, pipe bedding, and backfill as specified in Section 31 23 16.
- B. Provide proper facilities for lowering the sections into place without damaging the pipe.
- C. Begin at lowest point in line. Lay groove or bell end point upstream unless specifically noted otherwise.
- D. Prepare trench bottom to design line and grade so only minor movement of pipe is necessary after installation.
- E. Inspect pipe for defects before carefully lowering into trench. Do not install damaged or defective pipe.
- F. Clean pipe interior and joints prior to lowering into trench. Keep pipe clean during construction.
- G. Do not lay pipe in water or on saturated soil or bedding. Do not allow water to rise in trench around pipe.
- H. Place pipe with lifting holes at the top of the pipe and fill lift hole with non-shrink grout

or manufactured plugs.

- I. Lay pipe to design line and grade.
- J. Provide uniform bearing for full pipe barrel length.
 - 1. Excavate bell holes as necessary for uniform support of pipe barrel on bedding material.
 - 2. Do not block pipe above bedding.
- K. Assemble joints as specified.
- L. Protect exposed upstream ends of pipe to prevent soil sediment from entering storm sewer system with the watertight stopper, cap, or plug.
- M. Do not disturb installed pipe and bedding when using movable trench boxes and shields. Block or anchor pipe as necessary to prevent joint displacement.
- N. Saw cut ends of pipe at manholes, intakes, and structures. Do not hammer cut or break pipe.
- O. Provide manholes and intakes where indicated on plans and as specified in Section 333900.

3.04 PIPE JOINTING

- A. Joint Cleaning: Clean joint surfaces with wire brush to remove soil or foreign material prior to jointing pipe.
- B. Assemble Joints According to Pipe Manufacturer's Recommendations:
 - 1. Use equipment that does not apply damaging forces to pipe joints.
 - 2. Use bar and block or internal or external jointing devices or other methods recommended by pipe manufacturers.
- C. RCP, RCAP, and RCEP:
 - 1. Use cold applied bituminous or rubber rope gasket jointing materials unless otherwise specified.
 - a. Apply joint material to entire tongue or to top half of tongue and bottom half of groove, in sufficient quantity to fill joint; close joint between pipes.
 - b. Fill remaining voids in joint both inside and outside of pipe with joint material; smooth joint material on inside of pipe 24 inches and larger.
 - 2. If rubber O ring or profile gasket is specified for RCP, coat rubber ring gasket and

joint with soap based lubricant immediately prior to closing joint.

3. If wrapped pipe joint is specified, see details.
 - a. Secure engineering fabric in place to prevent displacement during backfill operations.
 - b. For combination storm sewer/subdrain or Type II subdrain, do not use joint sealant.
 4. Joint openings on the outside or inside of the pipe that do not exceed 1/8 inch at the bottom and 5/8 inch at the top are acceptable.
 5. Fully encase large joint openings, unless required for camber, with a Type II concrete collar. Use Class C structural concrete.
- D. RCPP: Coat rubber ring gasket and joint with soap based lubricant immediately prior to closing joint.
- E. CMP and CMAP:
1. Install coupling bands that match ends of pipes.
 2. End of coupling bands must lap or be fabricated to form tightly closed joint upon installation.
- F. PVC Pipe and Corrugated PVC Pipe: Coat rubber gasket and joint with soap based lubricant immediately prior to closing joint.
- G. High Density Polyethylene (HDPE): Coat rubber gasket and joint with soap based lubricant immediately prior to closing joint.
- H. Connections between Dissimilar Pipes:
1. Use manufactured adapters or couplings approved by Jurisdictional Engineer.
 2. Where adapters or couplings are not available, Jurisdictional Engineer may authorize use of concrete collar as shown in details.

3.05 PIPE END SECTIONS

- A. Install reinforced concrete pipe aprons where indicated on plans. Install apron footings according to details when specified.
- B. Install metal pipe aprons where indicated on plans. Install curtain walls when specified.
- C. Anchor last three pipe sections and aprons together with two pipe connections per joint.

- D. Install apron guard where indicated on plans. See plan details.

3.06 SUBDRAINS AND TRENCH DRAINS

- A. Provide Types I subdrain where indicated on plans. See details.
- B. Provide trench drains where indicated on plans. See details.
- C. If specified, install engineering fabric.

3.07 FOOTING DRAIN COLLECTOR

- A. Install footing drain collector per Section 31 23 16. Install Type II, combination subdrain/footing drain collector per details.
- B. If specified, install engineering fabric.
- C. Provide cleanouts and connections per details.
 - 1. Connect footing drain sewer collectors to storm sewer manhole or intake.
 - 2. Provide fabricated or preformed wye or tee service fitting for each platted lot or building.
- D. Provide manholes, if specified, according to Section 33 3900.

3.08 STORM SEWER SERVICE STUBS

- A. Provide storm sewer service connections and line from storm sewer mains or footing drain sewer mains for each platted lot or building at locations shown on plans.
- B. For new sewer main construction, except RCP sewers, install wye or tee fittings according to the manufacturer's requirements.
- C. For existing sewers and all RCP sewers, saw or drill a neat hole in sewer main and install preformed saddle wyes or tees according to the manufacturer's requirements.
- D. For undeveloped properties, extend the storm sewer service from the storm sewer or footing drain collector to a point 10 feet outside of the right-of-way or as shown on the plans. Place a watertight stopper or plug in the end of the storm sewer service.
- E. For reconnection of existing service pipe to new sewer service pipe, use a manufactured flexible connection.

3.09 TOLERANCES

- A. Horizontal and vertical alignment of gravity sewer lines shall not vary from design line and grade at any point along the pipe by more than 1% of the inside diameter of the pipe or 1/4 inch, whichever is larger.
- B. Tolerance allowed only if design line and grade is sufficient to prevent backslope when tolerance limits are reached.
- C. Reverse slope on pipe is prohibited.

3.10 CONFLICTS

- A. Provide temporary support for existing water, gas, telephone, power, and other utilities or services that cross trench.
- B. Compact backfill under existing utility crossing as specified in Section 31 23 16 or construct utility line supports where indicated on plans or as directed by Engineer.

3.11 STORM SEWER ABANDONMENT

When sewers are to be abandoned, standard sewer plugs shall be placed in accordance with the details. Prior to placing the plug, ensure the line is not in use. If noted on the plans, fill the line with gravity flow or pump the line full of flowable mortar or controlled low strength material (see Section 31 23 16).

END OF SECTION 33 41 00