



PROJECT MANUAL

Translational Research Facility
CVM Main

NC State Project Number:
SCO ID#
Building Name:
Designer Project Number:

202120009
21-24030-01A
Main Vet School
202207

Prepared For:

NC State University

Prepared By:

Wagner Architecture, pllc
92 Elam Court
New Hill, North Carolina 27562
(919) 612-5050
www.wagnerarch.com

Kramer Engineering Services, pllc
5517 Cascade Drive
Chapel Hill, NC 27514
(919) 933-3350
donna@kespllc.com

Bennett & Pless
formerly LHC Structural Engineers
5430 Wade Park Boulevard, Suite 400
Raleigh, North Carolina, 27607
(919) 832-5587
www.lhcengineers.com

NV5 Engineers & Consultants, Inc.
3300 Regency Parkway, Suite 100
Cary, NC 27518
(919) 851-1912
www.NV5.com

Set Number:

Construction Documents –
Issued for Review
April 24, 2023

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**Advertisement for Bids
&
Notice of Public Meeting for Proposed Alternate Bids for Preferred
Products**

Sealed proposals will be received by NC State University. Attention Laura Zaytoun, until **4pm** on **Tuesday June 27, 2023** in Conference Room 301, Administrative Services III Building 2601 Wolf Village Way, Raleigh, NC 27695 and immediately thereafter publicly opened and read for the furnishing of labor, material and equipment for the construction of:

NC State University
CVM Translational Research Facility
SCO ID No.: 21-24030
NC State Project No.: 202120009

The new CVM TRF, a one-story, free-standing, masonry, 3610 GSF building, will be located adjacent to the CVM academic facilities between the Lab Animal Research (LAR) area and the Teaching Animal Unit (TAU) farm. The facility, an extension of the LAR unit, includes animal holding rooms, feed storage, mechanical and electrical rooms, a toilet room, and a small but fully equipped sterile surgery suite. The building will be placed near to "Finger Barn #2" (referred to as the G20 facility), another swine research building, to allow for shared use of space. The spaces within the TRF, as typical for vivarium spaces, are a highly controlled environment; lighting, temperature, humidity, ventilation, air pressures and other factors are strictly controlled as part of the research environment.

Bids will be received for **single prime bid** contracts. All Proposals will be lump sum.

BID OPENING:

CVM Translational Research Facility

When: **June 27, 2023 at 4:00 pm** Eastern Time

Where: Conference Room 301, Administrative Services III Building 2601 Wolf Village Way,
Raleigh, NC 27695

The following General Contractors have been pre-qualified to bid this job:

- Berry Building Group.....Greenville, NC
- Brawley.....Raleigh, NC
- Christman Company.....Raleigh, NC
- CIC Construction Group.....Durham, NC
- CT Wilson Construction.....Durham, NC
- Daniels & Daniels Construction.....Goldsboro, NC
- ECBuild, LLC.....Raleigh, NC
- I.L. Long Construction.....Winston-Salem, NC
- Frank L. Blum.....Raleigh, NC
- JE Dunn Construction.....Raleigh, NC
- McDonald York Building Co.....Raleigh, NC
- Monteith Construction.....Wilmington, NC
- Muter Construction,,,,,.....Zebulon, NC
- Resolute Building Co.....Chapel Hill, NC
- Riggs-Harrod Builders.....Durham, NC
- Riley Contracting Group.....Cary, NC

Bid documents are available for examination in the plan rooms:

1. iSQFT; <http://www.isqft.com/start/> handles Associated General Contractors plan room.
2. The local North Carolina offices of Dodge Data and Analytics;
3. The Eastern Regional Offices of CMD Group in Norcross, GA;
4. The offices of the Designer: Wagner Architecture, 92 Elam Court, New Hill, NC 27562;
5. The North Carolina Institute of Minority Economic Development, Inc. (NCIMED) Plan and Resource Center at 114 W. Parrish St., 6th Floor, Durham, NC; 919-956-8889 or 919-287-3036
6. The Hispanic Contractors Association of the Carolinas (HCAC) in Winston-Salem, Charlotte and Raleigh Areas – 877-227-1680;

Complete plans and specifications for this project in electronic format can be obtained from Kim Wagner, Wagner Architecture, 92 Elam Court, New Hill, NC 27562 during normal office hours after **May 30, 2023**. Email requests for the electronic documents may be sent to kwagner@wagnerarch.com

Partial or full printed copies of the project documents may be purchased from ARC, 951 Aviation Parkway, Suite 700, Morrisville, NC 27560. Phone number for ordering is 919-388-9900. Documents may also be purchased from Document Imaging Systems, Inc. at 231 East Johnson Street, Units E, F, & G, Cary, NC 27513. Phone number for ordering is 919-460-9440.

The State reserves the unqualified right to reject any and all proposals.

North Carolina State University has an affirmative policy of fostering, promoting and conducting business with minority owned enterprises. Minority contractors are encouraged to participate in the bidding process.

The bidder must include completed minority business subcontractor documentation form(s) with their proposal, or the bid may be considered non-responsive and invalid.

Pre-Bid Meeting

CVM Translational Research Facility

When: **June 06, 2023 at 8:30 am** Eastern Time

A Pre-bid meeting will be held for all interested bidders on **Tuesday June 06, 2023 at 8:30am** at **the project site on the CBC (Centennial Biomedical Campus)**. The meeting will address project specific questions. **ATTENDANCE AT THE PRE-BID MEETING IS MANDATORY.**

Notice of Public Meeting for Proposed Alternate Bids for Preferred Products.

CVM Translational Research Facility

When: **June 06, 2023 at 8:00 am** Eastern Time

An open public meeting will be held on **Tuesday June 06, 2023 at 8:00** in Room **A101** of **The College of Veterinary Medicine (Main Building), 1052 William Moore Drive, Raleigh, NC 27606**. The meeting is to identify preferred brand alternates and their performance standards pertinent to this project.

In accordance with GS133-3, Section 64. (C) and State Construction Office procedures the following preferred brand items are being considered as Alternates by the owner for this project:

- A. Alternate 1: Mortise locks by Best, closers by LCN, cylinders by Schlage.
- B. Alternate 7: Sanitary Napkin Disposal and Dispenser by Bobrick, as indicated as the Basis of design in 102800.
- C. Alternate 10: BACnet based BAS by Johnson Controls Incorporated (JCI)
- D. Alternate 11: BACnet based BAS by Schneider Electric.

E. Alternate 12: Pilot operated steam regulator model by Spence.

F. Alternate 14: Electric hoist and motor trolley by Coffing, as indicated as the Basis of Design in 14 6200.

A copy of pertinent sections of the performance standards may be obtained by contacting the designer at the address or phone number noted above.

Laura Zaytoun
NC State University
Capital Project Management
llzaytou@ncsu.edu
919.515.8049

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NOTICE TO BIDDERS

Sealed proposals will be received by the Laura Zaytoun, NC State University in the Conference Room 301, Administrative Services III Building, 2601 Wolf Village Way, Raleigh, NC, 27695 up to **4:00 pm Tuesday June 27, 2023** and immediately thereafter publicly opened and read for the furnishing of labor, material and equipment entering into the construction of

NC State University Translational Research Facility

The project consists of a new facility of approximately 3610 GSF located in the laboratory animal resources area of the CVM and NC State's Biomedical Centennial Campus.

Bids will be received for Single Prime. All proposals shall be lump sum.

Pre-Bid Meeting

A **mandatory** Pre-bid meeting will be held for all interested bidders on June 06, 2023 at 8:30 am at the project site on the CBC (Centennial Biomedical Campus). The meeting will address project specific questions, issues, bidding procedures and bid forms, coordination with Owner activities and use of the premises, and record any questions for response in Addenda.

An open public meeting is also scheduled to identify preferred brand alternates and their performance standards that the owner will consider for approval on this project. This meeting will be held on Tuesday June 06, 2023 at 8:00am in Room A101 of The College of Veterinary Medicine (Main Building), 1052 William Moore Drive, Raleigh, NC 27606.

In accordance with General Statute GS 133-3, Specifications may list one or more preferred brands as an alternate to the base bid in limited circumstances. Specifications containing a preferred brand alternate under this section must identify the performance standards that support the preference. Performance standards for the preference must be approved in advance by the owner in an open meeting. Any alternate approved by the owner shall be approved only where (i) the preferred alternate will provide cost savings, maintain or improve the functioning of any process or system affected by the preferred item or items, or both, and (ii) a justification identifying these criteria is made available in writing to the public.

In accordance with GS133-3 and SCO procedures the following preferred brand items are being considered as Alternates by the owner for this project:

- A. Alternate 1: Mortise locks by Best, closers by LCN, cylinders by Schlage.
- B. Alternate 7: Sanitary Napkin Disposal and Dispenser by Bobrick, as indicated as the Basis of design in 102800.
- C. Alternate 10: BACnet based BAS by Johnson Controls Incorporated (JCI)
- D. Alternate 11: BACnet based BAS by Schneider Electric.
- E. Alternate 12: Pilot operated steam regulator model by Spence.
- F. Alternate 14: Electric hoist and motor trolley by Coffing, as indicated as the Basis of Design in 14 6200.

Justification of any approvals will be made available to the public in writing no later than seven (7) days prior to bid date.

Complete plans, specifications and contract documents will be open for inspection in the offices of Wagner Architecture, PLLC and in the plan rooms of the Associated General Contractors (iSQFT; <http://www.isqft.com/start/>), local North Carolina offices of Dodge Data and Analytics, and in the Eastern Regional Office of Reed Construction Data in Norcross, GA and in Minority Plan Rooms: Hispanic Contractors Association of the Carolinas (HCAC) in Winston-Salem, Charlotte and

Raleigh Areas – 877-227-1680; NCIMED Plan & Resource Center, 114 West Parrish Street, 6th Floor, Durham, NC 27701, 919-956-8889 or 919-287-3036, or may be obtained by those qualified as prime bidders, upon deposit of three hundred dollars (\$ 300.00) in cash or certified check. The full plan deposit will be returned to those bidders provided all documents are returned in good, usable condition within ten (10) days after the bid date.

NOTE: The bidder shall include with the bid proposal the form *Identification of Minority Business Participation* identifying the minority business participation it will use on the project and shall include either *Affidavit A* or *Affidavit B* as applicable. Forms and instructions are included within the Proposal Form in the bid documents. Failure to complete these forms is grounds for rejection of the bid. (GS143-128.2c Effective 1/1/2002.)

All contractors are hereby notified that they must have proper license as required under the state laws governing their respective trades.

General contractors are notified that Chapter 87, Article 1, General Statutes of North Carolina, will be observed in receiving and awarding general contracts. General contractors submitting bids on this project must have license classification for General Contractor - Building

NOTE--SINGLE PRIME CONTRACTS: Under GS 87-1, a contractor that superintends or manages construction of any building, highway, public utility, grading, structure or improvement shall be deemed a "general contractor" and shall be so licensed. Therefore a single prime project that involves other trades will require the single prime contractor to hold a proper General Contractors license. **EXCEPT:** On public buildings being bid single prime, where the total value of the general construction does not exceed 25% of the total construction value, contractors under GS87- Arts 2 and 4 (Plumbing, Mechanical & Electrical) may bid and contract directly with the Owner as the SINGLE PRIME CONTRACTOR and may subcontract to other properly licensed trades. [GS87-1.1- Rules .0210](#)

Each proposal shall be accompanied by a cash deposit or a certified check drawn on some bank or trust company, insured by the Federal Deposit Insurance Corporation, of an amount equal to not less than five percent (5%) of the proposal, or in lieu thereof a bidder may offer a bid bond of five percent (5%) of the bid executed by a surety company licensed under the laws of North Carolina to execute the contract in accordance with the bid bond. Said deposit shall be retained by the owner as liquidated damages in event of failure of the successful bidder to execute the contract within ten days after the award or to give satisfactory surety as required by law.

A performance bond and a payment bond will be required for one hundred percent (100%) of the contract price.

Payment will be made based on ninety-five percent (95%) of monthly estimates and final payment made upon completion and acceptance of work.

No bid may be withdrawn after the scheduled closing time for the receipt of bids for a period of 30 days.

The owner reserves the right to reject any or all bids and to waive informalities.

Designer:
Wagner Architecture, pllc
92 Elam Court, New Hill, NC 27562
919.612.5050

Owner:
NC State University
Laura Zaytoun, RA
919.515.8049

WAGNER ARCHITECTURE, PLLC

The professional identified above is responsible for performing certain professional services defined in the Contract Documents and is the author of the following Specification Sections for this project:

Division 01 – General Requirements

- 01 1000 Summary
- 01 2300 Alternates
- 01 2500 Substitution Procedures
- 01 3100 Project Management and Coordination
- 01 3200 Construction Progress Documentation
- 01 3233 Photographic Documentation
- 01 3300 Submittal Procedures
- 01 4000 Quality Requirements
- 01 5000 Temporary Facilities and Controls
- 01 6000 Product Requirements
- 01 7300 Execution Requirements
- 01 7419 Construction Waste Management and Disposal
- 01 7700 Closeout Procedures
- 01 7823 Operation and Maintenance Data
- 01 7839 Project Record Documents
- 01 7900 Demonstration and Training

Division 02 – Existing Conditions

- 02 4100 Selective Demolition

Division 04 – Masonry

- 04 4200 Unit Masonry

Division 05 – Metals

- 05 4000 Cold Formed Steel Framing
- 05 5000 Metal Fabrications
- 05 5100 Metal Stairs
- 05 5210 Pipe and Tube Railings
- 05 5300 Fiberglass Gratings

Division 06 – Wood, Plastics and Composites

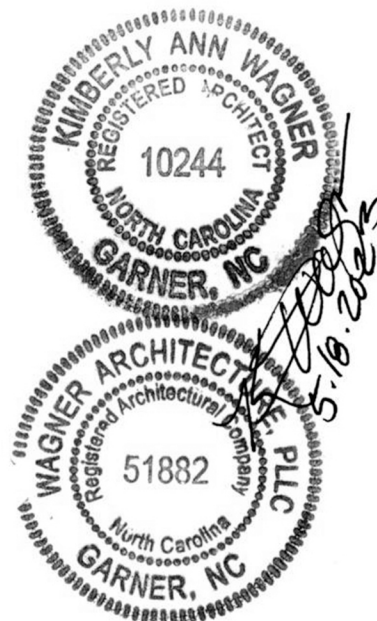
- 06 6100 Rough Carpentry

Division 07 – Thermal and Moisture Control

- 07 1150 Bituminous Damp Proofing
- 07 2113 Perimeter Insulation Under Slab on Grade
- 07 4113 Metal Roof Panel System
- 07 4646 Fiber Cement Siding
- 07 6200 Sheet Metal Flashing and Trim
- 07 6310 Gutters and Downspouts
- 07 9200 Joint Sealants

Division 08 – Openings

- 08 1113 Hollow Metal Doors and Frames
- 08 3113 Access Doors and Frames
- 08 7100 Door Hardware
- 08 8000 Glazing
- 08 9000 Louvers and Vents



Division 09 – Finishes

09 2216	Non-Structural Metal Framing
09 2900	Gypsum Board
09 6723	Resinous Flooring
09 9110	Exterior Painting
09 9330	Concrete Sealer
09 9610	High Performance Coatings

Division 10 – Specialties

10 2600	Wall and Door Protection
10 2800	Toilet, Bath and Laundry Accessories
10 4413	Fire Extinguisher Cabinets
10 5113	Metal Lockers

Division 12 - Furnishings

12 3553	Laboratory Casework
12 3653	Laboratory Countertops

Division 14 – Conveying Equipment

14 6200	Electric Trolley Hoists
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KRAMER ENGINEERING

The professional identified above is responsible for performing certain professional services defined in the Contract Documents and is the author of the following Specification Sections for this project:

Division 22 – Plumbing

- 22 0010 Plumbing General Requirements
- 22 2500 Plumbing Insulation
- 22 4200 Plumbing Fixtures
- 22 4300 Drainage Systems
- 22 4400 Water Systems
- 22 6000 Medical Gas Piping and Equipment

Division 23 – Heating, Ventilating, And Air Conditioning (HVAC)

- 23 0010 Hvac General Requirements
- 23 0050 Hvac Motors, Starters, and Variable Speed Drives
- 23 0095 Hvac Test Adjust and Balance
- 23 0801 Start-Up and Commissioning
- 23 0900 Bas General
- 23 0901 Bas Basic Materials, Interface Devices, & Sensors
- 23 0993 Sequences of Operation
- 23 1000 Hvac Piping, Valves and Accessories
- 23 1010 Underground Steam Systems
- 23 1020 Underground Chilled Water Systems
- 23 2500 Hvac Insulation
- 23 6000 Hvac Equipment
- 23 7000 Air Distribution

Division 26 - Electrical

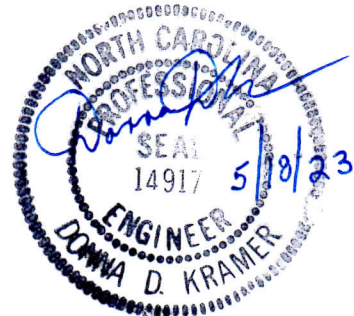
- 26 0000 Electrical General Requirements
- 26 0100 Operation and Maintenance Manuals
- 26 0126 Testing and Start-Up
- 26 0519 Wire and Cable
- 26 0526 Grounding
- 26 0533 Raceway
- 26 0535 Electrical Boxes and Fittings
- 26 0583 Electrical Connections for Equipment
- 26 0920 Lighting Controls
- 26 2416 Panelboards
- 26 2726 Wiring Devices and Plates
- 26 2816 Safety/Disconnect Switches, Manual Motor Starters, and Fuses
- 26 4300 Surge Protection Devices
- 26 5000 Lighting Fixtures and Lamps

Division 27 – Communications

- 27 0530 Communications Systems Empty Raceway System
- 27 1000 Voice/Data Telecommunications System

Division 28 – Electronic Safety and Security

- 28 3100 Fire Detection and Alarm



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NV5 ENGINEERS AND CONSULTANTS, INC.

The professional identified above is responsible for performing certain professional services defined in the Contract Documents and is the author of the following Specification Sections for this project:

Division 31 – Earthwork

31 1000 Site Cleaning
31 2000 Earth Moving

Division 32 – Exterior Improvements

32 1313 Concrete Paving
32 9200 Turf and Grasses

Division 33 – Utilities

33 1000 Site Water Distribution Piping
33 3000 Site Sanitary Sewers
33 4000 Stormwater Conveyance
33 4600 Subdrainage



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BENNET & PLESS, FORMERLY LHC STRUCTURAL ENGINEERS

The professional identified above is responsible for performing certain professional services defined in the Contract Documents and is the author of the following Specification Sections for this project:

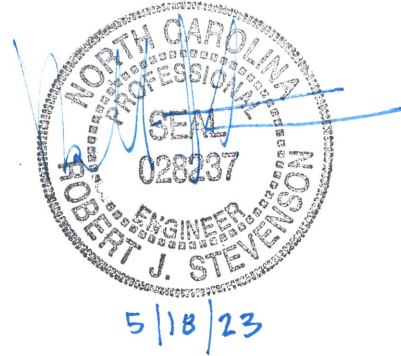
Division 03 – Concrete

03 3000 Cast-In-Place Concrete

Division 05 – Metals

05 1200 Structural Steel Framing

05 3100 Steel Decking



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Division 00 – Bidding and Contracting Requirements

00 01 05	Certifications Page
00 01 10	Table of Contents
	Notice to Bidders
	General Conditions of the Contract (Form OC-15CM)
	Supplementary General Conditions of the Contract
	Guidelines for Recruitment and Selection of Minority Businesses for Participation in State Construction Contracts
00 31 32	Geotechnical Data

Division 01 – General Requirements

01 1000	Summary
01 2300	Alternates
01 2500	Substitution Procedures
01 3100	Project Management and Coordination
01 3200	Construction Progress Documentation
01 3233	Photographic Documentation
01 3300	Submittal Procedures
01 4000	Quality Requirements
01 5000	Temporary Facilities and Controls
01 6000	Product Requirements
01 7300	Execution Requirements
01 7419	Construction Waste Management and Disposal
01 7700	Closeout Procedures
01 7823	Operation and Maintenance Data
01 7839	Project Record Documents
01 7900	Demonstration and Training

Division 02 – Existing Conditions

02 4100	Selective Demolition
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Division 03 – Concrete

03 3000	Cast-In-Place Concrete
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Division 04 – Masonry

04 4200	Unit Masonry
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Division 05 – Metals

05 1200	Structural Steel Framing
05 3100	Steel Decking
05 4000	Cold Formed Steel Framing
05 5000	Metal Fabrications
05 5100	Metal Stairs
05 5210	Pipe and Tube Railings
05 5300	Fiberglass Gratings

Division 06 – Wood, Plastics and Composites

06 6100	Rough Carpentry
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Division 07 – Thermal and Moisture Control

07 1150	Bituminous Damp Proofing
07 2113	Perimeter Insulation Under Slab on Grade
07 4113	Metal Roof Panel System

07 4646	Fiber Cement Siding
07 6200	Sheet Metal Flashing and Trim
07 6310	Gutters and Downspouts
07 9200	Joint Sealants

Division 08 – Openings

08 1113	Hollow Metal Doors and Frames
08 3113	Access Doors and Frames
08 7100	Door Hardware
08 8000	Glazing
08 9000	Louvers and Vents

Division 09 – Finishes

09 2216	Non-Structural Metal Framing
09 2900	Gypsum Board
09 6723	Resinous Flooring
09 9110	Exterior Painting
09 9330	Concrete Sealer
09 9610	High Performance Coatings

Division 10 – Specialties

10 2600	Wall and Door Protection
10 2800	Toilet, Bath and Laundry Accessories
10 4413	Fire Extinguisher Cabinets
10 5113	Metal Lockers

Division 12 - Furnishings

12 3553	Laboratory Casework
12 3653	Laboratory Countertops

Division 14 – Conveying Equipment

14 6200	Electric Trolley Hoists
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Division 22 – Plumbing

22 0010	Plumbing General Requirements
22 2500	Plumbing Piping Insulation
22 4200	Plumbing Fixtures
22 4300	Drainage Systems
22 4400	Water Systems
22 6000	Medical Gas Piping and Equipment

Division 23 – Heating, Ventilating, And Air Conditioning (HVAC)

23 0010	Hvac General Requirements
23 0050	Hvac Motors, Starters, and Variable Speed Drives
23 0095	Hvac Test Adjust and Balance
23 0801	Start-Up and Commissioning
23 0900	Bas General
23 0901	Bas Basic Materials, Interface Devices, & Sensors
23 0993	Sequences of Operation
23 1000	Hvac Piping, Valves and Accessories
23 1010	Underground Steam Systems
23 1020	Underground Chilled Water Systems

23 2500	Hvac Insulation
23 6000	Hvac Equipment
23 7000	Air Distribution

Division 26 - Electrical

26 0000	Electrical General Requirements
26 0100	Operation and Maintenance Manuals
26 0126	Testing and Start-Up
26 0519	Wire and Cable
26 0526	Grounding
26 0533	Raceway
26 0535	Electrical Boxes and Fittings
26 0583	Electrical Connections for Equipment
26 0920	Lighting Controls
26 2416	Panelboards
26 2726	Wiring Devices and Plates
26 2816	Safety/Disconnect Switches, Manual Motor Starters, and Fuses
26 4300	Surge Protection Devices
26 5000	Lighting Fixtures and Lamps

Division 27 – Communications

27 0530	Communications Systems Empty Raceway System
27 1000	Voice/Data Telecommunications System

Division 28 – Electronic Safety and Security

28 3100	Fire Detection and Alarm
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Division 31 – Earthwork

31 1000	Site Clearing
31 2000	Earth Moving

Division 32 – Exterior Improvements

32 1313	Concrete Paving
32 9200	Turf and Grasses

Division 33 – Utilities

33 1113	Site Water Distribution
33 1313	Site Sanitary Sewers
33 4200	Stormwater Conveyance
33 4600	Subdrainage

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**INSTRUCTIONS TO BIDDERS
AND
GENERAL CONDITIONS OF THE CONTRACT**

STANDARD FORM FOR CONSTRUCTION PROJECTS

**STATE CONSTRUCTION OFFICE
NORTH CAROLINA
DEPARTMENT OF ADMINISTRATION**

Form OC-15

This document is intended for use on State capital construction projects and shall not be used on any project that is not reviewed and approved by the State Construction Office. Extensive modification to the General Conditions by means of “Supplementary General Conditions” is strongly discouraged. State agencies and institutions may include special requirements in “Division 1 – General Requirements” of the specifications, where they do not conflict with the General Conditions.

Twenty Fourth Edition January 2013

INSTRUCTIONS TO BIDDERS

For a proposal to be considered it must be in accordance with the following instructions:

1. PROPOSALS

Proposals must be made in strict accordance with the Form of Proposal provided therefor, and all blank spaces for bids, alternates, and unit prices applicable to bidder's work shall be properly filled in. When requested alternates are not bid, the proposer shall so indicate by the words "No Bid". Any blanks shall also be interpreted as "No Bid". The bidder agrees that bid on Form of Proposal detached from specifications will be considered and will have the same force and effect as if attached thereto. Photocopied or faxed proposals will not be considered. Numbers shall be stated both in writing and in figures for the base bids and alternates. If figures and writing differ, the written number will supersede the figures.

Any modifications to the Form of Proposal (including alternates and/or unit prices) will disqualify the bid and may cause the bid to be rejected.

The bidder shall fill in the Form of Proposal as follows:

- a. If the documents are executed by a sole owner, that fact shall be evidenced by the word "Owner" appearing after the name of the person executing them.
- b. If the documents are executed by a partnership, that fact shall be evidenced by the word "Co-Partner" appearing after the name of the partner executing them.
- c. If the documents are executed on the part of a corporation, they shall be executed by either the president or the vice president and attested by the secretary or assistant secretary in either case, and the title of the office of such persons shall appear after their signatures. The seal of the corporation shall be impressed on each signature page of the documents.
- d. If the proposal is made by a joint venture, it shall be executed by each member of the joint venture in the above form for sole owner, partnership or corporation, whichever form is applicable.
- e. All signatures shall be properly witnessed.
- f. If the contractor's license of a bidder is held by a person other than an owner, partner or officer of a firm, then the licensee shall also sign and be a party to the proposal. The title "Licensee" shall appear under his/her signature.

Proposals should be addressed as indicated in the Advertisement for Bids and be delivered, enclosed in an opaque sealed envelope, marked "Proposal" and bearing the title of the work, name of the bidder, and the contractor's license number of the bidder. Bidders should clearly mark on the outside of the bid envelope which contract(s) they are bidding.

Bidder shall identify on the bid, the minority businesses that will be utilized on the project with corresponding total dollar value of the bid and affidavit listing good faith efforts or an affidavit indicating work under contract will be self-performed, as required by G.S. 143-128.2(c) and G.S. 143-128.2(f). Failure to comply with these requirements is grounds for rejection of the bid.

For projects bid in the single-prime alternative, the names and license numbers of major subcontractors shall be listed on the proposal form.

It shall be the specific responsibility of the bidder to deliver his bid to the proper official at the selected place and prior to the announced time for the opening of bids. Later delivery of a bid for any reason, including delivery by any delivery service, shall disqualify the bid.

Unit prices quoted in the proposal shall include overhead and profit and shall be the full compensation for the contractor's cost involved in the work. See General Conditions, Article 19c-1.

2. EXAMINATION OF CONDITIONS

It is understood and mutually agreed that by submitting a bid the bidder acknowledges that he has carefully examined all documents pertaining to the work, the location, accessibility and general character of the site of the work and all existing buildings and structures within and adjacent to the site, and has satisfied himself as to the nature of the work, the condition of existing buildings and structures, the conformation of the ground, the character, quality and quantity of the material to be encountered, the character of the equipment, machinery, plant and any other facilities needed preliminary to and during prosecution of the work, the general and local conditions, the construction hazards, and all other matters, including, but not limited to, the labor situation which can in any way affect the work under the contract, and including all safety measures required by the Occupational Safety and Health Act of 1970 and all rules and regulations issued pursuant thereto. It is further mutually agreed that by submitting a proposal the bidder acknowledges that he has satisfied himself as to the feasibility and meaning of the plans, drawings, specifications and other contract documents for the construction of the work and that he accepts all the terms, conditions and stipulations contained therein; and that he is prepared to work in cooperation with other contractors performing work on the site.

Reference is made to contract documents for the identification of those surveys and investigation reports of subsurface or latent physical conditions at the site or otherwise affecting performance of the work which have been relied upon by the designer in preparing the documents. The owner will make copies of all such surveys and reports available to the bidder upon request.

Each bidder may, at his own expense, make such additional surveys and investigations as he may deem necessary to determine his bid price for the performance of the work. Any on-site investigation shall be done at the convenience of the owner. Any reasonable request for access to the site will be honored by the owner.

3. BULLETINS AND ADDENDA

Any addenda to specifications issued during the time of bidding are to be considered covered in the proposal and in closing a contract they will become a part thereof. It shall be the bidder's responsibility to ascertain prior to bid time the addenda issued and to see that his bid includes any changes thereby required.

Should the bidder find discrepancies in, or omission from, the drawings or documents or should he be in doubt as to their meaning, he shall at once notify the designer who will send written instructions in the form of addenda to all bidders. Notification should be no later than seven (7) days prior to the date set for receipt of bids. Neither the owner nor the designer will be responsible for any oral instructions.

All addenda should be acknowledged by the bidder(s) on the Form of Proposal. However, even if not acknowledged, by submitting a bid, the bidder has certified that he has reviewed all issued addenda and has included all costs associated within his bid.

4. BID SECURITY

Each proposal shall be accompanied by a cash deposit or a certified check drawn on some bank or trust company insured by the Federal Deposit Insurance Corporation, or a bid bond in an amount equal to not less than five percent (5%) of the proposal, said deposit to be retained by the owner as liquidated damages in event of failure of the successful bidder to execute the contract within ten (10) days after the award or to give satisfactory surety as required by law (G.S. 143-129).

Bid bond shall be conditioned that the surety will, upon demand, forthwith make payment to the obligee upon said bond if the bidder fails to execute the contract. The owner may retain bid securities of any bidder(s) who may have a reasonable chance of award of contract for the full duration of time stated in the Notice to Bidders. Other bid securities may be released sooner, at the discretion of the owner. All bid securities (cash or certified checks) shall be returned to the bidders promptly after award of contracts, and no later than seven (7) days after expiration of the holding period stated in the Notice to Bidders. Standard Form of Bid Bond is included in these specifications and shall be used.

5. RECEIPT OF BIDS

Bids shall be received in strict accordance with requirements of the General Statutes of North Carolina. Bid security shall be required as prescribed by statute. Prior to the closing of the bid, the bidder will be permitted to change or withdraw his bid. Guidelines for opening of public construction bids are available from the State Construction Office.

6. OPENING OF BIDS

Upon opening, all bids shall be read aloud. Once bidding is closed, there shall not be any withdrawal of bids by any bidder and no bids may be returned by the designer to any bidder. After the opening of bids, no bid may be withdrawn, except under the provisions of General Statute 143-129.1, for a period of thirty days unless otherwise specified. Should the successful bidder default and fail to execute a contract, the contract may be awarded to the next lowest and responsible bidder. The owner reserves the unqualified right to reject any and all bids. Reasons for rejection may include, but shall not be limited to, the following:

- a. If the Form of Proposal furnished to the bidder is not used or is altered.
- b. If the bidder fails to insert a price for all bid items, alternate and unit prices requested.
- c. If the bidder adds any provisions reserving the right to accept or reject any award.
- d. If there are unauthorized additions or conditional bids, or irregularities of any kind which tend to make the proposal incomplete, indefinite or ambiguous as to its meaning.
- e. If the bidder fails to complete the proposal form where information is requested so the bid may be properly evaluated by the owner.
- f. If the unit prices contained in the bid schedule are unacceptable to the owner and the State Construction Office.
- g. If the bidder fails to comply with other instructions stated herein.

7. BID EVALUATION

The award of the contract will be made to the lowest responsible bidder as soon as practical. The owner may award on the basis of the base bid and any alternates the owner chooses.

Before awarding a contract, the owner may require the apparent low bidder to qualify himself to be a responsible bidder by furnishing any or all of the following data:

- a. The latest financial statement showing assets and liabilities of the company or other information satisfactory to the owner.
- b. A listing of completed projects of similar size.
- c. Permanent name and address of place of business.
- d. The number of regular employees of the organization and length of time the organization has been in business under present name.
- e. The name and home office address of the surety proposed and the name and address of the responsible local claim agent.
- f. The names of members of the firms who hold appropriate trade licenses, together with license numbers.
- g. If prequalified, contractor info will be reviewed and evaluated comparatively to submitted prequalification package.

Failure or refusal to furnish any of the above information, if requested, shall constitute a basis for disqualification of any bidder.

In determining the lowest responsible, responsive bidder, the owner shall take into consideration the bidder's compliance with the requirements of G.S. 143-128.2(c), the past performance of the bidder on construction contracts for the State with particular concern given to completion times, quality of work, cooperation with other contractors, and cooperation with the designer and owner. Failure of the low bidder to furnish affidavit and/or documentation as required by G.S. 143-128.2(c) shall constitute a basis for disqualification of the bid.

Should the owner adjudge that the apparent low bidder is not the lowest responsible, responsive bidder by virtue of the above information, said apparent low bidder will be so notified and his bid security shall be returned to him.

8. PERFORMANCE BOND

The successful bidder, upon award of contract, shall furnish a performance bond in an amount equal to 100 percent of the contract price. See Article 35, General Conditions.

9. PAYMENT BOND

The successful bidder, upon award of contract, shall furnish a payment bond in an amount equal to 100 percent of the contract price. See Article 35, General Conditions.

10. PAYMENTS

Payments to the successful bidders (contractors) will be made on the basis of monthly estimates. See Article 31, General Conditions.

11. PRE-BID CONFERENCE

Prior to the date set for receiving bids, the Designer may arrange and conduct a Pre-Bid Conference for all prospective bidders. The purpose of this conference is to review project requirements and to respond to questions from prospective bidders and their subcontractors or material suppliers related to the intent of bid documents. Attendance by prospective bidders shall be as required by the "Notice to Bidders".

12. SUBSTITUTIONS

In accordance with the provisions of G.S. 133-3, material, product, or equipment substitutions proposed by the bidders to those specified herein can only be considered during the bidding phase until ten (10) days prior to the receipt of bids when submitted to the Designer with sufficient data to confirm material, product, or equipment equality. Proposed substitutions submitted after this time will be considered only as potential change order.

Submittals for proposed substitutions shall include the following information:

- a. Name, address, and telephone number of manufacturer and supplier as appropriate.
- b. Trade name, model or catalog designation.
- c. Product data including performance and test data, reference standards, and technical descriptions of material, product, or equipment. Include color samples and samples of available finishes as appropriate.
- d. Detailed comparison with specified products including performance capabilities, warranties, and test results.
- e. Other pertinent data including data requested by the Designer to confirm product equality.

If a proposed material, product, or equipment substitution is deemed equal by the Designer to those specified, all bidders of record will be notified by Addendum.

GENERAL CONDITIONS OF THE CONTRACT

The use or reproduction of this document or any part thereof is authorized for and limited to use on projects of the State of North Carolina, and is distributed by, through and at the discretion of the State Construction Office, Raleigh, North Carolina, for that distinct and sole purpose.

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ARTICLE 1 - DEFINITIONS

- a. The **contract documents** consist of the Notice to Bidders; Instructions to Bidders; General Conditions of the Contract; special conditions if applicable; Supplementary General Conditions; the drawing and specifications, including all bulletins, addenda or other modifications of the drawings and specifications incorporated into the documents prior to their execution; the proposal; the contract; the performance bond; the payment bond; insurance certificates; the approval of the attorney general; and the certificate of the Office of State Budget and Management. All of these items together form the contract.
- b. The **owner** is the State of North Carolina through the agency named in the contract.
- c. The **designer(s)** are those referred to within this contract, or their authorized representatives. The Designer(s), as referred to herein, shall mean architect and/or engineer. They will be referred to hereinafter as if each were of the singular number, masculine gender.
- d. The **contractor**, as referred to hereinafter, shall be deemed to be either of the several contracting parties called the "Party of the First Part" in either of the several contracts in connection with the total project. Where, in special instances hereinafter, a particular contractor is intended, an adjective precedes the word "contractor," as "general," "heating," etc. For the purposes of a single prime contract, the term Contractor shall be deemed to be the single contracting entity identified as the "Party of the First Part" in the single Construction Contract. Any references or adjectives that name or infer multiple prime contractors shall be interpreted to mean the single prime Contractor.
- e. A **subcontractor**, as the term is used herein, shall be understood to be one who has entered into a direct contract with a contractor, and includes one who furnishes materials worked to a special design in accordance with plans and specifications covered by the contract, but does not include one who only sells or furnishes materials not requiring work so described or detailed.
- f. **Written notice** shall be defined as notice in writing delivered in person to the contractor, or to a partner of the firm in the case of a partnership, or to a member of the contracting organization, or to an officer of the organization in the case of a corporation, or sent to the last known business address of the contracting organization by registered mail.
- g. **Work**, as used herein as a noun, is intended to include materials, labor, and workmanship of the appropriate contractor.
- h. The **project** is the total construction work to be performed under the contract documents by the several contractors.
- i. **Project Expediter**, as used herein, is an entity stated in the contract documents, designated to effectively facilitate scheduling and coordination of work activities. See Article 14(f) for responsibilities of a Project Expediter. **For the purposes of a single prime contract, the single prime contractor shall be designated as the Project Expediter.**
- j. **Change order**, as used herein, shall mean a written order to the contractor subsequent to the signing of the contract authorizing a change in the contract. The change order shall be signed by the contractor, designer and the owner, and approved by the State Construction Office, in that order (Article 19).

- k. **Field Order**, as used herein, shall mean a written approval for the contractor to proceed with the work requested by owner prior to issuance of a formal Change Order. The field order shall be signed by the contractor, designer, owner, and State Construction Office.
- l. **Time of completion**, as stated in the contract documents, is to be interpreted as consecutive calendar days measured from the date established in the written Notice to Proceed, or such other date as may be established herein (Article 23).
- m. **Liquidated damages**, as stated in the contract documents [, is an amount reasonably estimated in advance to cover the consequential damages associated with the Owner's economic loss in not being able to use the Project for its intended purposes at the end of the contract's completion date as amended by change order, if any, by reason of failure of the contractor(s) to complete the work within the time specified. Liquidated damages does not include the Owner's extended contract administration costs (including but not limited to additional fees for architectural and engineering services, testing services, inspection services, commissioning services, etc.), such other damages directly resulting from delays caused solely by the contractor, or consequential damages that the Owner identified in the bid documents that may be impacted by any delay caused solely by the Contractor (e.g., if a multi-phased project-subsequent phases, delays in start other projects that are dependent on the completion of this Project, extension of leases and/or maintenance agreements for other facilities).
- n. **Surety**, as used herein, shall mean the bonding company or corporate body which is bound with and for the contractor, and which engages to be responsible for the contractor and his acceptable performance of the work.
- o. **Routine written communications between the Designer and the Contractor** are any communication other than a "request for information" provided in letter, memo, or transmittal format, sent by mail, courier, electronic mail, or facsimile. Such communications can not be identified as "request for information".
- p. **Clarification or Request for information (RFI)** is a request from the Contractor seeking an interpretation or clarification by the Designer relative to the contract documents. The RFI, which shall be labeled (RFI), shall clearly and concisely set forth the issue or item requiring clarification or interpretation and why the response is needed. The RFI must set forth the Contractor's interpretation or understanding of the contract documents requirements in question, along with reasons for such an understanding.
- q. **Approval** means written or imprinted acknowledgement that materials, equipment or methods of construction are acceptable for use in the work.
- r. **Inspection** shall mean examination or observation of work completed or in progress to determine its compliance with contract documents.
- s. **"Equal to" or "approved equal"** shall mean materials, products, equipment, assemblies, or installation methods considered equal by the bidder in all characteristics (physical, functional, and aesthetic) to those specified in the contract documents. Acceptance of equal is subject to approval of Designer and owner.
- t. **"Substitution" or "substitute"** shall mean materials, products, equipment, assemblies, or installation methods deviating in at least one characteristic (physical, functional, or aesthetic) from those specified, but which in the opinion of the bidder would improve competition and/or enhance the finished installation. Acceptance of substitution is subject to the approval of the Designer and owner.

- u. **Provide** shall mean furnish and install complete in place, new, clean, operational, and ready for use.
- v. **Indicated and shown** shall mean provide as detailed, or called for, and reasonably implied in the contract documents.
- w. **Special inspector** is one who inspects materials, installation, fabrication, erection or placement of components and connections requiring special expertise to ensure compliance with the approved construction documents and referenced standards.
- x. **Commissioning** is a quality assurance process that verifies and documents that building components and systems operate in accordance to the owner's project requirements and the project design documents.
- y. **Designer Final Inspection** is the inspection performed by the design team to determine the completeness of the project in accordance with approved plans and specifications. This inspection occurs prior to SCO final inspection.
- z. **SCO Final Inspection** is the inspection performed by the State Construction Office to determine the completeness of the project in accordance with NC Building Codes and approved plans and specifications.
- aa. **Beneficial Occupancy** is requested by the owner and is occupancy or partial occupancy of the building after all life safety items have been completed as determined by the State Construction Office. Life safety items include but not limited to fire alarm, sprinkler, egress and exit lighting, fire rated walls, egress paths and security.
- bb. Final Acceptance is the date in which the State Construction Office accepts the construction as totally complete. This includes the SCO Final Inspection and certification by the designer that all punch lists are completed.

ARTICLE 2 - INTENT AND EXECUTION OF DOCUMENTS

- a. The drawings and specifications are complementary, one to the other, and that which is shown on the drawings or called for in the specifications shall be as binding as if it were both called for and shown. The intent of the drawings and specifications is to establish the scope of all labor, materials, transportation, equipment, and any and all other things necessary to provide a bid for a complete job. In case of discrepancy or disagreement in the contract documents, the order of precedence shall be: Form of Contract, specifications, large-scale detail drawings, small-scale drawings.
- b. The wording of the specifications shall be interpreted in accordance with common usage of the language except that words having a commonly used technical or trade meaning shall be so interpreted in preference to other meanings.
- c. The contractor shall execute each copy of the proposal, contract, performance bond and payment bond as follows:
 - 1. If the documents are executed by a sole owner, that fact shall be evidenced by the word "Owner" appearing after the name of the person executing them.
 - 2. If the documents are executed by a partnership, that fact shall be evidenced by the word "Co-Partner" appearing after the name of the partner executing them.

3. If the documents are executed on the part of a corporation, they shall be executed by either the president or the vice president and attested by the secretary or assistant secretary in either case, and the title of the office of such persons shall appear after their signatures. The seal of the corporation shall be impressed on each signature page of the documents.
4. If the documents are made by a joint venture, they shall be executed by each member of the joint venture in the above form for sole owner, partnership or corporation, whichever form is applicable to each particular member.
5. All signatures shall be properly witnessed.
6. If the contractor's license is held by a person other than an owner, partner or officer of a firm, then the licensee shall also sign and be a party to the contract. The title "Licensee" shall appear under his/her signature.
7. The bonds shall be executed by an attorney-in-fact. There shall be attached to each copy of the bond a certified copy of power of attorney properly executed and dated.
8. Each copy of the bonds shall be countersigned by an authorized individual agent of the bonding company licensed to do business in North Carolina. The title "Licensed Resident Agent" shall appear after the signature.
9. The seal of the bonding company shall be impressed on each signature page of the bonds.
10. The contractor's signature on the performance bond and the payment bond shall correspond with that on the contract. The date of performance and payment bond shall not be prior to the date of the contract.

ARTICLE 3 - CLARIFICATIONS AND DETAIL DRAWINGS

- a. In such cases where the nature of the work requires clarification by the designer, such clarification shall be furnished by the designer with reasonable promptness by means of written instructions or detail drawings, or both. Clarifications and drawings shall be consistent with the intent of contract documents, and shall become a part thereof.
- b. The contractor(s) and the designer shall prepare, if deemed necessary, a schedule fixing dates upon which foreseeable clarifications will be required. The schedule will be subject to addition or change in accordance with progress of the work. The designer shall furnish drawings or clarifications in accordance with that schedule. The contractor shall not proceed with the work without such detail drawings and/or written clarifications.

ARTICLE 4 - COPIES OF DRAWINGS AND SPECIFICATIONS

The designer or Owner shall furnish free of charge to the contractors electronic copies of plans and specifications. If requested by the contractor, paper copies of plans and specifications shall be furnished free of charge as follows:

- a. General contractor - Up to twelve (12) sets of general contractor drawings and specifications, up to six (6) sets of which shall include drawings and specifications of all other contracts, plus a clean set of black line prints on white paper of all appropriate drawings, upon which the contractor shall clearly and legibly record all work-in-place that is at variance with the contract documents.

- b. Each other contractor - Up to six (6) sets of the appropriate drawings and specifications, up to three (3) sets of which shall include drawings and specifications of all other contracts, plus a clean set of black line prints on white paper of all appropriate drawings, upon which the contractor shall clearly and legibly record all work-in-place that is at variance with the contract documents.
- c. Additional sets shall be furnished at cost, including mailing, to the contractor upon request by the contractor. This cost shall be stated in the bidding documents.
- d. For the purposes of a single-prime contract, the contractor shall receive up to 30 sets of drawings and specifications, plus a clean set of black line prints on white paper of all appropriate drawings, upon which the contractor shall clearly and legibly record all work-in-place that is at variance with the contract documents.

ARTICLE 5 - SHOP DRAWINGS, SUBMITTALS, SAMPLES, DATA

- a. Within 15 consecutive calendar days after the notice to proceed, each prime contractor shall submit a schedule for submission of all shop drawings, product data, samples, and similar submittals through the Project Expediter to the Designer. This schedule shall indicate the items, relevant specification sections, other related submittal, data, and the date when these items will be furnished to the designer.
- b. The Contractor(s) shall review, approve and submit to the Designer all Shop Drawings, Coordination Drawings, Product Data, Samples, Color Charts, and similar submittal data required or reasonably implied by the Contract Documents. Required Submittals shall bear the Contractor's stamp of approval, any exceptions to the Contract Documents shall be noted on the submittals, and copies of all submittals shall be of sufficient quantity for the Designer to retain up to three (3) copies of each submittal for his own use plus additional copies as may be required by the Contractor. Submittals shall be presented to the Designer in accordance with the schedule submitted in paragraph (a). so as to cause no delay in the activities of the Owner or of separate Contractors.
- c. The Designer shall review required submittals promptly, noting desired corrections if any, and retaining three (3) copies (1 for the Designer, 1 for the owner and 1 for SCO) for his use. The remaining copies of each submittal shall be returned to the Contractor not later than twenty (20) days from the date of receipt by the Designer, for the Contractor's use or for corrections and resubmittal as noted by the Designer. When resubmittals are required, the submittal procedure shall be the same as for the original submittals.
- d. Approval of shop drawings/submittals by the Designer shall not be construed as relieving the Contractor from responsibility for compliance with the design or terms of the contract documents nor from responsibility of errors of any sort in the shop drawings, unless such lack of compliance or errors first have been called in writing to the attention of the Designer by the Contractor.

ARTICLE 6 - WORKING DRAWINGS AND SPECIFICATIONS AT THE JOB SITE

- a. The contractor shall maintain, in readable condition at his job office, one complete set of working drawings and specifications for his work including all shop drawings. Such drawings and specifications shall be available for use by the designer, his authorized representative, owner or State Construction Office.

- b. The contractor shall maintain at the job office, a day-to-day record of work-in-place that is at variance with the contract documents. Such variations shall be fully noted on project drawings by the contractor and submitted to the designer upon project completion and no later than 30 days after final acceptance of the project.
- c. The contractor shall maintain at the job office a record of all required tests that have been performed, clearly indicating the scope of work inspected and the date of approval or rejection.

ARTICLE 7 - OWNERSHIP OF DRAWINGS AND SPECIFICATIONS

All drawings and specifications are instruments of service and remain the property of the owner. The use of these instruments on work other than this contract without permission of the owner is prohibited. All copies of drawings and specifications other than contract copies shall be returned to the owner upon request after completion of the work.

ARTICLE 8 - MATERIALS, EQUIPMENT, EMPLOYEES

- a. The contractor shall, unless otherwise specified, supply and pay for all labor, transportation, materials, tools, apparatus, lights, power, heat, sanitary facilities, water, scaffolding and incidentals necessary for the completion of his work, and shall install, maintain and remove all equipment of the construction, other utensils or things, and be responsible for the safe, proper and lawful construction, maintenance and use of same, and shall construct in the best and most workmanlike manner, a complete job and everything incidental thereto, as shown on the plans, stated in the specifications, or reasonably implied therefrom, all in accordance with the contract documents.
- b. All materials shall be new and of quality specified, except where reclaimed material is authorized herein and approved for use. Workmanship shall at all times be of a grade accepted as the best practice of the particular trade involved, and as stipulated in written standards of recognized organizations or institutes of the respective trades except as exceeded or qualified by the specifications.
- c. Upon notice, the contractor shall furnish evidence as to quality of materials.
- d. Products are generally specified by ASTM or other reference standard and/or by manufacturer's name and model number or trade name. When specified only by reference standard, the Contractor may select any product meeting this standard, by any manufacturer. When several products or manufacturers are specified as being equally acceptable, the Contractor has the option of using any product and manufacturer combination listed. However, the contractor shall be aware that the cited examples are used only to denote the quality standard of product desired and that they do not restrict bidders to a specific brand, make, manufacturer or specific name; that they are used only to set forth and convey to bidders the general style, type, character and quality of product desired; and that equivalent products will be acceptable. Request for substitution of materials, items, or equipment shall be submitted to the designer for approval or disapproval; such approval or disapproval shall be made by the designer prior to the opening of bids. Alternate materials may be requested after the award if it can clearly be demonstrated that it is an added benefit to the owner and the designer and owner approves.
- e. The designer is the judge of equality for proposed substitution of products, materials or equipment.

- g. If at any time during the construction and completion of the work covered by these contract documents, the language, conduct, or attire of any workman of the various crafts be adjudged a nuisance to the owner or designer, or if any workman be considered detrimental to the work, the contractor shall order such parties removed immediately from grounds.

ARTICLE 9 - ROYALTIES, LICENSES AND PATENTS

It is the intention of the contract documents that the work covered herein will not constitute in any way infringement of any patent whatsoever unless the fact of such patent is clearly evidenced herein. The contractor shall protect and save harmless the owner against suit on account of alleged or actual infringement. The contractor shall pay all royalties and/or license fees required on account of patented articles or processes, whether the patent rights are evidenced hereinafter.

ARTICLE 10 - PERMITS, INSPECTIONS, FEES, REGULATIONS

- a. The contractor shall give all notices and comply with all laws, ordinances, codes, rules and regulations bearing on the conduct of the work under this contract. If the contractor observes that the drawings and specifications are at variance therewith, he shall promptly notify the designer in writing. See Instructions to Bidders, Paragraph 3, Bulletins and Addenda. Any necessary changes required after contract award shall be made by change order in accordance with Article 19. If the contractor performs any work knowing it to be contrary to such laws, ordinances, codes, rules and regulations, and without such notice to the designer, he shall bear all cost arising therefrom. Additional requirements implemented after bidding will be subject to equitable negotiations.
- b. All work under this contract shall conform to the North Carolina State Building Code and other State, local and national codes as are applicable. The cost of all required inspections and permits shall be the responsibility of the contractor and included within the bid proposal. All water taps, meter barrels, vaults and impact fees shall be paid by the contractor unless otherwise noted.
- d. Projects constructed by the State of North Carolina or by any agency or institution of the State are not subject to inspection by any county or municipal authorities and are not subject to county or municipal building codes. The contractor shall, however, cooperate with the county or municipal authorities by obtaining building permits. Permits shall be obtained at no cost.
- e. Projects involving local funding (community colleges) are subject also to county and municipal building codes and inspection by local authorities. The contractor shall pay the cost of these permits and inspections.

ARTICLE 11 - PROTECTION OF WORK, PROPERTY AND THE PUBLIC

- a. The contractors shall be jointly responsible for the entire site and the building or construction of the same and provide all the necessary protections, as required by the owner or designer, and by laws or ordinances governing such conditions. They shall be responsible for any damage to the owner's property, or of that of others on the job, by them, their personnel, or their subcontractors, and shall make good such damages. They shall be responsible for and pay for any damages caused to the owner. All contractors shall have access to the project at all times.
- b. The contractor shall provide cover and protect all portions of the structure when the work is not in progress, provide and set all temporary roofs, covers for doorways, sash and windows, and all other materials necessary to protect all the work on the building, whether set by him, or any of the subcontractors. Any work damaged through the lack of proper protection or from any other cause, shall be repaired or replaced without extra cost to the owner.
- c. No fires of any kind will be allowed inside or around the operations during the course of construction without special permission from the designer and owner.
- d. The contractor shall protect all trees and shrubs designated to remain in the vicinity of the operations by building substantial boxes around same. He shall barricade all walks, roads, etc., as directed by the designer to keep the public away from the construction. All trenches, excavations or other hazards in the vicinity of the work shall be well barricaded and properly lighted at night.
- e. The contractor shall provide all necessary safety measures for the protection of all persons on the job, including the requirements of the A.G.C. *Accident Prevention Manual in Construction*, as amended, and shall fully comply with all state laws or regulations and North Carolina State Building Code requirements to prevent accident or injury to persons on or about the location of the work. He shall clearly mark or post signs warning of hazards existing, and shall barricade excavations, elevator shafts, stairwells and similar hazards. He shall protect against damage or injury resulting from falling materials and he shall maintain all protective devices and signs throughout the progress of the work.
- f. The contractor shall adhere to the rules, regulations and interpretations of the North Carolina Department of Labor relating to Occupational Safety and Health Standards for the Construction Industry (Title 29, Code of Federal Regulations, Part 1926, published in Volume 39, Number 122, Part II, June 24, 1974, *Federal Register*), and revisions thereto as adopted by General Statutes of North Carolina 95-126 through 155.
- g. The contractor shall designate a responsible person of his organization as safety officer/inspector to inspect the project site for unsafe health and safety hazards, to report these hazards to the contractor for correction, and whose duties also include accident prevention on the project, and to provide other safety and health measures on the project site as required by the terms and conditions of the contract. The name of the safety inspector shall be made known to the designer and owner at the time of the preconstruction conference and in all cases prior to any work starting on the project.
- h. In the event of emergency affecting the safety of life, the protection of work, or the safety of adjoining properties, the contractor is hereby authorized to act at his own discretion, without further authorization from anyone, to prevent such threatened injury or damage.

Any compensation claimed by the contractor on account of such action shall be determined as provided for under Article 19(b).

- i. Any and all costs associated with correcting damage caused to adjacent properties of the construction site or staging area shall be borne by the contractor. These costs shall include but not be limited to flooding, mud, sand, stone, debris, and discharging of waste products.

ARTICLE 12 - SEDIMENTATION POLLUTION CONTROL ACT OF 1973

- a. Any land-disturbing activity performed by the contractor(s) in connection with the project shall comply with all erosion control measures set forth in the contract documents and any additional measures which may be required in order to ensure that the project is in full compliance with the Sedimentation Pollution Control Act of 1973, as implemented by Title 15, North Carolina Administrative Code, Chapter 4, Sedimentation Control, Subchapters 4A, 4B and 4C, as amended (15 N.C.A.C. 4A, 4B and 4C).
- b. Upon receipt of notice that a land-disturbing activity is in violation of said act, the contractor(s) shall be responsible for ensuring that all steps or actions necessary to bring the project in compliance with said act are promptly taken.
- c. The contractor(s) shall be responsible for defending any legal actions instituted pursuant to N.C.G.S. 113A-64 against any party or persons described in this article.
- d. To the fullest extent permitted by law, the contractor(s) shall indemnify and hold harmless the owner, the designer and the agents, consultants and employees of the owner and designer, from and against all claims, damages, civil penalties, losses and expenses, including, but not limited to, attorneys' fees, arising out of or resulting from the performance of work or failure of performance of work, provided that any such claim, damage, civil penalty, loss or expense is attributable to a violation of the Sedimentation Pollution Control Act. Such obligation shall not be construed to negate, abridge or otherwise reduced any other right or obligation of indemnity which would otherwise exist as to any party or persons described in this article.

ARTICLE 13 - INSPECTION OF THE WORK

- a. It is a condition of this contract that the work shall be subject to inspection during normal working hours and during any time work is in preparation and progress by the designer, designated official representatives of the owner, State Construction Office and those persons required by state law to test special work for official approval. The contractor shall therefore provide safe access to the work at all times for such inspections.
- b. All instructions to the contractor will be made only by or through the designer or his designated project representative. Observations made by official representatives of the owner shall be conveyed to the designer for review and coordination prior to issuance to the contractor.
- c. All work shall be inspected by designer, special inspector and/or State Construction Office prior to being covered by the contractor. Contractor shall give a minimum two weeks notice unless otherwise agreed to by all parties. If inspection fails, after the first reinspection all costs associated with additional reinspections shall be borne by the contractor.

- d. Where special inspection or testing is required by virtue of any state laws, instructions of the designer, specifications or codes, the contractor shall give adequate notice to the designer of the time set for such inspection or test, if the inspection or test will be conducted by a party other than the designer. Such special tests or inspections will be made in the presence of the designer, or his authorized representative, and it shall be the contractor's responsibility to serve ample notice of such tests.
- e. All laboratory tests shall be paid by the owner unless provided otherwise in the contract documents except the general contractor shall pay for laboratory tests to establish design mix for concrete, and for additional tests to prove compliance with contract documents where materials have tested deficient except when the testing laboratory did not follow the appropriate ASTM testing procedures.
- f. Should any work be covered up or concealed prior to inspection and approval by the designer, special inspector, and/or State Construction Office such work shall be uncovered or exposed for inspection, if so requested by the designer in writing. Inspection of the work will be made upon notice from the contractor. All cost involved in uncovering, repairing, replacing, recovering and restoring to design condition, the work that has been covered or concealed will be paid by the contractor involved.

ARTICLE 14 - CONSTRUCTION SUPERVISION AND SCHEDULE

- a. Throughout the progress of the work, each contractor shall keep at the job site, a competent superintendent and supervisory staff satisfactory to the designer and the owner. The superintendent and supervisory staff shall not be changed without the consent of the designer and owner unless said superintendent ceases to be employed by the contractor or ceases to be competent as determined by the contractor, designer or owner. The superintendent and other staff designated by the contractor in writing shall have authority to act on behalf of the contractor, and instructions, directions or notices given to him shall be as binding as if given to the contractor. However, directions, instructions, and notices shall be confirmed in writing.
- b. The contractor shall examine and study the drawings and specifications and fully understand the project design, and shall provide constant and efficient supervision to the work. Should he discover any discrepancies of any sort in the drawings or specifications, he shall report them to the designer without delay. He will not be held responsible for discrepancies in the drawings and/or specifications, but shall be held responsible to report them should they become known to him.
- c. All contractors shall be required to cooperate and consult with each other during the construction of this project. Prior to installation of work, all contractors shall jointly prepare coordination drawings, showing locations of various ductworks, piping, motors, pumps, and other mechanical or electrical equipment, in relation to the structure, walls and ceilings. These drawings shall be submitted to the designer through the Project Expediter for information only. Each contractor shall lay out and execute his work to cause the least delay to other contractors. Each contractor shall be financially responsible for any damage to other contractor's work and for undue delay caused to other contractors on the project.
- d. The contractor is required to attend job site progress conferences as called by the designer. The contractor shall be represented at these job progress conferences by both home office and project personnel. These representatives shall have authority to act on behalf of the contractor. These meetings shall be open to subcontractors, material

suppliers and any others who can contribute toward maintaining required job progress. It shall be the principal purpose of these meetings, or conferences, to effect coordination, cooperation and assistance in every practical way toward the end of maintaining progress of the project on schedule and to complete the project within the specified contract time. Each contractor shall be prepared to assess progress of the work as required in his particular contract and to recommend remedial measures for correction of progress as may be appropriate. The designer or his authorized representative shall be the coordinator of the conferences and shall preside as chairman. The contractor shall turn over a copy of his daily reports to the Designer and Owner at the job site progress conference. Owner will determine daily report format.

- e. The contractor(s) shall, employ an engineer or a land surveyor licensed in the State of North Carolina to lay out the work and to establish a bench mark in a location where same will not be disturbed and where direct instruments sights may be taken.
- f. The designer shall designate a Project Expediter on projects involving two or more prime contracts. The Project Expediter shall be designated in the Supplementary General Conditions. The Project Expediter shall have at a minimum the following responsibilities.
 - 1. Prepare the project construction schedule and shall allow all prime contractors (multi-prime contract) and subcontractors (single-prime contract) performing general, plumbing, HVAC, and electrical work equal input into the preparation of the initial construction schedule.
 - 2. Maintain a project progress schedule for all contractors.
 - 3. Give adequate notice to all contractors to ensure efficient continuity of all phases of the work.
 - 4. Notify the designer of any changes in the project schedule.
 - 5. Recommend to the owner whether payment to a contractor shall be approved.
- g. It shall be the responsibility of the Project Expediter to cooperate with and obtain from several prime contractors and subcontractors on the job, their respective work activities and integrate these activities into a project construction schedule in form of a detailed bar chart or Critical Path Method (CPM), schedule. Each prime contractor shall provide work activities within fourteen (14) days of request by the Project Expediter. A “work activity”, for scheduling purposes, shall be any component or contractual requirement of the project requiring at least one (1) day, but not more than fourteen (14) days, to complete or fulfill. The project construction schedule shall graphically show all salient features of the work required to construct the project from start to finish and within the allotted time established in the contract. The time (in days) between the contractor’s early completion and contractual completion dates is part of the project total float time; and shall be used as such, unless amended by a change order. On a multi-prime project, each prime contractor shall review the proposed construction schedule and approve same in writing. The Project Expediter shall submit the proposed construction schedule to the designer for comments. The complete Project construction schedule shall be of the type set forth in the Supplementary General Condition or subparagraph (1) or (2) below, as appropriate:

1. For a project with total contracts of \$500,000 or less, a bar chart schedule will satisfy the above requirement. The schedule shall indicate the estimated starting and completion dates for each major element of the work.
2. For a project with total contracts over \$500,000, a Critical Path Method (CPM) schedule shall be utilized to control the planning and scheduling of the Work. The CPM schedule shall be the responsibility of the Project Expediter and shall be paid for by the Project Expediter.

Bar Chart Schedule: Where a bar chart schedule is required, it shall be time-scaled in weekly increments, shall indicate the estimated starting and completion dates for each major element of the work by trade and by area, level, or zone, and shall schedule dates for all salient features, including but not limited to the placing of orders for materials, submission of shop drawings and other Submittals for approval, approval of shop drawings by designers, the manufacture and delivery of material, the testing and the installation of materials, supplies and equipment, and all Work activities to be performed by the Contractor. The Contractor shall allow sufficient time in his schedule for all commissioning, required inspections and completion of final punchlist(s). Each Work activity will be assigned a time estimate by the Contractor. One day shall be the smallest time unit used.

CPM Schedule: Where a CPM schedule is required, it shall be in time-scaled precedence format using the Project Expediter's logic and time estimates. The CPM schedule shall be drawn or plotted with activities grouped or zoned by Work area or subcontract as opposed to a random (or scattered) format. The CPM schedule shall be time-scaled on a weekly basis and shall be drawn or plotted at a level of detail and logic which will schedule all salient features of the work to be performed by the Contractor. The Contractor shall allow sufficient time in his schedule for all commissioning, required inspections and completion of final punchlist(s).. Each Work activity will be assigned a time estimate by the Contractor. One day shall be the smallest time unit used.

The CPM schedule will identify and describe each activity, state the duration of each activity, the calendar dates for the early and late start and the early and late finish of each activity, and clearly highlight all activities on the critical path. "Total float" and "free float" shall be indicated for all activities. Float time shall not be considered for the exclusive use or benefit of either the Owner or the Contractor, but must be allocated in the best interest of completing the Work within the Contract time. Extensions to the Contract time, when granted by Change Order, will be granted only when equitable time adjustment exceeds the Total Float in the activity or path of activities affected by the change. On contracts with a price over \$2,500,000, the CPM schedule shall also show what part of the Contract Price is attributable to each activity on the schedule, the sum of which for all activities shall equal the total Contract Price.

Early Completion of Project: The Contractor may attempt to complete the project prior to the Contract Completion Date. However, such planned early completion shall be for the Contractor's convenience only and shall not create any additional rights of the Contractor or obligations of the Owner under this Contract, nor shall it change the Time

for Completion or the Contract Completion Date. The Contractor shall not be required to pay liquidated damages to the Owner because of its failure to complete by its planned earlier date. Likewise, the Owner shall not pay the Contractor any additional compensation for early completion nor will the Owner owe the Contractor any compensation should the Owner, its officers, employees, or agents cause the Contractor not to complete earlier than the date required by the Contract Documents.

- h. The proposed project construction schedule shall be presented to the designer no later than fifteen (15) days after written notice to proceed. No application for payment will be processed until this schedule is accepted by the designer and owner.
- i. The approved project construction schedule shall be distributed to all contractors and displayed at the job site by the Project Expediter.
- j. The several contractors shall be responsible for their work activities and shall notify the Project Expediter of any necessary changes or adjustments to their work. The Project Expediter shall maintain the project construction schedule, making biweekly adjustments, updates, corrections, etc., that are necessary to finish the project within the Contract time, keeping all contractors and the designer fully informed. Copy of a bar chart schedule annotated to show the current progress shall be submitted by the Contractor(s) to the designer, along with monthly request for payment. For project requiring CPM schedule, the Contractor shall submit a biweekly report of the status of all activities. The bar chart schedule or status report shall show the actual Work completed to date in comparison with the original Work scheduled for all activities. If any activities of the work of several contractors are behind schedule, the contractor must indicate in writing, what measures will be taken to bring each such activity back on schedule and to ensure that the Contract Completion Date is not exceeded. A plan of action and recovery schedule shall be developed and submitted to the designer by the Project Expediter, when (1) the contractor's report indicates delays, that are in the opinion of the designer or the owner, of sufficient magnitude that the contractor's ability to complete the work by the scheduled completion is brought into question; (2) the updated construction schedule is thirty (30) days behind the planned or baseline schedule and no legitimate time extensions, as determined by the Designer, are in process; and (3) the contractor desires to make changes in the logic (sequencing of work) or the planned duration of future activities of the CPM schedule which, in the opinion of the designer or the owner, are of a major nature. The plan of action, when required shall be submitted to the Owner for review within two (2) business days of the Contractor receiving the Owner's written demand. The recovery schedule, when required, shall be submitted to the Owner within five (5) calendar days of the Contractor's receiving the Owner's written demand. Failure to provide an updated construction schedule or a recovery schedule may be grounds for rejection of payment applications or withholding of funds as set forth in Article 33.
- k. The Project Expediter shall notify each contractor of such events or time frames that are critical to the progress of the job. Such notice shall be timely and reasonable. Should the progress be delayed due to the work of any of the several contractors, it shall be the duty of the Project Expediter to immediately notify the contractor(s) responsible for such delay, the designer, the State Construction Office and other prime contractors. The designer shall determine the contractor(s) who caused the delays and notify the bonding company of the responsible contractor(s) of the delays; and shall make a recommendation to the owner regarding further action.
- l. Designation as Project Expediter entails an additional project control responsibility and does not alter in any way the responsibility of the contractor so designated, nor the

responsibility of the other contractors involved in the project. The project expeditor's Superintendent(s) shall be in attendance at the Project site at all times when work is in progress unless conditions are beyond the control of the Contractor or until termination of the Contract in accordance with the Contract Documents. It is understood that such Superintendent shall be acceptable to the Owner and Designer and shall be the one who will be continued in that capacity for the duration of the project unless he ceases to be on the Contractor's payroll or the Owner otherwise agrees. The Superintendent shall not be employed on any other project for or by the Contractor or by any other entity during the course of the Work. If the Superintendent is employed by the Contractor on another project without the Owner's approval, then the Owner may deduct from the Contractor's monthly general condition costs and amount representing the Superintendent's cost and shall deduct that amount for each month thereafter until the Contractor has the Superintendent back on the Owner's Project full-time.

ARTICLE 15 - SEPARATE CONTRACTS AND CONTRACTOR RELATIONSHIPS

- a. Effective from January 1, 2002, Chapter 143, Article 8, was amended, to allow public contracts to be delivered by the following delivery methods: single-prime, dual (single-prime and separate-prime), construction manager at risk, and alternative contracting method as approved by the State Building Commission. The owner reserves the right to prepare separate specifications, receive separate bids, and award separate contracts for such other major items of work as may be in the best interest of the State. For the purposes of a single prime contract, refer to Article 1 – Definitions.
- b. All contractors shall cooperate with each other in the execution of their work, and shall plan their work in such manner as to avoid conflicting schedules or delay of the work. See Article 14, Construction Supervision.
- c. If any part of contractor's work depends upon the work of another contractor, defects which may affect that work shall be reported to the designer in order that prompt inspection may be made and the defects corrected. Commencement of work by a contractor where such condition exists will constitute acceptance of the other contractor's work as being satisfactory in all respects to receive the work commenced, except as to defects which may later develop. The designer shall be the judge as to the quality of work and shall settle all disputes on the matter between contractors.
- d. Any mechanical or electrical work such as sleeves, inserts, chases, openings, penetrations, etc., which is located in the work of the general contractor shall be built in by the general contractor. The respective mechanical and electrical contractors shall set all sleeves, inserts and other devices that are to be incorporated into the structure in cooperation and under the supervision of the general contractor. The responsibility for the exact location of such items shall be that of the mechanical and/or electrical contractor.
- e. The designer and the owner shall have access to the work whenever it is in preparation and progress and during normal working hours. The contractor shall provide facilities for such access so the designer may perform his functions under the contract documents.
- f. Should a contractor cause damage to the work or property of another contractor, he shall be directly responsible, and upon notice, shall promptly settle the claim or otherwise resolve the dispute.

ARTICLE 16 - SUBCONTRACTS AND SUBCONTRACTORS

- a. Within thirty (30) days after award of the contract, the contractor shall submit to the designer, owner and to the State Construction Office a list giving the names and addresses of subcontractors and equipment and material suppliers he proposes to use, together with the scope of their respective parts of the work. Should any subcontractor be disapproved by the designer or owner, the designer or owner shall submit his reasons for disapproval in writing to the State Construction Office for its consideration with a copy to the contractor. If the State Construction Office concurs with the designer's or owner's recommendation, the contractor shall submit a substitute for approval. The designer and owner shall act promptly in the approval of subcontractors, and when approval of the list is given, no changes of subcontractors will be permitted except for cause or reason considered justifiable by the designer or owner.
- b. The designer will furnish to any subcontractor, upon request, evidence regarding amounts of money paid to the contractor on account of the subcontractor's work.
- c. The contractor is and remains fully responsible for his own acts or omissions as well as those of any subcontractor or of any employee of either. The contractor agrees that no contractual relationship exists between the subcontractor and the owner in regard to the contract, and that the subcontractor acts on this work as an agent or employee of the contractor.
- d. The owner reserves the right to limit the amount of portions of work to be subcontracted as hereinafter specified.

ARTICLE 17 - CONTRACTOR AND SUBCONTRACTOR RELATIONSHIPS

The contractor agrees that the terms of these contract documents shall apply equally to each subcontractor as to the contractor, and the contractor agrees to take such action as may be necessary to bind each subcontractor to these terms. The contractor further agrees to conform to the Code of Ethical Conduct as adopted by the Associated General Contractors of America, Inc., with respect to contractor-subcontractor relationships, and that payments to subcontractors shall be made in accordance with the provisions of G.S. 143-134.1 titled Interest on final payments due to prime contractors: payments to subcontractors.

- a. On all public construction contracts which are let by a board or governing body of the state government or any political subdivision thereof, except contracts let by the Department of Transportation pursuant to G.S. 136-28.1, the balance due prime contractors shall be paid in full within 45 days after respective prime contracts of the project have been accepted by the owner, certified by the architect, engineer or designer to be completed in accordance with terms of the plans and specifications, or occupied by the owner and used for the purpose for which the project was constructed, whichever occurs first. Provided, however, that whenever the architect or consulting engineer in charge of the project determines that delay in completion of the project in accordance with terms of the plans and specifications is the fault of the contractor, the project may be occupied and used for the purposes for which it was constructed without payment of any interest on amounts withheld past the 45 day limit. No payment shall be delayed because of the failure of another prime contractor on such project to complete his contract. Should final payment to any prime contractor beyond the date such contracts have been certified to be completed by the designer or architect, accepted by the owner, or occupied by the owner and used for the purposes for which the project was constructed, be delayed by more than 45 days, said prime contractor shall be paid interest, beginning on the 46th day, at the rate of one percent (1%) per month or fraction thereof unless a lower rate is

agreed upon on such unpaid balance as may be due. In addition to the above final payment provisions, periodic payments due a prime contractor during construction shall be paid in accordance with the payment provisions of the contract documents or said prime contractor shall be paid interest on any such unpaid amount at the rate stipulated above for delayed final payments. Such interest shall begin on the date the payment is due and continue until the date on which payment is made. Such due date may be established by the terms of the contract. Funds for payment of such interest on state-owned projects shall be obtained from the current budget of the owning department, institution or agency. Where a conditional acceptance of a contract exists, and where the owner is retaining a reasonable sum pending correction of such conditions, interest on such reasonable sum shall not apply.

- b. Within seven days of receipt by the prime contractor of each periodic or final payment, the prime contractor shall pay the subcontractor based on work completed or service provided under the subcontract. Should any periodic or final payment to the subcontractor be delayed by more than seven days after receipt of periodic or final payment by the prime contractor, the prime contractor shall pay the subcontractor interest, beginning on the eighth day, at the rate of one percent (1%) per month or fraction thereof on such unpaid balance as may be due.
- c. The percentage of retainage on payments made by the prime contractor to the subcontractor shall not exceed the percentage of retainage on payments made by the owner to the prime contractor. Any percentage of retainage on payments made by the prime contractor to the subcontractor that exceeds the percentage of retainage on payments made by the owner to the prime contractor shall be subject to interest to be paid by the prime contractor to the subcontractor at the rate of one percent (1%) per month or fraction thereof.
- d. Nothing in this section shall prevent the prime contractor at the time of application and certification to the owner from withholding application and certification to the owner for payment to the subcontractor for unsatisfactory job progress; defective construction not remedied; disputed work; third-party claims filed or reasonable evidence that claim will be filed; failure of subcontractor to make timely payments for labor, equipment and materials; damage to prime contractor or another subcontractor; reasonable evidence that subcontract cannot be completed for the unpaid balance of the subcontract sum; or a reasonable amount for retainage not to exceed the initial percentage retained by owner.

ARTICLE 18 - DESIGNER'S STATUS

- a. The designer shall provide general administration of the performance of construction contracts, including liaison and necessary inspection of the work to ensure compliance with plans and specifications. He is the agent of the owner only for the purpose of constructing this work and to the extent stipulated in the contract documents. He has authority to direct work to be performed, to stop work, to order work removed, or to order corrections of faulty work, where any such action by the designer may be necessary to assure successful completion of the work.
- b. The designer is the impartial interpreter of the contract documents, and, as such, he shall exercise his powers under the contract to enforce faithful performance by both the owner and the contractor, taking sides with neither.
- c. Should the designer cease to be employed on the work for any reason whatsoever, then the owner shall employ a competent replacement who shall assume the status of the former designer.

- d. The designer and his consultants will make inspections of the project. He will inspect the progress, the quality and the quantity of the work.
- e. The designer and the owner shall have access to the work whenever it is in preparation and progress during normal working hours. The contractor shall provide facilities for such access so the designer and owner may perform their functions under the contract documents.
- f. Based on the designer's inspections and evaluations of the project, the designer shall issue interpretations, directives and decisions as may be necessary to administer the project. His decisions relating to artistic effect and technical matters shall be final, provided such decisions are within the limitations of the contract.

ARTICLE 19 - CHANGES IN THE WORK

- a. The owner may have changes made in the work covered by the contract. These changes will not invalidate and will not relieve or release the contractor from any guarantee given by him pertinent to the contract provisions. These changes will not affect the validity of the guarantee bond and will not relieve the surety or sureties of said bond. All extra work shall be executed under conditions of the original contract.
- b. Except in an emergency endangering life or property, no change shall be made by the contractor except upon receipt of approved change order or written field order from the designer, countersigned by the owner and the state construction office authorizing such change. No claim for adjustments of the contract price shall be valid unless this procedure is followed.

A field order, transmitted by fax, electronically, or hand delivered, may be used where the change involved impacts the critical path of the work. A formal change order shall be issued as expeditiously as possible.

In the event of emergency endangering life or property, the contractor may be directed to proceed on a time and material basis whereupon the contractor shall proceed and keep accurately on such form as specified by the designer or owner, a correct account of costs together with all proper invoices, payrolls and supporting data. Upon completion of the work the change order will be prepared as outlined under either Method "c(1)" or Method "c(2)" or both.

- c. In determining the values of changes, either additive or deductive, contractors are restricted to the use of the following methods:
 - 1. Where the extra work involved is covered by unit prices quoted in the proposal, or subsequently agreed to by the Contractor, Designer, Owner and State Construction Office the value of the change shall be computed by application of unit prices based on quantities, estimated or actual as agreed of the items involved, except in such cases where a quantity exceeds the estimated quantity allowance in the contract by one hundred percent (100%) or more. In such cases, either party may elect to proceed under subparagraph c2 herein. If neither party elects to proceed under c2, then unit prices shall apply.
 - 2. The contracting parties shall negotiate and agree upon the equitable value of the change prior to issuance of the change order, and the change order shall stipulate the corresponding lump sum adjustment to the contract price.

- d. Under Paragraph "b" and Methods "c(2)" above, the allowances for overhead and profit combined shall be as follows: all contractors (the single contracting entity (prime), his subcontractors (1st tier subs), or their sub-subcontractors (2nd tier subs, 3rd tier subs, etc)) shall be allowed a maximum of 10% on work they each self-perform; the prime contractor shall be allowed a maximum of 5% on contracted work of his 1st tier sub; 1st tier, 2nd tier, 3rd tier, etc contractors shall be allowed a maximum of 2.5% on the contracted work of their subs. ; Under Method "c(1)", no additional allowances shall be made for overhead and profit. In the case of deductible change orders, under Method "c(2)" and Paragraph (b) above, the contractor shall include no less than five percent (5%) profit, but no allowances for overhead.
- e. The term "net cost" as used herein shall mean the difference between all proper cost additions and deductions. The "cost" as used herein shall be limited to the following:
1. The actual costs of materials and supplies incorporated or consumed as part of the work;
 2. The actual costs of labor expended on the project site; labor expended in coordination, change order negotiation, record document maintenance, shop drawing revision or other tasks necessary to the administration of the project are considered overhead whether they take place in an office or on the project site.
 3. The actual costs of labor burden, limited to the costs of social security (FICA) and Medicare/Medicaid taxes; unemployment insurance costs; health/dental/vision insurance premiums; paid employee leave for holidays, vacation, sick leave, and/or petty leave, not to exceed a total of 30 days per year; retirement contributions; worker's compensation insurance premiums; and the costs of general liability insurance when premiums are computed based on payroll amounts; the total of which shall not exceed thirty percent (30%) of the actual costs of labor;
 4. The actual costs of rental for tools, excluding hand tools; equipment; machinery; and temporary facilities required for the work;
 5. The actual costs of premiums for bonds, insurance, permit fees, and sales or use taxes related to the work.
- Overtime and extra pay for holidays and weekends may be a cost item only to the extent approved by the owner.
- f. Should concealed conditions be encountered in the performance of the work below grade, or should concealed or unknown conditions in an existing structure be at variance with the conditions indicated by the contract documents, the contract sum and time for completion may be equitably adjusted by change order upon claim by either party made within thirty (30) days after the condition has been identified. The cost of such change shall be arrived at by one of the foregoing methods. All change orders shall be supported by a unit cost breakdown showing method of arriving at net cost as defined above.
- g. In all change orders, the procedure will be for the designer to request proposals for the change order work in writing. The contractor will provide such proposal and supporting data in suitable format. The designer shall verify correctness. Delay in the processing of the change order due to lack of proper submittal by the contractor of all required supporting data shall not constitute grounds for a time extension or basis of a claim. Within fourteen (14) days after receipt of the contractor's accepted proposal including all supporting documentation required by the designer, the designer shall prepare the change order and forward to the contractor for his signature or otherwise respond, in writing, to

the contractor's proposal. Within seven (7) days after receipt of the change order executed by the contractor, the designer shall, certify the change order by his signature, and forward the change order and all supporting data to the owner for the owner's signature. The owner shall execute the change order and forward to the State Construction Office for final approval, within seven (7) days of receipt. The State Construction Office shall act on the change order within seven (7) days. In case of emergency or extenuating circumstances, approval of changes may be obtained verbally by telephone or field orders approved by all parties, then shall be substantiated in writing as outlined under normal procedure.

- h. At the time of signing a change order, the contractor shall be required to certify as follows:

"I certify that my bonding company will be notified forthwith that my contract has been changed by the amount of this change order, and that a copy of the approved change order will be mailed upon receipt by me to my surety."

- i. A change order, when issued, shall be full compensation, or credit, for the work included, omitted or substituted. It shall show on its face the adjustment in time for completion of the project as a result of the change in the work.
- j. If, during the progress of the work, the owner requests a change order and the contractor's terms are unacceptable, the owner, with the approval of the State Construction Office, may require the contractor to perform such work on a time and material basis whereupon the contractor shall proceed and keep accurately on such form as specified by the Designer or owner, a correct account of cost together with all proper invoices, payrolls and supporting data. Upon completion of the work a change order will be prepared with allowances for overhead and profit per paragraph d. above and "net cost" and "cost" per paragraph e. above. Without prejudice, nothing in this paragraph shall preclude the owner from performing or to have performed that portion of the work requested in the change order.

ARTICLE 20 - CLAIMS FOR EXTRA COST

- a. Should the contractor consider that as a result of instructions given by the designer, he is entitled to extra cost above that stated in the contract, he shall give written notice thereof to the designer within seven (7) days without delay. The written notice shall clearly state that a claim for extra cost is being made and shall provide a detailed justification for the extra cost. The contractor shall not proceed with the work affected until further advised, except in emergency involving the safety of life or property, which condition is covered in Article 19(b) and Article 11(h). No claims for extra compensation shall be considered unless the claim is so made. The designer shall render a written decision within seven (7) days of receipt of claim.
- b. The contractor shall not act on instructions received by him from persons other than the designer, and any claims for extra compensation or extension of time on account of such instruction will not be honored. The designer shall not be responsible for misunderstandings claimed by the contractor of verbal instructions which have not been confirmed in writing, and in no case shall instructions be interpreted as permitting a departure from the contract documents unless such instruction is confirmed in writing and supported by a properly authorized change order.
- c. Should a claim for extra compensation that complies with the requirements of (a) above by the contractor and is denied by the designer or owner, and cannot be resolved by a

representative of the State Construction Office, the contractor may request a mediation in connection with GS 143-128(f1) in the dispute resolution rules adopted by the State Building Commission (1 N.C.A.C. 30H .0101 through .1001). If the contractor is unable to resolve its claim as a result of mediation, the contractor may pursue the claim in accordance with the provisions of G.S. 143-135.3, or G.S. 143-135.6 where Community Colleges are the owner, and the following:

1. A contractor who has not completed a contract with a board for construction or repair work and who has not received the amount he claims is due under the contract may submit a verified written claim to the director of the State Construction Office of the Department of Administration for the amount the contractor claims is due. The director may deny, allow or compromise the claim, in whole or in part. A claim under this subsection is not a contested case under Chapter 150B of the General Statutes.
2.
 - (a) A contractor who has completed a contract with a board for construction or repair work and who has not received the amount he claims is due under the contract may submit a verified written claim to the director of the State Construction Office of the Department of Administration for the amount the contractor claims is due. The claim shall be submitted within sixty (60) days after the contractor receives a final statement of the board's disposition of his claim and shall state the factual basis for the claim.
 - (b) The director shall investigate a submitted claim within ninety (90) days of receiving the claim, or within any longer time period upon which the director and the contractor agree. The contractor may appear before the director, either in person or through counsel, to present facts and arguments in support of his claim. The director may allow, deny or compromise the claim, in whole or in part. The director shall give the contractor a written statement of the director's decision on the contractor's claim.
 - (c) A contractor who is dissatisfied with the director's decision on a claim submitted under this subsection may commence a contested case on the claim under Chapter 150B of the General Statutes. The contested case shall be commenced within sixty (60) days of receiving the director's written statement of the decision.
 - (d) As to any portion of a claim that is denied by the director, the contractor may, in lieu of the procedures set forth in the preceding subsection of this section, within six (6) months of receipt of the director's final decision, institute a civil action for the sum he claims to be entitled to under the contract by filing a verified complaint and the issuance of a summons in the Superior Court of Wake County or in the superior court of any county where the work under the contract was performed. The procedure shall be the same as in all civil actions except that all issues shall be tried by the judge, without a jury.

ARTICLE 21 - MINOR CHANGES IN THE WORK

The designer will have the authority to order minor changes in the work not involving an adjustment in the contract sum or time for completion, and not inconsistent with the intent of the contract documents. Such changes shall be effected by written order, copied to the State Construction Office, and shall be binding on the owner and the contractor.

ARTICLE 22 - UNCORRECTED FAULTY WORK

Should the correction of faulty or damaged work be considered inadvisable or inexpedient by the owner and the designer, the owner shall be reimbursed by the contractor. A change order will be issued to reflect a reduction in the contract sum.

ARTICLE 23 - TIME OF COMPLETION, DELAYS, EXTENSION OF TIME

- a. The time of completion is stated in the Supplementary General Conditions and in the Form of Construction Contract. The Project Expediter, upon notice of award of contract, shall prepare a construction schedule to complete the project within the time of completion as required by Article 14.
- b. The contractors shall commence work to be performed under this agreement on a date to be specified in a written Notice to Proceed from the designer and shall fully complete all work hereunder within the time of completion stated. Time is of the essence and the contractor acknowledges the Owner will likely suffer financial damage for failure to complete the work within the time of completion. For each day in excess of the above number of days, the contractor(s) shall pay the owner the sum stated as liquidated damages reasonably estimated in advance to cover the losses to be incurred by the owner by reason of failure of said contractor(s) to complete the work within the time specified, such time being in the essence of this contract and a material consideration thereof.
- c. In the event of multiple prime contractors, the designer shall be the judge as to the division of responsibility between the contractor(s), based on the construction schedule, weekly reports and job records, and shall apportion the amount of liquidated damages to be paid by each of them, according to delay caused by any or all of them.
- d. If the contractor is delayed at any time in the progress of his work solely by any act or negligence of the owner, the designer, or by any employee of either; by any separate contractor employed by the owner; by changes ordered in the work; by labor disputes at the project site; by abnormal weather conditions not reasonably anticipated for the locality where the work is performed; by unavoidable casualties; by any causes beyond the contractor's control; or by any other causes which the designer and owner determine may justify the delay, then the contract time may be extended by change order only for the time which the designer and owner may determine is reasonable.

Time extensions will not be granted for rain, wind, snow or other natural phenomena of normal intensity for the locality where work is performed. For purpose of determining extent of delay attributable to unusual weather phenomena, a determination shall be made by comparing the weather for the contract period involved with the average of the preceding five (5) year climatic range during the same time interval based on the National Oceanic and Atmospheric Administration National Weather Service statistics for the locality where work is performed and on daily weather logs kept on the job site by the contractor reflecting the effect of the weather on progress of the work and initialed by the designer's representative. No weather delays shall be considered after the building is dried in unless work claimed to be delayed is on the critical path of the baseline schedule or approved updated schedule. Time extensions for weather delays, acts of God, labor disputes, fire, delays in transportation, unavoidable casualties or other delays which are beyond the control of the Owner do not entitle the Contractor to compensable damages for delays. Any contractor claim for compensable damages for delays is limited to delays caused solely by the owner or its agents. Contractor caused delays shall be accounted for before owner or designer caused delays in the case of concurrent delays.

- e. Request for extension of time shall be made in writing to the designer, copies to the owner and SCO, within twenty (20) days following cause of delay. In case of continuing cause for delay, the Contractor shall notify the Designer to the designer, copies to the owner and SCO, of the delay within 20 days of the beginning of the delay and only one claim is necessary.
- f. The contractor shall notify his surety in writing of extension of time granted.
- g. No claim for time extension shall be allowed on account of failure of the designer to furnish drawings or instructions until twenty (20) days after demand for such drawings and/or instructions. See Article 5c. Demand must be in written form clearly stating the potential for delay unless the drawings or instructions are provided. Any delay granted will begin after the twenty (20) day demand period is concluded.

ARTICLE 24 - PARTIAL UTILIZATION/BENEFICIAL OCCUPANCY

- a. The owner may desire to occupy or utilize all or a portion of the project prior to the completion of the project.
- b. Should the owner request a utilization of a building or portion thereof, the designer shall perform a designer final inspection of area after being notified by the contractor that the area is ready for such. After the contractor has completed designer final inspection punch list and the designer has verified, then the designer shall schedule a beneficial occupancy inspection at a time and date acceptable to the owner, contractor(s) and State Construction Office. If beneficial occupancy is granted by the State Construction Office, in such areas the following will be established:
 - 1. The beginning of guarantees and warranties period for the equipment necessary to support. in the area.
 - 2. The owner assumes all responsibilities for utility costs for entire building.
 - 2. Contractor will obtain consent of surety.
 - 3. Contractor will obtain endorsement from insurance company permitting beneficial occupancy.
- c. The owner shall have the right to exclude the contractor from any part of the project which the designer has so certified to be substantially complete, but the owner will allow the contractor reasonable access to complete or correct work to bring it into compliance with the contract.
- d. Occupancy by the owner under this article will in no way relieve the contractor from his contractual requirement to complete the project within the specified time. The contractor will not be relieved of liquidated damages because of beneficial occupancy. The designer may prorate liquidated damages based on the percentage of project occupied.

ARTICLE 25 - FINAL INSPECTION, ACCEPTANCE, AND PROJECT CLOSEOUT

- a. Upon notification from the contractor(s) that the project is complete and ready for inspection, the designer shall make a Designer final inspection to verify that the project is complete and ready for SCO final inspection. Prior to SCO final inspection, the contractor(s) shall complete all items requiring corrective measures noted at the Designer

final inspection. The designer shall schedule a SCO final inspection at a time and date acceptable to the owner, contractor(s) and State Construction Office.

- b. At the SCO final inspection, the designer and his consultants shall, if job conditions warrant, record a list of items that are found to be incomplete or not in accordance with the contract documents. At the conclusion of the SCO final inspection, the designer and State Construction Office representative shall make one of the following determinations:
 - 1. That the project is completed and accepted.
 - 2. That the project will be accepted subject to the correction of the list of discrepancies (punch list). All punch list items must be completed within thirty (30) days of SCO final inspection or the owner may invoke Article 28, Owner's Right to Do Work.
 - 4. That the project is not complete and another date for a SCO final inspection will be established.
- c. Within fourteen (14) days of final acceptance per Paragraph b1 or within fourteen (14) days after completion of punch list per Paragraph b2 above, the designer shall certify the work and issue applicable certificate(s) of compliance.
- d. Any discrepancies listed or discovered after the date of SCO final inspection and acceptance under Paragraphs b1 or b2 above shall be handled in accordance with Article 42, Guarantee.
- f. The final acceptance date will establish the following:
 - 1. The beginning of guarantees and warranties period.
 - 2. The date on which the contractor's insurance coverage for public liability, property damage and builder's risk may be terminated.
 - 3. That no liquidated damages (if applicable) shall be assessed after this date.
 - 4. The termination date of utility cost to the contractor.
- g. **Prior to issuance of final acceptance date, the contractor shall have his authorized representatives visit the project and give full instructions to the designated personnel regarding operating, maintenance, care, and adjustment of all equipment and special construction elements. In addition, the contractor shall provide to the owner a complete instructional video (media format acceptable to the owner) on the operation, maintenance, care and adjustment of all equipment and special construction elements.**

ARTICLE 26 - CORRECTION OF WORK BEFORE FINAL PAYMENT

- a. Any work, materials, fabricated items or other parts of the work which have been condemned or declared not in accordance with the contract by the designer shall be promptly removed from the work site by the contractor, and shall be immediately replaced by new work in accordance with the contract at no additional cost to the owner. Work or property of other contractors or the owner, damaged or destroyed by virtue of such faulty work, shall be made good at the expense of the contractor whose work is faulty.

- b. Correction of condemned work described above shall commence within twenty-four (24) hours after receipt of notice from the designer, and shall make satisfactory progress, as determined by the designer, until completed.
- c. Should the contractor fail to proceed with the required corrections, then the owner may complete the work in accordance with the provisions of Article 28.

ARTICLE 27 - CORRECTION OF WORK AFTER FINAL PAYMENT

See Article 35, Performance Bond and Payment Bond, and Article 42, Guarantee. Neither the final certificate, final payment, occupancy of the premises by the owner, nor any provision of the contract, nor any other act or instrument of the owner, nor the designer, shall relieve the contractor from responsibility for negligence, or faulty material or workmanship, or failure to comply with the drawings and specifications. Contractor shall correct or make good any defects due thereto and repair any damage resulting there from, which may appear during the guarantee period following final acceptance of the work except as stated otherwise under Article 42, Guarantee. The owner will report any defects as they may appear to the contractor and establish a time limit for completion of corrections by the contractor. The owner will be the judge as to the responsibility for correction of defects.

ARTICLE 28 - OWNER'S RIGHT TO DO WORK

If, during the progress of the work or during the period of guarantee, the contractor fails to prosecute the work properly or to perform any provision of the contract, the owner, after seven (7) days' written notice sent by certified mail, return receipt requested, to the contractor from the designer, may perform or have performed that portion of the work. The cost of the work may be deducted from any amounts due or to become due to the contractor, such action and cost of same having been first approved by the designer. Should the cost of such action of the owner exceed the amount due or to become due the contractor, then the contractor or his surety, or both, shall be liable for and shall pay to the owner the amount of said excess.

ARTICLE 29 - ANNULMENT OF CONTRACT

If the contractor fails to begin the work under the contract within the time specified, or the progress of the work is not maintained on schedule, or the work is not completed within the time above specified, or fails to perform the work with sufficient workmen and equipment or with sufficient materials to ensure the prompt completion of said work, or shall perform the work unsuitably or shall discontinue the prosecution of the work, or if the contractor shall become insolvent or be declared bankrupt or commit any act of bankruptcy or insolvency, or allow any final judgment to stand against him unsatisfied for a period of forty-eight (48) hours, or shall make an assignment for the benefit of creditors, or for any other cause whatsoever shall not carry on the work in an acceptable manner, the owner may give notice in writing, sent by certified mail, return receipt requested, to the contractor and his surety of such delay, neglect or default, specifying the same, and if the contractor within a period of seven (7) days after such notice shall not proceed in accordance therewith, then the owner shall, declare this contract in default, and, thereupon, the surety shall promptly take over the work and complete the performance of this contract in the manner and within the time frame specified. In the event the surety shall fail to take over the work to be done under this contract within seven (7) days after being so notified and notify the owner in writing, sent by certified mail, return receipt requested, that he is taking the same over and stating that he will diligently pursue and complete the same, the owner shall have full power and authority, without violating the contract, to take the prosecution of the work out of the hands of said contractor, to appropriate or use any or all contract materials and equipment on the grounds as may be suitable and acceptable and may enter into an agreement, either by public letting or negotiation, for the completion of said contract according to the terms and provisions thereof

or use such other methods as in his opinion shall be required for the completion of said contract in an acceptable manner. All costs and charges incurred by the owner, together with the costs of completing the work under contract, shall be deducted from any monies due or which may become due said contractor and surety. In case the expense so incurred by the owner shall be less than the sum which would have been payable under the contract, if it had been completed by said contractor, then the said contractor and surety shall be entitled to receive the difference, but in case such expense shall exceed the sum which would have been payable under the contract, then the contractor and the surety shall be liable and shall pay to the owner the amount of said excess.

ARTICLE 30 - CONTRACTOR'S RIGHT TO STOP WORK OR TERMINATE THE CONTRACT

- a. Should the work be stopped by order of a court having jurisdiction, or by order of any other public authority for a period of three months, due to cause beyond the fault or control of the contractor, or if the owner should fail or refuse to make payment on account of a certificate issued by the designer within forty-five (45) days after receipt of same, then the contractor, after fifteen (15) days' written notice sent by certified mail, return receipt requested, to the owner and the designer, may suspend operations on the work or terminate the contract.
- b. The owner shall be liable to the contractor for the cost of all materials delivered and work performed on this contract plus 10 percent overhead and profit and shall make such payment. The designer shall be the judge as to the correctness of such payment.

ARTICLE 31 - REQUEST FOR PAYMENT

- a. Not later than the fifth day of the month, the contractor shall submit to the designer a request for payment for work done during the previous month. The request shall be in the form agreed upon between the contractor and the designer, but shall show substantially the value of work done and materials delivered to the site during the period since the last payment, and shall sum up the financial status of the contract with the following information:
 1. Total of contract including change orders.
 2. Value of work completed to date.
 3. Less five percent (5%) retainage, provided however, that after fifty percent (50%) of the contractor's work has been satisfactorily completed on schedule, with approval of the owner and the State Construction Office and written consent of the surety, further requirements for retainage will be waived only so long as work continues to be completed satisfactorily and on schedule.
 4. Less previous payments.
 5. Current amount due.
- b. The contractor, upon request of the designer, shall substantiate the request with invoices of vouchers or payrolls or other evidence.
- c. Prior to submitting the first request, the contractor shall prepare for the designer a schedule showing a breakdown of the contract price into values of the various parts of the work, so arranged as to facilitate payments to subcontractors in accordance with Article 17, Contractor and Subcontractor Relationships. The contractor(s) shall list the

value of each subcontractor and supplier, identifying each minority business subcontractor and supplier as listed in Affidavit C, if applicable.

- d. When payment is made on account of stored materials and equipment, such materials must be stored on the owner's property, and the requests for payments shall be accompanied by invoices or bills of sale or other evidence to establish the owner's title to such materials and equipment. Such payments will be made only for materials that have been customized or fabricated specifically for this project. Raw materials or commodity products including but not limited to piping, conduit, CMU, metal studs and gypsum board may not be submitted. Responsibility for such stored materials and equipment shall remain with the contractor regardless of ownership title. Such stored materials and equipment shall not be removed from the owner's property. Should the space for storage on-site be limited, the contractor, at his option, shall be permitted to store such materials and/or equipment in a suitable space off-site. Should the contractor desire to include any such materials or equipment in his application for payment, they must be stored in the name of the owner in an independent, licensed, bonded warehouse approved by the designer, owner and the State Construction Office and located as close to the site as possible. The warehouse selected must be approved by the contractor's bonding and insurance companies; the material to be paid for shall be assigned to the owner and shall be inspected by the designer. Upon approval by the designer, owner and SCO of the storage facilities and materials and equipment, payment therefore will be certified. Responsibility for such stored materials and equipment shall remain with the contractor. Such stored materials and equipment shall not be moved except for transportation to the project site. Under certain conditions, the designer may approve storage of materials at the point of manufacture, which conditions shall be approved by the designer, the owner and the State Construction Office prior to approval for the storage and shall include an agreement by the storing party which unconditionally gives the State absolute right to possession of the materials at anytime. Bond, security and insurance protection shall continue to be the responsibility of the contractor(s).
- e. In the event of beneficial occupancy, retainage of funds due the contractor(s) may be reduced with the approval of the State Construction Office to an equitable amount to cover the list of items to be completed or corrected. Retainage may not be reduced to less than two and one-half (2 1/2) times the estimated value of the work to be completed or corrected. Reduction of retainage must be with the consent and approval of the contractor's bonding company.

ARTICLE 32 - CERTIFICATES OF PAYMENT AND FINAL PAYMENT

- a. Within five (5) days from receipt of request for payment from the contractor, the designer shall issue and forward to the owner a certificate for payment. This certificate shall indicate the amount requested or as approved by the designer. If the certificate is not approved by the designer, he shall state in writing to the contractor and the owner his reasons for withholding payment.
- b. No certificate issued or payment made shall constitute an acceptance of the work or any part thereof. The making and acceptance of final payment shall constitute a waiver of all claims by the owner except:
 - 1. Claims arising from unsettled liens or claims against the contractor.
 - 2. Faulty work or materials appearing after final payment.
 - 3. Failure of the contractor to perform the work in accordance with drawings and specifications, such failure appearing after payment.

4. As conditioned in the performance bond and payment bond.
- c. The making and acceptance of final payment shall constitute a waiver of all claims by the contractor except those claims previously made and remaining unsettled (Article 20(c)).
- d. Prior to submitting request for final payment to the designer for approval, the contractor shall fully comply with all requirements specified in the “project closeout” section of the specifications. These requirements include but not limited to the following:
 1. Submittal of Product and Operating Manuals, Warranties and Bonds, Guarantees, Maintenance Agreements, As-Built Drawings, Certificates of Inspection or Approval from agencies having jurisdiction. (The designer must approve the Manuals prior to delivery to the owner).
 2. Transfer of Required attic stock material and all keys in an organized manner.
 3. Record of Owner’s training.
 4. Resolution of any final inspection discrepancies.
 5. Granting access to Contractor’s records, if Owner’s internal auditors have made a request for such access pursuant to Article 52.
- e. The contractor shall forward to the designer, the final application for payment along with the following documents:
 1. List of minority business subcontractors and material suppliers showing breakdown of contract amounts and total actual payments to subs and material suppliers.
 2. Affidavit of Release of Liens.
 3. Affidavit of contractors of payment to material suppliers and subcontractors. (See Article 36).
 4. Consent of Surety to Final Payment.
 5. Certificates of state agencies required by state law.
- f. The designer will not authorize final payment until the work under contract has been certified by designer, certificates of compliance issued, and the contractor has complied with the closeout requirements. The designer shall forward the contractor’s final application for payment to the owner along with respective certificate(s) of compliance required by law.

ARTICLE 33 - PAYMENTS WITHHELD

- a. The designer with the approval of the State Construction Office may withhold payment for the following reasons:
 1. Faulty work not corrected.

2. The unpaid balance on the contract is insufficient to complete the work in the judgment of the designer.
 3. To provide for sufficient contract balance to cover liquidated damages that will be assessed.
- b. The secretary of the Department of Administration may authorize the withholding of payment for the following reasons:
 1. Claims filed against the contractor or evidence that a claim will be filed.
 2. Evidence that subcontractors have not been paid.
 - c. The Owner may withhold all or a portion of Contractor's general conditions costs set forth in the approved schedule of values, if Contractor has failed to comply with: (1) a request to access its records by Owner's internal auditors pursuant to Article 52; (2) a request for a plan of action and/or recovery schedule under Article 14.j or provide The Owner; (3) a request to provide an electronic copies of Contractor's baseline schedule, updates with all logic used to create the schedules in the original format of the scheduling software; and (4) Contractor's failure to have its Superintendent on the Project full-time; (
 - d. When grounds for withholding payments have been removed, payment will be released. Delay of payment due the contractor without cause will make owner liable for payment of interest to the contractor in accordance with G.S. 143-134.1. As provided in G.S.143-134.1(e) the owner shall not be liable for interest on payments withheld by the owner for unsatisfactory job progress, defective construction not remedied, disputed work, or third-party claims filed against the owner or reasonable evidence that a third-party claim will be filed.

ARTICLE 34 - MINIMUM INSURANCE REQUIREMENTS

The work under this contract shall not commence until the contractor has obtained all required insurance and verifying certificates of insurance have been approved in writing by the owner. These certificates shall document that coverages afforded under the policies will not be cancelled, reduced in amount or coverages eliminated until at least thirty (30) days after mailing written notice, by certified mail, return receipt requested, to the insured and the owner of such alteration or cancellation. If endorsements are needed to comply with the notification or other requirements of this article copies of the endorsements shall be submitted with the certificates.

a. Worker's Compensation and Employer's Liability

The contractor shall provide and maintain, until final acceptance, workmen's compensation insurance, as required by law, as well as employer's liability coverage with minimum limits of \$100,000.

b. Public Liability and Property Damage

The contractor shall provide and maintain, until final acceptance, comprehensive general liability insurance, including coverage for premises operations, independent contractors, completed operations, products and contractual exposures, as shall protect such contractors from claims arising out of any bodily injury, including accidental death, as well as from claims for property damages which may arise from operations under this contract, whether such operations be by the contractor or by any subcontractor, or by

anyone directly or indirectly employed by either of them and the minimum limits of such insurance shall be as follows:

Bodily Injury:	\$500,000 per occurrence
Property Damage:	\$100,000 per occurrence / \$300,000 aggregate

In lieu of limits listed above, a \$500,000 combined single limit shall satisfy both conditions.

Such coverage for completed operations must be maintained for at least two (2) years following final acceptance of the work performed under the contract.

c. Property Insurance (Builder's Risk/Installation Floater)

The contractor shall purchase and maintain property insurance until final acceptance, upon the entire work at the site to the full insurable value thereof. This insurance shall include the interests of the owner, the contractor, the subcontractors and sub-subcontractors in the work and shall insure against the perils of fire, wind, rain, flood, extended coverage, and vandalism and malicious mischief. If the owner is damaged by failure of the contractor to purchase or maintain such insurance, then the contractor shall bear all reasonable costs properly attributable thereto; the contractor shall effect and maintain similar property insurance on portions of the work stored off the site when request for payment per articles so includes such portions.

d. Deductible

Any deductible, if applicable to loss covered by insurance provided, is to be borne by the contractor.

e. Other Insurance

The contractor shall obtain such additional insurance as may be required by the owner or by the General Statutes of North Carolina including motor vehicle insurance, in amounts not less than the statutory limits.

f. Proof of Carriage

The contractor shall furnish the owner with satisfactory proof of carriage of the insurance required before written approval is granted by the owner.

ARTICLE 35 - PERFORMANCE BOND AND PAYMENT BOND

- a. Each contractor shall furnish a performance bond and payment bond executed by a surety company authorized to do business in North Carolina. The bonds shall be in the full contract amount. Bonds shall be executed in the form bound with these specifications.
- b. All bonds shall be countersigned by an authorized agent of the bonding company who is licensed to do business in North Carolina.

ARTICLE 36 - CONTRACTOR'S AFFIDAVIT

The final payment of retained amount due the contractor on account of the contract shall not become due until the contractor has furnished to the owner through the designer an affidavit signed, sworn and notarized to the effect that all payments for materials, services or subcontracted work in connection with his contract have been satisfied, and that no claims or

liens exist against the contractor in connection with this contract. In the event that the contractor cannot obtain similar affidavits from subcontractors to protect the contractor and the owner from possible liens or claims against the subcontractor, the contractor shall state in his affidavit that no claims or liens exist against any subcontractor to the best of his (the contractor's) knowledge, and if any appear afterward, the contractor shall save the owner harmless.

ARTICLE 37 - ASSIGNMENTS

The contractor shall not assign any portion of this contract nor subcontract in its entirety. Except as may be required under terms of the performance bond or payment bond, no funds or sums of money due or become due the contractor under the contract may be assigned.

ARTICLE 38 - USE OF PREMISES

- a. The contractor(s) shall confine his apparatus, the storage of materials and the operations of his workmen to limits indicated by law, ordinances, permits or directions of the designer and owner and shall not exceed those established limits in his operations.
- b. The contractor(s) shall not load or permit any part of the structure to be loaded with a weight that will endanger its safety.
- c. The contractor(s) shall enforce the designer's and owner's instructions regarding signs, advertisements, fires and smoking.
- d. No firearms, any type of alcoholic beverages, or drugs (other than those prescribed by a physician) will be permitted at the job site.

ARTICLE 39 - CUTTING, PATCHING AND DIGGING

- a. The contractor shall do all cutting, fitting or patching of his work that may be required to make its several parts come together properly and fit it to receive or be received by work of other contractors shown upon or reasonably implied by the drawings and specifications for the completed structure, as the designer may direct.
- b. Any cost brought about by defective or ill-timed work shall be borne by the party responsible therefor.
- c. No contractor shall endanger any work of another contractor by cutting, digging or other means. No contractor shall cut or alter the work of any other contractor without the consent of the designer and the affected contractor(s).

ARTICLE 40 - UTILITIES, STRUCTURES, SIGNS

- a. The contractor shall provide necessary and adequate facilities for water, electricity, gas, oil, sewer and other utility services which maybe necessary and required for completion of the project including all utilities required for testing, cleaning, balancing, and sterilization of designated plumbing, mechanical and electrical systems. Any permanent meters installed shall be listed in the contractor's name until work has a final acceptance. The contractor will be solely responsible for all utility costs prior to final acceptance. Contractor shall contact all affected utility companies prior to bid to determine their requirements to provide temporary and permanent service and include all costs associated with providing those services in their bid. Coordination of the work of the utility companies during construction is the sole responsibility of the contractor.

- b. Meters shall be relisted in the owner's name on the day following final acceptance of the Project Expediter's work, and the owner shall pay for services used after that date.
- c. The owner shall be reimbursed for all metered utility charges after the meter is relisted in the owner's name and prior to completion and acceptance of the work of **all** contractors. Reimbursement shall be made by the contractor whose work has not been completed and accepted. If the work of two or more contractors has not been completed and accepted, reimbursement to the owner shall be paid by the contractors involved on the basis of assessments by the designer.
- d. Prior to the operation of permanent systems, the Project Expediter will provide temporary power, lighting, water, and heat to maintain space temperature above freezing, as required for construction operations.
- e. All contractors shall have the permanent building systems in sufficient readiness for furnishing temporary climatic control at the time a building is enclosed and secured. The HVAC systems shall maintain climatic control throughout the enclosed portion of the building sufficient to allow completion of the interior finishes of the building. A building shall be considered enclosed and secured when windows, doorways (exterior, mechanical, and electrical equipment rooms), and hardware are installed; and other openings have protection which will provide reasonable climatic control. The appropriate time to start the mechanical systems and climatic condition shall be jointly determined by the contractor(s), the designer and owner. Use of the equipment in this manner shall be subject to the approval of the Designer and owner and shall in no way affect the warranty requirements of the contractor(s).
- f. The electrical contractor shall have the building's permanent power wiring distribution system in sufficient readiness to provide power as required by the HVAC contractor for temporary climatic control.
- g. The electrical contractor shall have the building's permanent lighting system ready at the time the general contractor begins interior painting and shall provide adequate lighting in those areas where interior painting and finishing is being performed.
- h. Each prime contractor shall be responsible for his permanently fixed service facilities and systems in use during progress of the work. The following procedures shall be strictly adhered to:
 - 1. Prior to final acceptance of work by the State Construction Office, each contractor shall remove and replace any parts of the permanent building systems damaged through use during construction.
 - 2. Temporary filters as recommended by the equipment manufacturer in order to keep the equipment and ductwork clean and free of dust and debris shall be installed in each of the heating and air conditioning units and at each return grille during construction. New filters shall be installed in each unit prior to the owner's acceptance of the work.
 - 3. Extra effort shall be maintained to keep the building and the site adjacent to the building clean and under no circumstances shall air systems be operated if finishing and site work operations are creating dust in excess of what would be considered normal if the building were occupied.
 - 4. It shall be understood that any warranty on equipment presented to the owner shall extend from the day of final acceptance by the owner. The cost of warranting the

equipment during operation in the finishing stages of construction shall be borne by the contractor whose system is utilized.

5. The electrical contractor shall have all lamps in proper working condition at the time of final project acceptance.
- i. The Project Expediter shall provide, if required and where directed, a shed for toilet facilities and shall furnish and install in this shed all water closets required for a complete and adequate sanitary arrangement. These facilities will be available to other contractors on the job and shall be kept in a neat and sanitary condition at all times. Chemical toilets are acceptable.
- j. The Project Expediter shall, if required by the Supplementary General Conditions and where directed, erect a temporary field office, complete with lights, telephone, heat and air conditioning. A portion of this office shall be partitioned off, of sufficient size, for the use of a resident inspector, should the designer so direct.
- k. On multi-story construction projects, the Project Expediter shall provide temporary elevators, lifts, or other special equipment for the general use of all contractors. The cost for such elevators, lifts or other special equipment and the operation thereof shall be included in the Project Expediter's bid.
- l. The Project Expediter will erect one sign on the project if required. The sign shall be of sound construction, and shall be neatly lettered with black letters on white background. The sign shall bear the name of the project, and the names of prime contractors on the project, and the name of the designer and consultants. Directional signs may be erected on the owner's property subject to approval of the owner with respect to size, style and location of such directional signs. Such signs may bear the name of the contractor and a directional symbol. No other signs will be permitted except by permission of the owner.

ARTICLE 41 - CLEANING UP

- a. The contractors shall keep the building and surrounding area reasonably free from rubbish at all times, and shall remove debris from the site on a timely basis or when directed to do so by the designer or Project Expediter. The Project Expediter shall provide an on site refuse container(s) for the use of all contractors. Each contractor shall remove their rubbish and debris from the building on a daily basis. The Project Expediter shall broom clean the building as required to minimize dust and dirt accumulation.
- b. The Project Expediter shall provide and maintain suitable all-weather access to the building.
- c. Before final inspection and acceptance of the building, each contractor shall clean his portion of the work, including glass, hardware, fixtures, masonry, tile and marble (using no acid), clean and wax all floors as specified, and completely prepare the building for use by the owner, with no cleaning required by the owner.

ARTICLE 42 - GUARANTEE

- a. The contractor shall unconditionally guarantee materials and workmanship against patent defects arising from faulty materials, faulty workmanship or negligence for a period of twelve (12) months following the date of final acceptance of the work or beneficial occupancy and shall replace such defective materials or workmanship without cost to the owner.

- b. Where items of equipment or material carry a manufacturer's warranty for any period in excess of twelve (12) months, then the manufacturer's warranty shall apply for that particular piece of equipment or material. The contractor shall replace such defective equipment or materials, without cost to the owner, within the manufacturer's warranty period.
- c. Additionally, the owner may bring an action for latent defects caused by the negligence of the contractor which is hidden or not readily apparent to the owner at the time of beneficial occupancy or final acceptance, whichever occurred first, in accordance with applicable law.
- d. Guarantees for roof, equipment, materials, and supplies shall be stipulated in the specifications sections governing such roof, equipment, materials, or supplies.

ARTICLE 43 - CODES AND STANDARDS

Wherever reference is given to codes, standard specifications or other data published by regulating agencies including, but not limited to, national electrical codes, North Carolina state building codes, federal specifications, ASTM specifications, various institute specifications, etc., it shall be understood that such reference is to the latest edition including addenda published prior to the date of the contract documents.

ARTICLE 44 - INDEMNIFICATION

To the fullest extent permitted by law, the contractor shall indemnify and hold harmless the owner, the designer and the agents, consultants and employees of the owner and designer, from and against all claims, damages, losses and expenses, including, but not limited to, attorneys' fees, arising out of or resulting from the performance or failure of performance of the work, provided that any such claim, damage, loss or expense (1) is attributable to bodily injury, sickness, disease or death, or to injury to or destruction of tangible property (other than the work itself) including the loss of use resulting there from, and (2) is caused in whole or in part by any negligent act or omission of the contractor, the contractor's subcontractor, or the agents of either the contractor or the contractor's subcontractor. Such obligation shall not be construed to negate, abridge or otherwise reduce any other right or obligation of indemnity which would otherwise exist as to any party or person described in this article.

ARTICLE 45 - TAXES

- a. Federal excise taxes do not apply to materials entering into state work (Internal Revenue Code, Section 3442(3)).
- b. Federal transportation taxes do not apply to materials entering into state work (Internal Revenue Code, Section 3475(b) as amended).
- c. North Carolina sales tax and use tax, as required by law, do apply to materials entering into state work and such costs shall be included in the bid proposal and contract sum.
- d. Local option sales and use taxes, as required by law, do apply to materials entering into state work as applicable and such costs shall be included in the bid proposal and contract sum.
- e. **Accounting Procedures for Refund of County Sales & Use Tax**

Amount of county sales and use tax paid per contractor's statements:

Contractors performing contracts for state agencies shall give the state agency for whose project the property was purchased a signed statement containing the information listed in G.S. 105-164.14(e).

The Department of Revenue has agreed that in lieu of obtaining copies of sales receipts from contractors, an agency may obtain a certified statement as of April 1, 1991 from the contractor setting forth the date, the type of property and the cost of the property purchased from each vendor, the county in which the vendor made the sale and the amount of local sales and use taxes paid thereon. If the property was purchased out-of-state, the county in which the property was delivered should be listed. The contractor should also be notified that the certified statement may be subject to audit.

In the event the contractors make several purchases from the same vendor, such certified statement must indicate the invoice numbers, the inclusive dates of the invoices, the total amount of the invoices, the counties, and the county sales and use taxes paid thereon.

Name of taxing county: The position of a sale is the retailer's place of business located within a taxing county where the vendor becomes contractually obligated to make the sale. Therefore, it is important that the county tax be reported for the county of sale rather than the county of use.

When property is purchased from out-of-state vendors and the county tax is charged, the county should be identified where delivery is made when reporting the county tax.

Such statement must also include the cost of any tangible personal property withdrawn from the contractor's warehouse stock and the amount of county sales or use tax paid thereon by the contractor.

Similar certified statements by his subcontractors must be obtained by the general contractor and furnished to the claimant.

Contractors are not to include any tax paid on supplies, tools and equipment which they use to perform their contracts and should include only those building materials, supplies, fixtures and equipment which actually become a part of or annexed to the building or structure.

ARTICLE 46 - EQUAL OPPORTUNITY CLAUSE

The non-discrimination clause contained in Section 202 (Federal) Executive Order 11246, as amended by Executive Order 11375, relative to equal employment opportunity for all persons without regard to race, color, religion, sex or national origin, and the implementing rules and regulations prescribed by the secretary of Labor, are incorporated herein.

ARTICLE 47 - EMPLOYMENT OF INDIVIDUALS WITH DISABILITIES

The contractor(s) agree not to discriminate against any employee or applicant for employment because of physical or mental disabilities in regard to any position for which the employee or applicant is qualified. The contractor agrees to take affirmative action to employ, advance in employment and otherwise treat qualified individuals with such disabilities without discrimination based upon their physical or mental disability in all employment practices.

ARTICLE 48 - ASBESTOS-CONTAINING MATERIALS (ACM)

The State of North Carolina has attempted to address all asbestos-containing materials that are to be disturbed in the project. However, there may be other asbestos-containing materials in the work areas that are not to be disturbed and do not create an exposure hazard.

Contractors are reminded of the requirements of instructions under Instructions to Bidders and General Conditions of the Contract, titled Examination of Conditions. Statute 130A, Article 19, amended August 3, 1989, established the Asbestos Hazard Management Program that controls asbestos abatement in North Carolina. The latest edition of *Guideline Criteria for Asbestos Abatement* from the State Construction Office is to be incorporated in all asbestos abatement projects for the Capital Improvement Program.

ARTICLE 49 - MINORITY BUSINESS PARTICIPATION

GS 143-128.2 establishes a ten percent (10%) goal for participation by minority businesses in total value of work for each State building project. The document, *Guidelines for Recruitment and Selection of Minority Businesses for Participation in State Construction Contracts* including Affidavits and Appendix E are hereby incorporated into and made a part of this contract.

ARTICLE 50 – CONTRACTOR EVALUATION

The contractor's overall work performance on the project shall be fairly evaluated in accordance with the State Building Commission policy and procedures, for determining qualifications to bid on future State capital improvement projects. In addition to final evaluation, interim evaluation may be prepared during the progress of project. The document, Contractor Evaluation Procedures, is hereby incorporated and made a part of this contract. The owner may request the contractor's comments to evaluate the designer.

ARTICLE 51 – GIFTS

Pursuant to N.C. Gen. Stat. § 133-32, it is unlawful for any vendor or contractor (i.e. architect, bidder, contractor, construction manager, design professional, engineer, subcontractor, supplier, vendor, etc.), to make gifts or to give favors to any State employee. This prohibition covers those vendors and contractors who: (1) have a contract with a governmental agency; or (2) have performed under such a contract within the past year; or (3) anticipate bidding on such a contract in the future. For additional information regarding the specific requirements and exemptions, vendors and contractors are encouraged to review G.S. Sec. 133-32.

During the construction of the Project, the Contractor is prohibited from making gifts to any of the Owner's employees, Owner's project representatives (architect, engineers, construction manager and their employees), employees of the State Construction Office and/or any other State employee that may have any involvement, influence, responsibilities, oversight, management and/or duties that pertain to and/or relate to the contract administration, financial administration and/or disposition of claims arising from and/or relating to the Contract and/or Project.

ARTICLE 52 – AUDITING-ACCESS TO PERSONS AND RECORDS

In accordance with N.C. General Statute 147-64.7, the State Auditor shall have access to Contractor's officers, employees, agents and/or other persons in control of and/or responsible for the Contractor's records that relate to this Contracts for purposes of conducting audits under the referenced statute. The Owner's internal auditors shall also have the right to access and copy the Contractor's records relating to the Contract and Project during the term of the Contract and within two years following the completion of the Project/close-out of the Contract to verify accounts, accuracy, information, calculations and/or data affecting and/or

relating to Contractor's requests for payment, requests for change orders, change orders, claims for extra work, requests for time extensions and related claims for delay/extended general conditions costs, claims for lost productivity, claims for loss efficiency, claims for idle equipment or labor, claims for price/cost escalation, pass-through claims of subcontractors and/or suppliers, and/or any other type of claim for payment or damages from Owner and/or its project representatives.

ARTICLE 53 – NORTH CAROLINA FALSE CLAIMS ACT

The North Carolina False Claims Act ("NCFCA"), N.C. Gen. Stat. § 1-605 through 1-618, applies to this Contract. The Contractor should familiarize itself with the entire NCFCA and should seek the assistance of an attorney if it has any questions regarding the NCFCA and its applicability to any requests, demands and/or claims for payment it submits to the State through the contracting state agency, institution, university or community college.

The purpose of the NCFCA "is to deter persons from knowingly causing or assisting in causing the State to pay claims that are false or fraudulent and to provide remedies in the form of treble damages and civil penalties when money is obtained from the State by reason of a false or fraudulent claim." (Section 1-605(b).) A contractor's liability under the NCFCA may arise from, but is not limited to: requests for payment, invoices, billing, claims for extra work, requests for change orders, requests for time extensions, claims for delay damages/extended general conditions costs, claims for lost productivity, claims for loss efficiency, claims for idle equipment or labor, claims for price/cost escalation, pass-through claims of subcontractors and/or suppliers, documentation used to support any of the foregoing requests or claims, and/or any other request for payment from the State through the contracting state agency, institution, university or community college. The parts of the NCFCA that are most likely to be enforced with respect to this type of contract are as follows:

- A "claim" is "[a]ny request or demand, whether under a contract or otherwise, for money or property and whether or not the State has title to the money or property that (i) is presented to an officer, employee, or agent of the State or (ii) is made to a contractor ... if the money or property is to be spent or used on the State's behalf or to advance a State program or interest and if the State government: (a) provides or has provided any portion of the money or property that is requested or demanded; or (b) will reimburse such contractor ... for any portion of the money or property which is requested or demanded." (Section 1-606(2).)
- "Knowing" and "knowingly." – Whenever a person, with respect to information, does any of the following: (a) Has actual knowledge of the information; (b) Acts in deliberate ignorance of the truth or falsity of the information; and/or (c) Acts in reckless disregard of the truth or falsity of the information. (Section 1-606(4).) Proof of specific intent to defraud is not required. (Section 1-606(4).)
- "Material" means having a natural tendency to influence, or be capable of influencing, the payment or receipt of money or property. (Section 1-606(4).)
- Liability. – "Any person who commits any of the following acts shall be liable to the State for three times the amount of damages that the State sustains because of the act of that person[:] ... (1) Knowingly presents or causes to be presented a false or fraudulent claim for payment or approval. (2) Knowingly makes, uses, or causes to be made or used, a false record or statement material to a false or fraudulent claim. (3) Conspires to commit a violation of subdivision (1), (2) ..." (Section 1-607(a)(1), (2).)

- The NCFCA shall be interpreted and construed so as to be consistent with the federal False Claims Act, 31 U.S.C. § 3729, et seq., and any subsequent amendments to that act. (Section 1-616(c).)

Finally, the contracting state agency, institution, university or community college may refer any suspected violation of the NCFCA by the Contractor to the Attorney General's Office for investigation. Under Section 1-608(a), the Attorney General is responsible for investigating any violation of NCFCA, and may bring a civil action against the Contractor under the NCFCA. The Attorney General's investigation and any civil action relating thereto are independent and not subject to any dispute resolution provision set forth in this Contract. (See Section 1-608(a).)

ARTICLE 54 – TERMINATION FOR CONVENIENCE

Owner may at any time and for any reason terminate Contractor's services and work at Owner's convenience. Upon receipt of such notice, Contractor shall, unless the notice directs otherwise, immediately discontinue the work and placing of orders for materials, facilities and supplies in connection with the performance of this Agreement.

Upon such termination, Contractor shall be entitled to payment only as follows: (1) the actual cost of the work completed in conformity with this Agreement; plus, (2) such other costs actually incurred by Contractor as are permitted by the prime contract and approved by Owner; (3) plus ten percent (10%) of the cost of the work referred to in subparagraph (1) above for overhead and profit. There shall be deducted from such sums as provided in this subparagraph the amount of any payments made to Contractor prior to the date of the termination of this Agreement. Contractor shall not be entitled to any claim or claim of lien against Owner for any additional compensation or damages in the event of such termination and payment.

SUPPLEMENTARY GENERAL CONDITIONS (SGC's) OF THE CONTRACT

STANDARD FORM FOR CONSTRUCTION CONTRACTS

NORTH CAROLINA STATE UNIVERSITY

1.0 SGC Article 1 – Definitions

- A. As defined in Article 1 of the General Conditions, the Supplementary General Conditions are considered part of the contract documents. The SGC's include this document and the following pages titled "SUPPLEMENTARY GENERAL CONDITIONS (SGC'S) OF THE CONTRACT, STAND FORM FOR CONSTRUCTION CONTRACTS, NORTH CAROLINA STATE UNIVERSITY", "NC State University Design and Construction Guidelines – Division 01 Contractor Safety Requirements" and "NC State University Design and Construction Guidelines – Division 01 NC State's Requirements."
- B. The Owner is the State of North Carolina through NC State University.
- C. The Designer referred to herein shall mean Wagner Architecture pllc, 92 Elam Court, New Hill, NC 27562.

END OF SECTION

**SUPPLEMENTARY GENERAL CONDITIONS
(SGC's) OF THE CONTRACT**

**STANDARD FORM FOR CONSTRUCTION
CONTRACTS**

**NORTH CAROLINA STATE
UNIVERSITY**

NC State University Design and Construction Guidelines

Supplementary General Conditions

SUPPLEMENTARY GENERAL CONDITIONS (SGC's) OF THE CONTRACT

The use or reproduction of this document or any part thereof is authorized for and limited to use on projects of North Carolina State University, and is distributed by, through and at the discretion of the University for that distinct and sole purpose. This document supplements but does not alter in any way the requirements of the General Conditions of the Contract.

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1.0 SGC Article 1 – Definitions

- A. As defined in Article 1 of the General Conditions, the Supplementary General Conditions are considered part of the contract documents.
- B. The Owner is the State of North Carolina through North Carolina State University.
- C. Provide shall mean purchase, deliver, and install, new, clean, and completely operational, fully tested and ready for use.

2.0 SGC Article 14 – Construction Supervision and Schedule

- A. The contractor(s) shall employ an engineer or a land surveyor licensed in the State of North Carolina to lay out the work and to establish a benchmark nearby in a location where same will not be disturbed and where direct instruments sights may be taken.
- B. The designer shall designate a Project Expediter on projects involving two or more prime contracts. The Project Expediter shall be the General Contractor unless determined otherwise by the designer. The Project Expediter shall have the responsibilities described in Article 14.f. of the General Conditions.
- C. Project Construction Schedule. North Carolina State University requires a CPM schedule for all projects, regardless of size and/or dollar amount. Bar Chart schedules may be allowed on a case-by-case basis. All CPM schedules shall meet the requirements of the General Conditions as well as the following:
 - 1. The CPM Baseline Schedule or Updated Schedule shall consist of the computer files on electronic media necessary to recreate the schedule. Files shall consist of four discrete items:
 - a) The Activity description including the original and remaining durations, and percent complete. Show other computed information such as early and late computed start and finish times and various types of floats.
 - b) The logical predecessor and successor relationships that connect the various activities together to form a CPM network. All activities shall be linked with no

NC State University Design and Construction Guidelines

Supplementary General Conditions

constraints placed on any activity unless critical milestone dates are dictated in the contract.

- c) Constraints listing if any must exist.
- d) All hidden codes or constraints assigned to activities by the Scheduler, which help define the intended workflow or project organization.
- 2. Each schedule submittal shall include a cover letter, a narrative, a hard copy of the schedule and the schedule files on electronic media. The schedule update narrative should state what activity changes happened on the project, including missing data, upcoming changes, documented delays, potential delays and other facts.
- 3. Contractors and subcontractors shall include a minimum of five (5) full days in their base bid for their project superintendent and project manager to attend a preliminary scheduling meeting with the project expediter. Each contractor shall attend additional scheduling meetings as required until an acceptable construction schedule conforming to the contract time is completed and approved via signing of the printed schedule by the single or each prime contractor (project manager and superintendent). Copies of the signed schedule shall be given to the Designer, Owner and each signatory; the original shall be displayed at the jobsite. The submitted schedule shall show the contract project completion date.
- 4. The schedule shall be updated monthly or at the Designer and/or Owner's request. The project expediter shall make all updates, adjustments, corrections, etc., with input provided from the other prime or subcontractors. It will be the responsibility of each prime and/or subcontractor to either agree or disagree with the updated schedule via signing and dating the schedule submitted by the project expediter or providing a written summary of schedule exceptions and/or inaccuracies.
- 5. Project expediter is required to provide an updated construction schedule with each monthly payment application. It will be the responsibility of each prime and/or subcontractor to either agree or disagree with the updated schedule via signing and dating the schedule submitted by the project expediter or providing a written summary of schedule exceptions and/or inaccuracies. Payment requests received without one or the other of the above will be considered incomplete and will be returned as being incomplete. The only contractor required to submit a copy of the updated progress schedule with his monthly payment application is the project expediter.
- 6. A completion or finish schedule is required at 80% project completion, illustrating tasks remaining to complete the project. The designer and Owner are required to approve finish schedule.
- 7. Project expediter shall include all relevant testing and inspections on the CPM schedule, including but not limited to: telecom/data wiring tests and as-built drawings, fire alarm system testing, fire suppression system testing, piping pressure testing, all applicable NFPA, DOI, DOL tests and commissioning activities.
- 8. The Contractor will schedule as Milestones in the CPM schedule and ensure they are met the following activities: MEPFP Coordination drawings, Casework and Fume Hood Submittals and shop drawings shall be submitted to the design team for review NO LATER than 30 days after the Notice To Proceed.

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3.0 SGC Article 23 - Time Of Completion, Delays, Extension of Time

- A. For each day in excess of the number of days shown below, the contractor(s) shall pay the owner liquidated damages in the amount of \$_____ per consecutive calendar day. [Designer and Owner to jointly determine amount of LD's based on specific project requirements.]

☐

This project does not include Commissioning

- B. The time of completion for this project is _____ consecutive calendar days and begins on the date stated in the Designer's Notice to Proceed letter issued to the contractor.

☐

This project includes Commissioning

- B. The time of completion to SUBSTANTIAL COMPLETION for this project is _____ consecutive calendar days and begins on the date stated in the Designer's Notice to Proceed letter issued to the contractor. SUBSTANTIAL COMPLETION for this project is defined as the General Contractor and its subcontractors having completed the following:

1. GC's Pre-Final Punch List
2. Testing Adjusting and Balancing (TAB) is complete per the project specifications.
3. Pre-Functional Testing shall be complete and the completed report shall be issued to the design team prior to SUBSTANTIAL COMPLETION.

For a period not to exceed _____ weeks following immediately after SUBSTANTIAL COMPLETION, the Owner's agents will perform Enhanced Start UP of MEP systems and punch list generation and back punch activities. The contractor will be responsible for assisting in all testing and punch activities including the completion of all adjusting, balancing, repairing, correcting, replacing and completing unacceptable or otherwise incomplete work identified by the design team.

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Supplementary General Conditions

4.0 SGC Article 40 – Utilities, Structures, Signs

- A. UTILITIES FOR NEW BUILDINGS - The Project Expediter will make arrangements with the appropriate utility service providers to provide temporary utilities to the site. The Project Expediter shall bear the costs of providing all temporary utilities to the site and all charges for temporary utilities during the project duration.
- B. UTILITIES FOR EXISTING BUILDINGS – The Project Expediter will make arrangements with either the appropriate utility service providers or with NCSU (if the existing building is already metered) to provide temporary utilities to the site. The University will bear the cost of all temporary utilities except the use of supplemental generators for power. The contractor may use what is available on site without affecting the ongoing operations of the Owner in any way, but may not request additional services that are not already present. Anything additional required by the contractor will be procured and paid for by the contractor

Electricity: \$_____/KWH (kilo-watt hour)

Water: \$_____/CCS (hundred cubic feet)

Steam: \$_____/thousand pounds

Natural gas: \$_____/deca-therm

NC State University Design and Construction Guidelines

Division 01 Contractor Safety Requirements

[Designer shall incorporate this document into the specification in its entirety.]

Safety Measures pertaining to COVID-19 Transmission

North Carolina State University is committed to preventing transmission of COVID-19 in our community. Safety protocols have been implemented throughout the university for faculty, staff, and students to prevent the spread of COVID-19. These protocols were developed based on guidance from the Centers for Disease Control and Prevention, the Occupational Safety and Health Administration, and the State of North Carolina. Contractors shall comply with any NC State, federal, state, or local mandates relative to the pandemic. The most stringent requirement shall be enforced, including those established by any contractor's corporate policy in place.

Face Coverings – Student Health Services and CVM Areas

Face coverings must be worn, tightly covering the mouth and nose, inside all buildings (even those under construction). Until further notice, NC State Student Health Services and the College of Veterinary Medicine (CVM) will require face coverings to be worn by contractors while indoors in any facility until further notice. Minimum expectation is that face coverings must be properly worn at all times while indoors; face coverings may be removed only while eating and/or drinking.

1.0 Purpose

- A. The purpose of this guideline is to define NC State contractor safety requirements. This guideline is intended to be a supplement to the General Conditions of the contract.
- B. The Designer shall incorporate this document into the Project Manual in its entirety.
- C. Contractors and subcontractors are responsible for the safety of their employees and all persons on and around a work site. Contractors are solely responsible for the development and implementation of their safety programs. This document does not relieve the duty and responsibility of contractors, subcontractors, their agents, employees, and other persons performing portions of the work on a project to comply with federal, state, and/or local laws or regulations that relate to work site safety.

2.0 Scope

- A. This document provides contractors with the University's specific requirements that must be incorporated into the contractor's Site-Specific Safety Plan. This document is not designed or intended to replace the contractor's safety program, nor to address every possible safety, environmental, or health hazard associated with the contractor's work. In the event that the contractor's safety program includes a requirement or practice that is more stringent than set forth herein, the more stringent shall be followed. This document does not relieve the contractor of this obligation to: (1) control the means and methods by which its employees, and any subcontractors perform work, and (2) independently ascertain what health and safety practices are necessary for the performance of the work.

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- B. No specific requirements herein shall be construed to limit, replace or supersede applicable provisions of federal, state, or local laws or regulations. [Occupational Safety and Health Administration \(OSHA\) Regulations; Standard Number 29 CFR 1926](#) are the foundation of these Guidelines.
- C. Deliverables
 - 1. Competent Person Designation (see attached form) (4.0/C)
 - 2. Verification of OSHA 30 or OSHA 10 compliance, based on project requirements. (4.0/D/1/b)
 - 3. Contractor Site Specific Safety Plan (SSSP). (4.0/I)
 - 4. Summary of the Daily Safety Inspections documented as part of regular project meeting minutes. (4.0/F/1)
 - 5. Monthly Safety Reports. (4.0/F/2)

3.0 Reference Materials

- A. The following reference materials are required to be available upon request at every job site:
 - 1. OSHA Regulations published by NC Department of Labor (DOL) (Available at: (800) NC-LABOR, <http://www.nclabor.com/pubs.htm>).
 - 2. Safety Data Sheets (SDS) for all chemical products the contractor has brought to the worksite.
 - 3. The written Safety Plan of the Contractor or Subcontractor.
 - 4. Site inspection documentation.
 - 5. Worksite employee training records.
 - 6. Mishap reports and investigations.

4.0 General Responsibilities

- A. The contractor must notify the NC State Project Manager in writing at least 10 days prior to:
 - 1. Utilizing powder-actuated tools
 - 2. Starting operations that will produce excessive odor, dust, noise affecting occupied buildings or work near air intakes
 - 3. Using a combustion engine indoors
 - 4. Using a mobile crane or tower crane (50-day notice is required)
 - 5. Breaking ground for an excavation or trench
 - 6. Using a laser
 - 7. Using any source of radioactive material
 - 8. Working with lead or asbestos containing materials
 - 9. Performing energized electrical work
 - 10. Working on or near active underground utility infrastructure (steam, chilled water, natural gas, water, etc.)
 - 11. Entering electrical distribution assets

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Violation of any safety, security, or environmental requirement may result in the permanent removal of the contractor or their employees from the NC State premises.

B. Construction Management

1. Contractor is responsible for compliance with all federal, state, and local laws, regulations, standards, executive orders, etc. applicable in part or whole pertaining to the scope of work.
2. Contractors are responsible for compliance with all applicable NC State safety practices, procedures, policies, standards, and requirements.
3. Contractors are responsible for providing qualified and competent personnel to perform activities under the scope of work. Contractors must provide documentation of training prior to beginning work on-site.
4. Contractors are responsible for ensuring that subcontractors, their agents, employees, visitors, and other persons performing portions of the work on a project comply with federal, state, and/or local laws or regulations that relate to work site safety.
5. Contractors are responsible for ensuring that subcontractors are informed of and comply with all applicable requirements within the scope of work.

C. Competent Person Designation

1. Contractors shall designate a competent person for activities as specified in OSHA 29 CFR 1926. Such activities include, but are not limited to, the following activities, as applicable to the job:
 - a) general provisions
 - b) ionizing/non-ionizing radiation
 - c) gases, vapors, fumes, mists, dusts
 - d) ventilation
 - e) hazard communication
 - f) lead
 - g) asbestos
 - h) personal protective equipment
 - i) hearing conservation
 - j) respiratory protection
 - k) rigging and material handling equipment
 - l) welding, cutting, brazing
 - m) electrical
 - n) scaffold
 - o) fall protection
 - p) cranes (overhead and mobile)
 - q) motor vehicles and equipment
 - r) excavations
 - s) concrete and masonry
 - t) steel erection
 - u) demolition

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- v) stairways and ladders
 - w) toxic and hazardous substances.
 - 2. OSHA 29 CFR 1926.32(f) "Competent person" means one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.
- D. Contractor Safety Personnel
 - 1. Safety Representative
 - a) For all projects contractors must designate a Safety Representative prior to the start of the project. The Safety Representative may be the Project Superintendent, and as such, must be onsite during any and all construction operations.
 - b) **For projects bid through Capital Project Management, the Safety Representative must have completed, at a minimum, an OSHA 30-hour Construction Safety Course. For projects bid through Construction Services, the safety representative must have completed, at a minimum, an OSHA 10-hour Construction Safety Course.**
 - c) The Safety Representative must actively monitor the jobsite for safety issues on a daily basis. The safety representative may have additional site duties outside the scope of safety; when the safety representative is not on the project site, a competent designee must be assigned to monitor safety on the site.
 - 2. Safety Professional
 - a) When appropriate, the contractor shall provide a full-time safety professional assigned to the project. The duties of the full-time safety professional must be strictly limited to safety-related activities, with no additional job site duties.
 - b) Safety professionals must have one or more of the following credentials: a professional certification (beyond an OSHA 30-hour course), a college or professional degree related to safety and health, or significant previous experience and skills necessary to thoroughly understand the health and safety hazard and controls relevant to the project. The designation and adequacy of qualifications of the full-time safety professional shall be reviewed and accepted by the University prior to commencement of the work.
 - c) Project-specific requirements for a full-time safety professional will be addressed in the contract documents and discussed during the Pre-Bid Meeting.
- E. Daily Pre-Job Meetings.
 - 1. A pre-job meeting (i.e. "Tailgate" or "toolbox" meeting) shall be held at the beginning of each work period (normally in the morning before leaving the yard or work staging area). The pre-job meeting should include a discussion of the scope of work to be completed, associated hazards, and means and methods to mitigate the hazards. The pre-job meeting must be led by the supervisor or other competent person.
- F. Safety Inspections.
 - 1. Daily Inspections: The Contractor shall perform daily job inspections and correct any unsafe conditions or actions. A summary of these inspections will be reviewed as a

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- portion of and captured in the minutes of the weekly Owner, Designer, Contractor job meetings.
2. Monthly Inspections: For projects with a duration of more than one calendar month (4 weeks), the safety inspection must be documented and include, at a minimum, the name of the person performing the inspection, the date, a checklist of items observed, any identified safety concerns, and actions taken to address identified concerns.
 3. University Project Visits: The NC State Project Manager, or other owner representative, may perform unscheduled visits to project sites to address adherence to the Contractor Safety Requirements or Site-Specific Safety Plans. Any safety concerns identified will be reported to the responsible contractor for prompt mitigation.
- G. Mishap Reporting: All mishaps occurring on the project site must be investigated to determine causes and actions must be taken to prevent recurrence. Mishaps resulting in injury requiring medical treatment or damage to NC State property must be reported in writing to the NC State Project Manager as soon as possible but no later than 24 hours from occurrence; the Project Manager shall be notified immediately of mishaps resulting in life-threatening injury.
- H. The Contractor shall address safety concerns at regularly scheduled meetings with subcontractors.
- I. Contractor Site-Specific Safety Plan - The Contractor must develop and implement a Site-Specific Safety Plan (SSSP) The SSSP is a comprehensive safety plan for his or her employees, which covers all aspects of onsite construction operations and activities associated with the contract. This plan must comply with all applicable health and safety regulations and any project-specific requirements. The Safety Plan must be submitted to, reviewed and accepted by NC State prior to beginning any on-site work activities.
1. As applicable to the project, these items must be included in the Safety Plan:
 - a) Scope of Work
 - b) Emergency Procedures
 - c) 24-hour emergency points of contact
 - d) Identification of Designated Competent On-Site Personnel (per OSHA requirements)
 - e) Designated On-Site Safety Personnel
 - f) Safety orientation program
 - g) Site logistics Plan: address public (student, faculty, staff, visitor) safety, traffic plan, equipment and lay-down areas, site security, dust containment, etc.
 - h) Minimum PPE requirements
 - i) Hazard Assessment (for defined project tasks) - include hazard identification and mitigation
 - j) Mishap reporting and investigation procedures
 - k) Safety inspection/audit procedures
 - l) Sub-contractor requirements

5.0 General Requirements

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- A. Asbestos - If asbestos-containing materials are uncovered during construction, NC State must be notified *immediately*. Do *not* attempt to remove the material. Contractors shall comply with provision of the [State Construction Office Asbestos Abatement Guidelines and Policies](#) and the [NC State Asbestos Management Plan](#).
 - 1. If asbestos containing material is present in any building material and is in good condition (i.e. non-friable) and will not be disturbed during construction, the material may be left in place. If asbestos containing material is disturbed during construction activities, then it shall be removed; removal shall be performed by appropriately qualified and accredited personnel and in accordance with federal, state and local regulations.
- B. Compressed Gas Cylinders
 - 1. Compressed gas cylinders shall be properly used, stored, and maintained as per federal, state, and local requirements.
 - 2. Cylinders shall not be stored in a location in which they are subject to mobile equipment traffic (including vehicles) unless adequately protected.
- C. Confined Space Entry
 - 1. Contractors required to enter a confined space at NC State must have and implement a written confined space entry program in accordance with OSHA 1926 Subpart AA Confined Spaces in Construction or OSHA 1910.146 permit required confined spaces, as applicable.
 - 2. Controlling contractors (those with overall responsibility for construction at the work site) must ensure space entry coordination when more than one entity will enter the space.
 - 3. Each contractor must have a competent person that will identify confined spaces associated with the scope of their work. Before entry into a permit required confined space, contractors must obtain the following information from the controlling contractor (when there is no controlling contractor, the contractor will obtain the information from the NC State Project Manager):
 - a) The location of each known permit space associated with the project scope;
 - b) The known hazards or potential hazards that make it a permit space;
 - c) Any precautions needed to be taken based on the known hazards or potential hazards.
 - 4. Each contractor performing work in a permit space must perform a hazard assessment specific to the work to be performed and establish corresponding hazard controls.
 - 5. A competent person from each contractor performing work in a permit space must complete and sign [Appendix F](#) to the [NC State Confined Space Entry Program](#).
- D. Contaminated Soil - If soil or any materials appear to be contaminated, the NC State Project Manager must be notified immediately. The NC State Project Manager will contact NC State EHS for assistance (919) 515-7915.
- E. Electrical Power Lines (Overhead) - The contractor shall have a trained and knowledgeable observer (signal person) within sight of the operator and the overhead lines that will effectively provide guidance and clearance information to the operator as the equipment

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may approach the minimum approach distances. Advising the operator shall be the signal person's one and only task. When conducting any work with a crane, derrick or hoist in the vicinity of any overhead electric power transmission or distribution line, the contractor shall observe all clearance requirements dictated by all applicable OSHA rules, as specifically contained within 29 CFR 1910 - Standards for General Industry, CFR 1926 - Standards for Construction, IEEE C2 - NEC, NFPA 70 - NEC, the NCSBC, ANSI standards and other applicable NC State safety guidelines and requirements. Further, no crane, derrick or hoist operator or contractor shall conduct any operation at any distance closer than 20 feet to any electric power line lower than 200 kV or closer than 35 feet to any electric power transmission line at voltages higher than 200 kV and lower than 250 kV, unless the requirements of OSHA 1926 Sub CC for preventing encroachment/electrocution are strictly followed.

- F. Elevators/Material Hoists
 1. Any persons operating elevators/hoists must be trained to do so. Documentation shall be kept onsite.
 2. No elevator/hoist with a defect shall be used.
 3. Elevator/hoist safety devices shall not be overridden or made inoperable.
- G. Emergency Equipment- The following shall not be moved, blocked, disabled or rendered inaccessible unless authorized by NC State:
 1. Fire equipment
 2. First aid equipment, fire blankets, stretchers, eyewash fountains and safety showers
 3. Fire protection, hydrants, and detection systems
- H. Emergency Medical Treatment - To receive immediate assistance for emergency medical treatment call 911.
- I. Environmental and Chemical Requirements
 1. Contractors must provide NC State with a list of all chemicals to be used on NC State property and maintain a copy on site of the SDS for each chemical prior to being brought on site. Each chemical container must be labeled clearly with the identity of the chemical and any associated hazards in accordance with the OSHA Hazard Communication Standard (1910.1200).
 2. Contractors must follow the safety procedures recommended by the manufacturer or seller of any chemicals, tools, equipment, or other materials. Contractors are to remove all empty containers, excess chemicals and chemical waste from NC State property.
 3. For all chemical incidents, contractors shall call 911 and also notify the NC State Project Manager.
- J. Excavation and Trenches - Before doing any excavation work, the Contractor must locate all utilities by calling the local utility locator service and NC State.
- K. Excavations
 1. Underground Facilities Locate. Contractors shall ensure underground installations and facilities are identified by calling 811 (Call Before You Dig) before performing any excavating activity. Note: excavation includes movement or removal of earth, rock, or other materials in or on the ground by use of manual or mechanized equipment. This is

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required for any project with earth-moving activities before you dig so that underground facilities can be identified and avoided. Detailed instructions and requirements can be found at nc811.org.

2. Competent Person. Trench and excavation work must be performed under the direction of a competent person. Responsibilities include: classifying soil, inspecting protective systems, monitoring water removal and conducting site inspections.
 3. Cave-In Protective Systems. A protective system is required by OSHA-1926 Subpart P for trenches and excavations that are 5 feet or more in-depth OR if the competent person has examined the ground and finds indication of a potential cave-in. Protective systems typically include: sloping/benching, shoring or shielding. In order to determine what protective systems are appropriate, the competent person must first determine the soil type: Stable Rock, Type A, Type B or Type C soil. Type C soil is the least cohesive and therefore, the least stable. No work shall be permitted in excavations where water has accumulated unless the integrity of the excavation has been protected.
 4. Excavations >20 feet in depth or which cannot comply with OSHA requirements require written approval by a Registered Professional Engineer (RPE).
 5. A ladder, stairway, ramp or other means of access must be provided within the excavation, when excavations are >4 feet in depth.
 6. Barricades (stop-logs) shall be provided where vehicles or mobile equipment are used near or adjacent to excavations.
 7. Spoil piles must be placed a minimum of 2 feet from the edge of the excavation.
 8. Air monitoring must be performed if the excavation is >4 feet in depth and there is a potential for a hazardous atmosphere to exist.
- L. Exit Routes
1. Exit routes must be maintained at all times during construction.
 2. Lighting and marking must be adequate and appropriate.
 3. Exit routes must be kept free of explosive or highly flammable furnishings.
 4. Exit routes must be free and unobstructed. No materials or equipment may be placed, either permanently or temporarily, within the exit route. The exit access must not go through a room that can be locked, such as a bathroom, to reach an exit or exit discharge, nor may it lead into a dead-end corridor. Stairs or a ramp must be provided where the exit route is not substantially level. No materials shall be stored in a stairwell.
- M. Explosives: Blasting on university property is prohibited.
- N. Fall Prevention. A fall hazard is any condition on a walking-working surface that exposes an employee to a risk of fall on the same level or to a lower level. Examples of fall hazards include, but are not limited to: floor openings, hoist area, roofs, leading edge, scaffolding, ramps, etc.
1. Preventing or protecting falls from height may be necessary at any height given the circumstances, but is required when an employee is at a height of 6 feet or more above a lower level.
 2. Contractor work generally falls within construction industry applications, where acceptable methods depend on the type of work being performed: unprotected sides or

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edges, roof work, leading edge, etc. In all cases, contractors shall comply with the respective OSHA standards.

3. Contractors shall ensure that every employee required to work at unprotected heights (greater than 6 feet) are trained in fall hazard recognition and prevention.
4. **Guardrail System.** A guardrail system provides the highest level of protection and is always preferred. The system must be capable of supporting 200 lbs. in any direction and still maintain its integrity. The individual heights of the components must conform to the following minimum standards:
 - a) The top rail of the system must be at a height of 42" (+ or - 3");
 - b) the mid rail must be at a height of 21" with a 3" variation possible;
 - c) the toe board must have a minimum vertical height of 3.5".

Note: building code has more stringent requirements for permanent installations.

5. **Personal Fall Protection Systems.** At times, it is necessary to work in areas where guardrails cannot be constructed; in these instances, a personal fall protection system must be used. Personal Fall Protection Systems are systems (including all components) that provide protection from falling or that safely arrest a fall. Examples include travel restraint and personal fall arrest. All components of this system shall meet the applicable design requirements as specified in OSHA 1910, 1926, or ANSI Z359. All components shall be inspected by the wearer prior to each use and at least annually by a competent person. No employee may use a personal fall protection system without proper training and an understanding of proper use and safe application of the system.
 - a) **Travel Restraint System.** A travel restraint system is a combination of an anchorage, anchorage connector, lanyard (or other means of connection) and body support that the wearer uses to eliminate the possibility of going over the edge of a walking-working surface. Anchorages for travel restraint systems shall have a strength capable of sustaining static loads of at least 1,000 lbs. (per person) or two times the foreseeable forces for certified anchorages. Anchorage connectors, lanyards (or other means of connection) and body support devices shall be used in accordance with the manufacturer's requirements. The system shall be installed so that a fall cannot occur; therefore, a rescue plan is not required.
 - b) **Personal Fall Arrest System.** A personal fall arrest system is a system used to safely arrest a user in a fall from a walking-working surface. It includes an anchorage, anchorage connector and a full body harness. The means of connection may include a lanyard, deceleration device, lifeline or a suitable combination of these. Equipment must be worn and used in accordance with the manufacturer's requirements. Anchorages for personal fall arrest systems shall have a strength capable of sustaining static loads of at least 5,000 lbs. (per person) or two times the maximum arresting force for certified anchorages. The system shall be installed so that should a fall occur, the wearer will not contact the lower level or any other obstruction. Since there is a potential for a fall to occur, a rescue plan written by a qualified person is required.

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- c) **Warning Line System.** A warning line may be used for construction roofing work when closer to the fall hazard than 15ft, but no closer than 6ft and in conjunction with one of the following: a guardrail system, a safety net system, a personal fall protection system, or a safety monitoring system. A warning line system shall conform to regulatory requirements and enclose all authorized employees conducting work protected by the Warning Line System. Refer to OSHA 1926.502(f).
- O. Fire Protection and Prevention
 - 1. The contractor shall be responsible for the development and maintenance of an effective fire protection and prevention program at the job site throughout all phases of the construction. Contractors shall perform inspections on fire extinguishers monthly. Contractors shall immediately replace fire extinguishers that do not pass inspection.
 - 2. Fire cutoffs shall be retained in buildings undergoing alterations or demolition until operations necessitate their removal.
 - 3. If work requires the disabling of Fire Protection Devices, then the Contractor must request a Fire Alarm Disconnect; through the appropriate NC State process; beginning with the Project Manager. No alarm shall be disabled at any time by the Contractor.
- P. Hand and Power Tools
 - 1. All hand and power tools and similar equipment, whether furnished by the employer or the employee, shall be maintained in a safe condition. Any tool found not in proper working order, or that develops a defect during use, shall be immediately removed from service and not used until properly repaired.
 - 2. All tools shall be used, operated and maintained in accordance with OSHA and manufacturer requirements.
- Q. Hot Work Permits - A Hot Work Permit is required when any indoor or outdoor work will involve hot work, defined as operations including cutting, welding, thermite welding, brazing, soldering, grinding, thermal spraying, thawing pipe, installation of torch-applied roof systems or other similar activities. Requirements for Contractors performing this work are contained in the NC State Hot Work Permit Program that is a part of the specifications package and can also be found at [Hot Work Permit Form](#).
- R. Housekeeping
 - 1. The Contractor must maintain a clean and orderly project job site. The Contractor shall maintain NC State's pathways free of rocks, mud, and other miscellaneous construction debris. The Contractor shall prevent the accumulation of dirt, dust, and/or other debris on NC State's roadways. The Contractor shall clean the travel ways on a daily basis. (Refer to project specifications for requirements.)
 - 2. Waste material and debris must be removed from the work and access areas at least once a day. Waste material and debris should not be thrown from one level to another but should be carried down, lowered in containers or deposited in a disposal chute.
 - 3. Materials must be neatly piled, stacked or otherwise stored to prevent tipping or collapsing. Materials must be carefully stacked and located so they do not block aisles,

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- doors, fire extinguishers, safety showers and eyewash stations, fixed ladders or stairways.
- 4. Material to be lifted by crane or other hoisting devices must not be stored under overhead power lines.
- 5. No materials may be stored on penthouses, roofs, or other areas until a specific area is assigned by NC State for a specific project.
- 6. Adverse Weather: If NC State becomes aware of an adverse weather event, the NC State Project Manager shall notify the construction superintendent, and the contractor shall perform a job site review to ensure any debris or construction materials are secured and protected from the elements.
- S. Illumination - Construction areas, ramps, runways, corridors, offices, shops, and storage areas shall be lit to not less than the minimum illumination intensities required by OSHA.
- T. Ladders - All ladders must meet OSHA requirements.
- U. Lasers
 - 1. Lasers must comply with the OSHA Construction Industry Standards.
 - 2. Lasers must be low power (<5mw) devices with visible beams. Lasers to be used must bear a label indicating this maximum power output. Lasers that do not bear this label shall not be used.
 - 3. "Laser in use" signs shall be posted according to OSHA requirements.
 - 4. Lasers must be used in a manner that will not risk exposure to others.
- V. Lead
 - 1. Lead may be found in certain painted surfaces. A check for lead presence should be conducted prior to certain activities such as grinding, sanding, or burning over painted surfaces. If lead containing paint is disturbed or a material is questionable the NC State Project Manager must be notified *immediately*. Do *not* attempt to remove the material.
 - 2. Hot Work over lead painted surfaces is generally not permitted.
- W. Lock Out/Tag Out
 - 1. All contractors that work on energized equipment with any hazardous energy source are required to have a hazardous energy control (i.e. lockout tagout) program. The program shall specify policy and procedures for deenergizing, verifying deenergized, and secure the source potential using energy isolating devices and applying locks/tags or implement other forms of hazardous energy control as specified in OSHA standards. Types of potential energy sources include, but are not limited to:
 - a) Electrical (refer to section of these requirements titled "Electrical")
 - b) Pneumatic
 - c) Hydraulic,
 - d) Thermal
 - e) Kinetic (motion)
 - f) Hazardous gas, liquid, air
 - g) Radiation
 - h) Lasers

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2. When multiple contractors are performing work on the same project, hazardous energy control procedures shall be coordinated by the controlling entity which includes establishing device standardization.
3. Contractors shall ensure site personnel are trained on the hazardous energy control program.
4. Central [Utility Plant \(CUP\) - Lockout Tagout Procedure](#).
 - a) Contractors with the need to perform LOTO operations within the operating CUP shall be trained in accordance with the procedure and comply with applicable sections of the procedure. The contractor is responsible for providing this training; a copy of this procedure will be provided to the contractor.
 - b) Contractor management shall ensure that authorized personnel are assigned to perform work in which they are qualified.
 - c) Contractor management shall comply with applicable sections of the procedure.
- X. Mobile Cranes, Tower Cranes, etc. (Reference OSHA 1926 Subpart CC).
 1. Prior to the set up or operation of any crane on university property, the NC State Project Manager (or other point of contact) shall be notified; notification must be made with as much lead time as possible, but no fewer than fifty (50) working days
 2. Cranes shall be set up and operated in compliance with the manufacturer and applicable OSHA requirements.
 3. Contractors are responsible for ensuring ground conditions are capable of supporting the equipment and load, which will include performing underground facilities/utilities location (i.e. 811 call) as well as factual confirmation of necessary compaction capacities. This confirmation is to be by third party inspection services, at the expense of the contractor.
 4. No lifts may occur over occupied spaces unless a registered structural engineer evaluates and certifies that the building can withstand the impact of load being dropped on the building as a worst-case scenario. If it is determined that the building cannot withstand the impact without compromising the structure, areas of the building within the load fall zone must be evacuated during the duration of the lift. This evacuation process must be a part of the lift plan and managed by the contractor.
 5. The crane contractor shall provide equipment documentation, including the annual inspection and last monthly inspection. Documentation must be signed.
 6. Crane operators shall be certified by an Accredited Crane Operator Certification Agency for the type of equipment operated. Examples of such agencies, include, but are not limited to:
 - a) National Commission for the Certification of Crane Operators (NCCCO)
 - b) National Center for Construction Education and Research (NCCER)
 - c) Operating Engineers Certification Program (OECF)
 - d) Electrical Industry Certifications Association (EICA)

Additionally, the crane operator's employer must attest that the operator was evaluated to verify the operator demonstrates skills and knowledge to safely

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operate the equipment as well as the ability to recognize and avert risk, as required under 29CFR1926.1427(f).

7. All rigging personnel and signal persons shall be qualified in accordance with OSHA 1926 Subpart CC.
8. Crane Lift Plan. A lift plan is required for any lift in a location not under the exclusive control of the contractor, including lifts affecting NC State property, structures, employees, students, or visitors. Each lift plan must be developed by a qualified person and include at least the following:
 - a) The identity of the controlling entity, meaning the employer with the overall responsibility for construction operations associated with the crane lift.
 - b) Identify a lift director (i.e. primary signal person) and method of communication (hand signals, radio, etc.).
 - c) Contractors conducting crane operations are required to obtain required FAA permits according to 14CFR Part 77; to be submitted with the lift plan.
 - d) Equipment positioning locations, including load staging and movement and paths to and from the working position
 - e) Equipment specifications including load and reach capacities
 - f) Current qualifications, certifications, and licenses of operators and riggers
 - g) For lifts involving more than one crane, the lift plan shall encompass all cranes.
 - h) Fall Zone: The contractor shall identify the Fall Zone. The Fall Zone is the area (including but not limited to the area directly beneath the load) in which it is reasonably foreseeable that partially or completely suspended materials could fall. Spaces within the Fall Zone (including buildings, foot traffic, vehicle traffic, etc.) shall be barricaded to control access. The Fall Zone shall be cleared of personnel not participating in the lift.
 - i) Wind limitations
 - j) Ground and subsurface stability at crane and load placement locations. The contractor must ensure a qualified person evaluates the crane set-up location to ensure ground conditions are sufficient. (See X., 3. above)
 - k) Other conditions or factors that may affect the safety of the lift
 - l) A pre-lift meeting must be completed immediately before the lift and shall include all personnel involved with the lift and a thorough review of the elements and specifics of the lift plan and personnel assignments.
 - m) Specify distance to closest energized lines and applicable minimum approach distance of any lift component.
 - n) Where items positioned by a crane lift are rigged at heights above easy reach height, the lift plan shall include safe attachment and de-attachment procedures and the control of exposure to fall hazards.
 - o) The contractor must provide documentation of annual and monthly inspections for the previous 3 months. 1926.1412(f) & .1412(e)

Y. Electrical

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1. Electrical Contractor shall ensure that their personnel using electrically powered equipment are trained to recognize electrical hazards, inspect and maintain electrically powered equipment, and on safe work procedures to prevent exposure to electric shock.
 2. Premises Electrical Equipment. All electrical installations must comply with the National Electrical Code® (NEC®). Work associated with electrical equipment installed in accordance with the NEC® will be conducted in accordance with NFPA 70E® Standard for Electrical Safety in the Workplace. NC State's goal is to minimize exposure to shock and arc flash hazards during the installation, repair, maintenance, and operation of electrical equipment, components, and systems.
 - a) Electrical power sources shall be deenergized, verified, and locked out prior to working on electrical equipment except when de-energization creates a greater hazard and a properly executed Energized Electrical Work Permit (EWP) has been completed.
 - b) Contractors performing electrical work must have their own energized electrical work program that includes a permit process.
 3. Power Generation & Distribution: Work by Qualified Persons and Unqualified Persons working on or near power generation or distribution equipment is addressed in OSHA 29CFR1910.269. It includes work on or directly associated with installations used for the generation, control, transformation, transmission, and distribution of electricity. Any work involving the NC State distribution system shall be coordinated by the NC State Project Manager (or other university contact person) in collaboration with the Facilities Division Power Systems group.
 - a) Work involving the NC State electrical distribution system shall only be performed after authorization by the Facilities Division Power Systems group in accordance with the Power Systems Switching Procedure.
 - b) System Check In/Out: Prior to entering any primary enclosure (substation, transformer, manhole, switch, switching station, etc.) of the NC State Power System the NC State Project Manager or other designated person shall send a text or email to group-powersystementry@ncsu.edu with the work location and brief description of the tasks to be performed (photos are welcomed). When exiting the enclosure, check out with NC State Power Systems using the same method. This is only for unescorted access. For example, if you're with a member of the Power Systems team there's no need to check-in/out, but if that team member has to leave your work site, you're expected to check-in and check-out.
 4. Contractor will follow all requirements as noted in NFPA 70E.
- Z. Mobile Elevating Work Platforms (MEWPs)
1. General Requirements.
 - a) MEWPs shall be operated in accordance with the manufacturer's requirements and specifications.
 - b) Employees must always stand firmly on the floor of the MEWP and must not sit or climb on the edge of guardrails, or use planks, ladders or other devices for a work

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position. The guardrail system of the platform must not be used to support materials, other work platforms, or employees.

- c) A personal fall arrest/restraint system shall be used in accordance with the manufacturer's requirements. A scissor lift with approved guardrails may be used without a personal fall arrest system when specified by the manufacturer, however, if there are designated anchor points, the use of a fall arrest/restraint system is required.
 - d) The MEWP must be used only in accordance with the manufacturer's operating instructions and safety rules.
 - e) The designed rated capacity for a given angle of elevation must not be exceeded.
 - f) At least 10 ft distance must be maintained away from overhead power lines with a nominal voltage of 50kV or less; 20 ft for power lines over 50kV (or if voltage is unknown). Note: qualified workers using appropriately insulated MEWPs may approach closer than 10 ft when following provisions specified in OSHA 1910.268, 1910.269, and 1926 Subpart V, as applicable.
 - g) The manufacturer's rated load capacity must not be exceeded. The load and its distribution on the platform must be in accordance with the manufacturer's specifications. The rated load capacity must not be exceeded when loads are transferred to the platform at elevated heights. Only employees, their tools, and necessary materials must be on or in the platform.
 - h) A trained spotter with no other job duties is required when a MEWP is driven; the spotter will assess conditions that could pose a hazard to the operation (for example, drop-offs, holes, slopes, inadequate surface and support, obstructions, pedestrians, vehicles, debris, electric lines, etc.) and stop operations and alert the operator. The operator shall halt operations until hazards are adequately controlled.
2. Training
- a) Only personnel who have received training to operate the specific type(s) of MEWPs are authorized to operate them on NC State property.
 - b) Training must include inspection, application, and operation of MEWPs (including recognition and avoiding hazards associated with their operation). Operators are only authorized to use MEWPs of the specific model for which they are trained and evaluated.
 - c) Training must be provided by a person who has knowledge regarding the laws, regulations, safe use practices, manufacturer's requirements, and recognition and avoidance of hazards, and is familiar with the specific type(s) of MEWPs. Note: Personnel may not operate rented equipment unless qualified to operate the specific equipment; the rental provider or other authorized evaluator must provide familiarization training to satisfy this requirement.
3. Inspection, Maintenance, and Testing
- a) Each MEWP must be inspected, maintained, repaired, and kept in proper working condition in accordance with the manufacturer's operating or maintenance and

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repair manual or manuals. Maintenance inspections shall be completed at intervals no less frequent than annual.

- b) Before use, visual equipment inspections and a functional check must be performed before each shift in accordance with the manufacturer's operating manual. Any MEWP found not to be in a safe operating condition must be removed from service until repaired. All repairs must be made by an authorized person in accordance with the manufacturer's operating or maintenance and repair manual or manuals.
- c) Before and during use, visual worksite inspections must be performed and include workplace risk assessment. The workplace risk assessment includes identifying and evaluating hazards (for example, drop-offs, holes, slopes, inadequate surface and support, obstructions, pedestrians, vehicles, debris, electric lines, etc.) and establishing effective control measures. Uncontrolled hazardous situations must be corrected prior to initial or continued use of the MEWP.

AA. Noise/Vibration

- 1. Noise producing equipment, such as power drills, jackhammers, welders, etc., can create sound levels of 80dB(A) or greater in and around a construction area. Notify the NC State Project Manager in advance to determine the appropriate times to operate high noise/vibration equipment for that project's location.
- 2. Appropriate personal protective equipment shall be used when working around high noise/vibration equipment.

BB. Overhead Work

- 1. Work must not be performed above other personnel, including other contractor employees. Affected areas must be roped off or barricaded and marked to prohibit traffic.
- 2. Contractors must not climb on the heating and air-conditioning ductwork, plumbing steam piping, sprinkler piping, electrical cable trays, fixtures, or furniture or use as work platforms.
- 3. Contractors are expected to comply with OSHA fall protection requirements.

CC. Paints and Solvents - Contractors must provide the following safeguards:

- 1. Adequate ventilation must be maintained at all times when paints or solvents are being used. Refer to NC State Odor Prevention and Dust Control in Occupied Buildings for additional information.
- 2. Contractor personnel must use proper respiratory protection and protective clothing when toxicity of the material requires such protection.
- 3. Flammable solvents and materials must be used with extreme caution when possible sources of ignition exist.
- 4. Flammable paints and solvents must be stored in an approved flammable liquid storage cabinet when storage is required inside buildings. Acids and flammables must never be stored together. If an approved flammable liquid storage cabinet is not available, flammable paints and solvents must be removed from the building.
- 5. Flammable liquids must be dispensed in a safety can with a flash screen bearing a Factory Mutual or Underwriters Laboratory (UL) approval.

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- DD. Personal Protective Clothing and Equipment - Contractor shall determine this minimum level of protective equipment to be worn on the jobsite (example: hard hat, eye protection, safety vest, gloves and safety shoes); NC State expects contractors to conform to industry accepted minimum PPE standards, for example, hard hats, safety glasses, and protective toe footwear. Any additional safety equipment required by a specific activity shall also be worn and shall meet or exceed OSHA standards. (Refer to NC State Community Standards for specific COVID-19 related PPE).
- EE. Powder-Actuated Tools
 - 1. Powder-actuated tools are not to be used on NC State property unless specific approval is obtained from NC State prior to usage.
 - 2. If approved, powder-actuated tools must be used in accordance with OSHA and manufacturer regulations.
- FF. Power Vehicle Equipment
 - 1. Only trained operators are allowed to use power vehicles on NC State property. Contractor management will be expected to provide proof of training if requested.
 - 2. Generally, LP gas powered trucks are not to be used inside NC State buildings. Prior approval from NC State is required.
 - 3. The design of the LP gas fueled industrial truck for use within NC State buildings must comply with the following:
 - a) LP gas fueled industrial trucks must comply with NFPA 505-1982.
 - b) If trucks are in continuous use in a populated area, they must be equipped with a catalytic converter.
 - c) LP gas containers must not exceed the nominal 45 pounds LP gas.
 - 4. The following conditions and requirements will govern the use of LP gas fueled vehicles inside the confines of NC State buildings and structures:
 - a) LP gas fueled trucks must be removed from the building and parked at the end of each workday and not left unattended while in use. When the job requiring the truck is complete, the truck must be removed from the job site.
 - b) Trucks and tanks must not be refueled inside buildings.
 - c) All areas where LP gas fueled trucks are used must be well ventilated.
 - 5. All LP cylinders must be stored outside and secured by a chain in an upright position.
- GG. Roof Safety
 - 1. The contractor shall request authorization from NC State prior to accessing a roof.
 - 2. During all rooftop operations, the contractor must provide fall protection measures in accordance with OSHA.
 - 3. A Hot Work Permit and at least two appropriate fire extinguishers of the correct ABC type are required when performing hot work on roofs. Other persons acting as a Fire Watch shall be in place on the roof and on the floor(s) directly below operation.
- HH. Sanitation
 - 1. Drinking Water - An adequate supply of water, meeting the U.S. Public Health Service Drinking Water Standards, shall be provided.
 - 2. Washing Facilities

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- a) The contractor shall provide adequate washing facilities for employees engaged in the application of paints, coating, herbicides, or insecticides, or in other operations where contaminants may be harmful to the employees. Such facilities shall be in near proximity to the worksite and shall be so equipped as to enable employees to remove such substances. (Refer to NC State Community Standards for specific COVID-19 related washing requirements).
- b) Hand soap or similar cleansing agents shall be provided.
- c) Individual hand towels, cloth or paper, warm air blowers or clean individual sections of continuous cloth toweling, shall be provided.
3. Toilet facilities shall be provided for employees according to the OSHA requirements.
- II. Scaffolding
 1. Contractor shall erect, use and dismantle scaffolding in accordance with OSHA and manufacturer regulations.
 2. Competent Person. Scaffolds must be erected and dismantled under the direction of a competent person. Responsibilities include, but are not limited to:
 - a) supervise and direct scaffold erection, moving, dismantling, or alteration.
 - b) determine the feasibility and safety of providing fall protection for employees erecting or dismantling supported scaffolds. Employers are required to provide fall protection for employees erecting or dismantling supported scaffolds where the installation and use of such protection is feasible and does not create a greater hazard.
 - c) inspect scaffold and scaffold components for visible defects before each work shift and after any occurrence which could affect a scaffolds structural integrity and ensure identified deficiencies are corrected,
 - d) determine if it is safe for employees to work on scaffolds during storms or high winds.
 3. Access. When scaffold platforms are more than 2 feet (0.6 m) above or below a point of access, portable ladders, hook-on ladders, attachable ladders, stair towers (scaffold stairways/towers), stairway-type ladders (such as ladder stands), ramps, walkways, integral prefabricated scaffold access, or direct access from another scaffold, structure, personnel hoist, or similar surface shall be used. Crossbraces shall not be used as a means of access.
 4. Fall Protection. Each employee on a scaffold more than 10 feet (3.1 m) above a lower level shall be protected from falling to that lower level; each employee on a suspended scaffold shall be protected by a personal fall arrest system attached to an independent anchorage.
 5. Falling Object Protection. Where potential for tools, materials, or other equipment could fall from a scaffold, the area below must be barricaded, and personnel not permitted to enter the area OR effective means shall be implemented to prevent objects from falling.
- JJ. Signs, Tags, and Barricades (references 1926 Sub G and ANSI Z535)
 1. Signs and Tags: Each sign and tag must include a signal word, symbol, and text.

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- a) Signal words:
 - (1) DANGER = the hazard will most likely result in serious injury or death;
 - (2) WARNING = the hazard could possibly result in serious injury or death;
 - (3) CAUTION = the hazard would not likely result in serious injury or death;
 - (4) NOTICE = indicates important information, but not directly hazard-related.
 - b) Symbols or graphics are used to bridge language barriers and draw attention to the message.
 - c) Text is used to convey the safety message in a clear, concise manner.
2. Barricades. Barricades must be installed for situations where a physical obstruction is necessary to deter the passage of people, vehicles, or equipment. When used, barricades must be installed at all points of access.
- a) Barricades associated with traffic control in a public roadway must comply with the Federal Manual of Uniform Traffic Control Devices and the North Carolina Supplement. Coordinate with the NC State Transportation Office.
 - b) Barricades may take many forms on construction sites, but when used, they must clearly indicate the intent of the barricade. All barricades are required to include a sign that includes the name of the person responsible for the barricaded area, method for contacting the responsible person (ex. phone number), and clear and concise text describing the purpose of the barricade.
 - (1) CAUTION Tape Barricades should be used when the hazardous condition is not likely to cause serious physical harm but could result in injury. Standard CAUTION Tape must be used, which includes yellow tape with the word “CAUTION” in black letters. Personnel may enter the barricaded area only when implementing precautions to address the identified hazard.
 - (2) DANGER Tape Barricades are used when a serious or imminent danger may exist. Standard DANGER Tape must be used, which includes red tape with the word “DANGER” in black letters. Only personnel specifically authorized by the person responsible for the barricaded area may enter the barricaded area.
- KK. Silica (Respirable Crystalline Silica) – The following requirements apply to all operations involving exposure to respirable crystalline silica. Examples of such operations include: cutting, grinding, drilling, or crushing brick, block, concrete, stone, rock, mortar, and other materials that contain crystalline silica.
- 1. Contractors shall comply with OSHA standard 29 CFR 1926.1153 including taking all necessary steps to comply with the established exposure limits.
 - 2. Contractors must have a written Exposure Control Plan specific to their operations in accordance with 29 CFR 1926.1153 that includes specific detail for controlling exposure to NC State personnel and the public. A copy of this plan shall be made available to NC State EHS and/or the university Project Manager upon request.
 - 3. Tasks performed indoors or in an enclosed area, shall have effective exhaust ventilation to minimize the accumulation of visible airborne dust. In situations where ventilation is exhausted in an area with potential to expose people to dust must incorporate effective

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HEPA filtration; such areas include but are not limited to, inside a building or outside where people may be present.

4. When a building ventilation system services an area where work with the potential for generating respirable crystalline silica exists, the building air returns shall be blanked or closed while such work is in progress. Contractors must coordinate this with the university project manager.
5. Contractors must establish a "Temporary Restricted Area" for tasks that require the use of respiratory protection in accordance with 29 CFR 1926.1153.
 - a) *Temporary Restricted Area* means an area demarcated by the employer where an employee is required to wear respiratory protection.
 - b) *Temporary Restricted Areas* must be designated with signs, barriers, or other effective means that will ensure unauthorized persons do not enter.

If such work is performed in *occupied* buildings, dust barriers shall be installed as necessary to isolate the restricted area. Refer to [NC State Odor Prevention and Dust Control in Occupied Buildings](#) for additional information.

LL. Smoking and Open Flames

1. Smoking is not allowed in any NC State buildings, including roofs, penthouses, electrical/mechanical rooms and basements.
2. The use of open flames is strictly prohibited in areas where flammable liquids, gases, or highly combustible materials are stored, handled or processed.
3. The use of open flames, where allowed, requires a Hot Work Permit.

MM. Tarpaulins - When tarpaulins are required for the deflection of hot slag, dust, paint drippings, etc., or as a security barrier, they must be flame resistant and in good condition, free of holes and worn edges.

NN. Tar Pots (tar kettles) - Tar Pots are not allowed on roofs. The contractor must notify the NC State Project Manager prior to using tar pots and obtain a Hot Work permit.

OO. Temporary Heating - When heaters are used in confined spaces, special care shall be taken to provide sufficient ventilation in order to ensure proper combustion, maintain the health and safety of workmen, and limit temperature rise in the area.

PP. Temporary Lighting - Contractor shall submit a lighting plan for night work, underground work, and any other worksites without adequate lighting.

QQ. Temporary Traffic Control

1. All traffic control shall be approved by NC State and meet the Institute for Transportation Research and Education (ITRE) Work Zone Safety Guidelines for Construction, Maintenance and Utility Operations. Should this be referencing the federal [Manual on Uniform Traffic Control Devices](#) and the [North Carolina Supplement to the Manual on Uniform Traffic Control Devices](#)?
2. The contractor shall provide warning signs, barriers, barricades, etc., in accordance with the construction plans and specifications or whenever such protection is needed.
3. Where signs and barricades do not provide adequate protection, particularly along a road, walkway, or main aisle, flagmen shall be used.

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4. Review with the crew, each person's responsibility regarding the traffic control set-up (e.g. sign installation, lane closure setup, etc.).
5. Review traffic control devices to be used at the site. Assure that traffic control set-up is properly installed. Installer shall document what traffic control set-up was used (including the sign types and sign locations) and how it was installed.

RR. Vehicle Operation

1. All equipment shall have operational backup alarms. Equipment shall not be utilized until such device is functioning properly.
2. All vehicles shall be operated in accordance with OSHA and manufacturer regulations.

SS. Vertical Lifts - All contractors' platforms or vertical lifts must meet OSHA and manufacturer requirements.

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Division 01 Temporary Facilities

1.0 Purpose

- A. The following guidelines for the use of temporary facilities during construction shall be incorporated into the Construction Documents.

2.0 General Requirements

- A. Project Signs – Project signs are not allowed. Directional signs for material deliveries are allowed within the construction area, if required, and shall be 4' wide x 2' high maximum, black and white only. The NCSU Project Manager shall approve the design of the sign and the sign text. **[Designer shall coordinate with NCSU PM for a sample layout of temporary construction sign.]**
- B. **[Designer shall provide detailed pedestrian detour plans as part of the contract documents]** and show quantity, location, and layout of pedestrian detour signs on the detour plan.] Sidewalks shall remain open and accessible during construction. Should sidewalks require closure, an accessible and safe temporary (concrete, asphalt or plywood) pedestrian path around construction shall be required if an alternative accessible route is not close by. Temporary paths shall be shown on the contract documents clearly showing path and type of construction.
- C. The construction site shall be secured. Contract documents shall clearly indicate limits of construction and location of the construction fence. The fence shall be constructed of heavy-duty chain link material, have a minimum height of six feet and shall have a continuous top tubular rail. Swing gates shall be included at every access to the enclosed area and shall be lockable. The fence shall have an integral visual barrier or shall have shading type material applied and maintained for the duration of the project. Locks for the gates shall be interlocked with a padlock provided by NCSU in order to allow access by NCSU or other emergency personnel in case of emergency.
- D. Walks, Root Zones, and Lawn Protection - A permit, issued by NC State Grounds Management, is required for vehicular access to brick and landscape areas. For single loads up to 9000 lbs., a ¾" minimum plywood base shall be placed over brick paving, root zones of trees, and lawn areas to be protected from vehicular work traffic at a construction site. For single loads over 9000 lbs., two layers of ¾" plywood is required. Root zones and lawn areas shall not be covered with plywood for more than 3 consecutive days.
- E. For projects of duration longer than 3 days or requiring multiple heavy loads into a construction landscape protection zone, a construction entry road shall be included in the contract documents **[Designer must show on the contract drawings, including a detailed cross section]** to indicate access route for heavy loads into the site. This construction entry shall consist of 10' x 16' oak logging mats on 6" coarse, chipped, hardwood placed on a permeable structural, filter fabric, top-dressed with an additional 10" of hardwood mulch. Mulch and logging mats shall be supplemented throughout the project to keep the access area structurally functional. At the end of the project the

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Division 01 Temporary Facilities

logging mats shall be offered to Facilities Operations for salvage or disposed of off site at the discretion of the Owner.

- F. All pruning of existing plant materials, including roots and limbs, for construction clearances shall be done by a trained, licensed, insured arborist and according to standards set forth in the National Arborist Association publication "Standards for the Pruning for Shade Trees". All pruning shall be coordinated with and inspected by NC State Grounds Management. **[The Designer and University Landscape Architect shall assess the necessity for this work during the design phase and determine whether work will be performed by contractor or NC State Grounds Management. Designer shall identify on contract drawings who will perform pruning.]**
- G. Transportation/Parking. **[Designer shall incorporate latest NC State Transportation Guidelines for Parking, Traffic Control and Road Closures.]**

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Division 02 Waste Materials Management – Reuse, Recycling, & Hazardous Waste

1.1 Purpose

- A. The following guidelines define waste management and disposal responsibilities for both hazardous and non-hazardous construction and demolition (C&D) wastes. The guidelines also address performance and reporting requirements.

2.0 General Requirements

A. Definitions

1. Construction & Demolition Waste: Building and site improvement materials, and other solid waste resulting from construction, demolition, renovation, or repair operations. Material stream also includes brick, concrete, asphalt, and aggregate.
2. Special Waste: Solid wastes that require special handling and management.
3. Hazardous Waste: Any solid waste that is ignitable, corrosive, reactive, or toxic; a listed hazardous material or containing a listed hazardous material per Title 40 Code of Federal Regulations Parts 260-270.
4. Universal Waste: Hazardous wastes that have been provided specific exemptions (40 CFR 273) to encourage recycling. Universal wastes are limited to recalled or cancelled pesticides and intact batteries, lamps, and mercury containing devices. State regulations prohibit the crushing of fluorescent lamps.
5. Salvage: Recovery of waste for reuse in the existing facility, a different facility, subsequent sale as State Surplus property, or other reuse efforts.
6. Recycle: Recovery of waste for processing and preparation into products or raw materials.
7. Yard waste: A solid waste consisting solely of vegetative matter resulting from landscaping maintenance.

B. Performance Goals and Requirements

1. All hazardous and non-hazardous generated waste shall be managed in accordance with local, state, and federal regulations.
2. Seventy-five percent (75%) of a project's non-hazardous waste must be diverted from landfill disposal through reuse and recycling.
3. One hundred percent (100%) of yard waste must be diverted from landfill disposal through reuse and recycling.
4. The Designer must complete the Designer Waste Information Form (<http://go.ncsu.edu/wasteinfoform>) and identify regulated wastes, as well as materials, fixtures, and equipment that are to be salvaged for reuse or recycled. The location of the staging area as well as the responsible party for removal, delivery, and/or pick up must also be included.
5. The completed **Designer Waste Information Form must be included in the Construction Documents** that go out for review and bid.
6. The Contractor must provide a Waste Management Plan (<http://go.ncsu.edu/wastemanagementplan>) to NC State for approval prior to implementing work. The plan shall include details on how the hazardous and non-hazardous generated waste will be managed in accordance with local, state, and federal regulations. Contractor must also provide all

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materials, personnel, and protective equipment necessary to remove and store wastes in accordance with the plan. The Contractor must coordinate salvage or reuse efforts identified on the Designer Waste Information Form with NC State and/or the non-profit entity.

C. Reporting Requirements

1. Hazardous Waste

- a) The Contractor must provide NC State with a copy of all hazardous, universal, and special waste disposal certifications and/or manifests for all waste shipped.

2. Non-Hazardous C&D Waste

- a) All reuse, recycling, and landfilled materials are to be tracked and complied on NC State's tracking forms, which can be found at <https://recycling.ncsu.edu/wp-content/uploads/sites/3/2018/04/CD-Tracking-forms-for-upload.pdf>. The completed form, with weight tickets/invoices attached, is considered a required close-out document and must be submitted before final payment is issued.

3.0 Management of Hazardous, Universal, and Special Wastes

A. Hazardous, universal, and special wastes must be managed separately from other C&D wastes.

B. Disposal must be coordinated with NC State Environmental Health & Safety.

C. Special wastes include:

1. Paints, varnish, solvents, sealers, thinners, resins, roofing cement, adhesives, lubricants, and caulk, or drums and containers that once held these materials.
2. Treated wood including lumber, posts, ties, decks, and utility poles (creosote, arsenic, chromium, pentachlorophenol).
3. Asbestos, PCBs, mercury, or lead containing materials
4. Used oil
5. Lead acid batteries
6. Medical wastes

D. Waste disposal responsibility falls to one of two parties: the Contractor or NC State, as defined in the NC State Environmental Health and Safety's document:

Management of Building Demolition Debris available at: <http://go.ncsu.edu/demodebris>

1. Containers used for waste storage must be United States Department of Transportation approved. The Contractor must supply bins, tanks or tank trucks. Containers must remain closed at all times except when material is being added. NC State will provide containers for items collected by NC State.
2. Hazardous waste containers must have labels that clearly identify waste streams. Different waste streams cannot be combined in a shared container. The Contractor must identify the initial accumulation date on

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Division 02 Waste Materials Management – Reuse, Recycling, & Hazardous Waste

- the hazardous waste label when waste is first placed in the container.
3. Waste containers must be stored in a secured, covered, and well identified area of the construction site. Hazardous waste cannot be stored for more than 90 days. Any waste stored for more than six days must be inspected, and the inspection documented, weekly.
 4. Spill response supplies must be on-site and adequate to contain 110% of any accumulated waste. Portable fire extinguishers must also be readily available. If a spill occurs, Contractor must contact NC State immediately and proceed with spill containment and clean up.
 5. The Contractor must provide NC State with a copy of all hazardous, universal, and special waste disposal certifications and/or manifests for all waste shipped.

4.0 Management of Non-Hazardous Waste

- A. Priority 1 - Salvage of Construction and Demolition Waste for Reuse
1. Salvaged materials should first be evaluated for use in University construction projects. NC State Surplus Property Services should be considered if there are reusable materials that have resale value and are no longer needed by the University. Contact Waste Reduction and Recycling (ajbensle@ncsu.edu) for assistance with disposition.
Examples of Salvageable material include:
 - a) Furniture and electronics
 - b) Cabinets and shelves that are not built-in
 - c) Sinks and water fountains
 - d) Paper towel dispensers
 - e) Newer light fixtures
 - f) Dry erase boards, chalkboards, and cork boards
 - g) Solid wood panel doors
 - h) Brick pavers
 2. Contact vendors about take-back programs to recycle materials their company provides. These materials include, but are not limited to ceiling tiles, carpet tiles, and cubicle walls.
 3. Coordinate with the Project Manager to utilize the [NC State Construction Shop](#) for the careful removal of salvageable items prior to contractor demolition. An estimate for the Construction Shop's work must be received during design and must be initiated prior to the project going out to bid.
- B. Priority 2 - Recycling of Construction and Demolition Waste
1. If materials are not a salvageable for reuse, they must be source separated to the greatest extent possible and recycled.
 2. Common source separated materials for recycling include:
 - a) Cardboard
 - b) Bottles and cans
 - c) Scrap metal and wire

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- d) Rigid plastics
 - e) Untreated/unpainted dimensional lumber
 - f) Gypsum board (unpainted)
 - g) Concrete
 - h) Asphalt (pavement and shingles)
 - i) Aggregate
 - j) Brick and CMU
3. 100% of the following materials must be recycled:
- a) Cardboard
 - b) Bottles and cans
 - c) Scrap metal and wire
 - d) Concrete
 - e) Asphalt (pavement and shingles)
 - f) Aggregate
 - g) Brick and CMU
 - h) Designer shall coordinate with Waste Reduction and Recycling office during design to properly coordinate selective demolition requirements and recycling goals.**
- C. Priority 3 - Disposal of Construction and Demolition Waste
- 1. If material/s cannot be salvaged for reuse or source separated and recycled, they must be sent to a C&D recycling and reclamation facility. Materials are not to be sent directly to a landfill or a facility that does not sort and recycle.
- D. All solid waste management facilities must be permitted to operate by NCDEQ in accordance with [15A NCAC 13B .0201](#).
- E. University Contract Pricing**
- 1. When available, the contractor may utilize University contract pricing for related facility tip costs or recycling rebates. In order to utilize contracts, contractor must coordinate with the University project manager and Waste Reduction and Recycling office.
- F. University Rolloff Services
- 1. Depending upon the scale of the work, dumpster services can be provided for Informal or Formal construction projects. Coordinate with NCSU Waste Reduction and Recycling to provide 17-20 cubic yard rollofs. Rental and contact information; <https://recycling.ncsu.edu/rentals/>

GUIDELINES FOR RECRUITMENT AND SELECTION OF MINORITY BUSINESSES FOR PARTICIPATION IN STATE CONSTRUCTION CONTRACTS

In accordance with G.S. 143-128.2 (effective January 1, 2002) these guidelines establish goals for minority participation in single-prime bidding, separate-prime bidding, construction manager at risk, and alternative contracting methods, on State construction projects in the amount of \$300,000 or more. The legislation provides that the State shall have a verifiable ten percent (10%) goal for participation by minority businesses in the total value of work for each project for which a contract or contracts are awarded. These requirements are published to accomplish that end.

SECTION A: INTENT

It is the intent of these guidelines that the State of North Carolina, as awarding authority for construction projects, and the contractors and subcontractors performing the construction contracts awarded shall cooperate and in good faith do all things legal, proper and reasonable to achieve the statutory goal of ten percent (10%) for participation by minority businesses in each construction project as mandated by GS 143-128.2. Nothing in these guidelines shall be construed to require contractors or awarding authorities to award contracts or subcontracts to or to make purchases of materials or equipment from minority-business contractors or minority-business subcontractors who do not submit the lowest responsible, responsive bid or bids.

SECTION B: DEFINITIONS

1. Minority - a person who is a citizen or lawful permanent resident of the United States and who is:
 - a. Black, that is, a person having origins in any of the black racial groups in Africa;
 - b. Hispanic, that is, a person of Spanish or Portuguese culture with origins in Mexico, South or Central America, or the Caribbean Islands, regardless of race;
 - c. Asian American, that is, a person having origins in any of the original peoples of the Far East, Southeast Asia and Asia, the Indian subcontinent, the Pacific Islands;
 - d. American Indian, that is, a person having origins in any of the original peoples of North America; or
 - e. Female
2. Minority Business - means a business:
 - a. In which at least fifty-one percent (51%) is owned by one or more minority persons, or in the case of a corporation, in which at least fifty-one percent (51%) of the stock is owned by one or more minority persons or socially and economically disadvantaged individuals; and
 - b. Of which the management and daily business operations are controlled by one or more of the minority persons or socially and economically disadvantaged individuals who own it.
3. Socially and economically disadvantaged individual - means the same as defined in 15 U.S.C. 637. "Socially disadvantaged individuals are those who have been subjected to racial or ethnic prejudice or cultural bias because of their identity as a member of a group without regard to their individual qualities". "Economically disadvantaged individuals are those socially disadvantaged individuals whose ability to compete in the free enterprise system has been impaired due to diminished capital and credit opportunities as compared to others in the same business area who are not socially disadvantaged".
4. Public Entity - means State and all public subdivisions and local governmental units.
5. Owner - The State of North Carolina, through the Agency/Institution named in the contract.
6. Designer - Any person, firm, partnership, or corporation, which has contracted with the State of North Carolina to perform architectural or engineering, work.
7. Bidder - Any person, firm, partnership, corporation, association, or joint venture seeking to be awarded a public contract or subcontract.

8. Contract - A mutually binding legal relationship or any modification thereof obligating the seller to furnish equipment, materials or services, including construction, and obligating the buyer to pay for them.
9. Contractor - Any person, firm, partnership, corporation, association, or joint venture which has contracted with the State of North Carolina to perform construction work or repair.
10. Subcontractor - A firm under contract with the prime contractor or construction manager at risk for supplying materials or labor and materials and/or installation. The subcontractor may or may not provide materials in his subcontract.

SECTION C: RESPONSIBILITIES

1. Office for Historically Underutilized Businesses, Department of Administration (hereinafter referred to as HUB Office).

The HUB Office has established a program, which allows interested persons or businesses qualifying as a minority business under G.S. 143-128.2, to obtain certification in the State of North Carolina procurement system. The information provided by the minority businesses will be used by the HUB Office to:

- a. Identify those areas of work for which there are minority businesses, as requested.
- b. Make available to interested parties a list of prospective minority business contractors and subcontractors.
- c. Assist in the determination of technical assistance needed by minority business contractors.

In addition to being responsible for the certification/verification of minority businesses that want to participate in the State construction program, the HUB Office will:

- (1) Maintain a current list of minority businesses. The list shall include the areas of work in which each minority business is interested.
- (2) Inform minority businesses on how to identify and obtain contracting and subcontracting opportunities through the State Construction Office and other public entities.
- (3) Inform minority businesses of the contracting and subcontracting process for public construction building projects.
- (4) Work with the North Carolina trade and professional organizations to improve the ability of minority businesses to compete in the State construction projects.
- (5) The HUB Office also oversees the minority business program by:
 - a. Monitoring compliance with the program requirements.
 - b. Assisting in the implementation of training and technical assistance programs.
 - c. Identifying and implementing outreach efforts to increase the utilization of minority businesses.
 - d. Reporting the results of minority business utilization to the Secretary of the Department of Administration, the Governor, and the General Assembly.

2. State Construction Office

The State Construction Office will be responsible for the following:

- a. Furnish to the HUB Office a minimum of twenty-one days prior to the bid opening the following:
 - (1) Project description and location;
 - (2) Locations where bidding documents may be reviewed;
 - (3) Name of a representative of the owner who can be contacted during the advertising period to advise who the prospective bidders are;
 - (4) Date, time and location of the bid opening.
 - (5) Date, time and location of prebid conference, if scheduled.
- b. Attending scheduled prebid conference, if necessary, to clarify requirements of the general statutes regarding minority-business participation, including the bidders' responsibilities.

- c. Reviewing the apparent low bidders' statutory compliance with the requirements listed in the proposal, that must be complied with, if the bid is to be considered as responsive, prior to award of contracts. The State reserves the right to reject any or all bids and to waive informalities.
- d. Reviewing of minority business requirements at Preconstruction conference.
- e. Monitoring of contractors' compliance with minority business requirements in the contract documents during construction.
- f. Provide statistical data and required reports to the HUB Office.
- g. Resolve any protest and disputes arising after implementation of the plan, in conjunction with the HUB Office.

3. Owner

Before awarding a contract, owner shall do the following:

- a. Develop and implement a minority business participation outreach plan to identify minority businesses that can perform public building projects and to implement outreach efforts to encourage minority business participation in these projects to include education, recruitment, and interaction between minority businesses and non-minority businesses.
- b. Attend the scheduled prebid conference.
- c. At least 10 days prior to the scheduled day of bid opening, notify minority businesses that have requested notices from the public entity for public construction or repair work and minority businesses that otherwise indicated to the Office for Historically Underutilized Businesses an interest in the type of work being bid or the potential contracting opportunities listed in the proposal. The notification shall include the following:
 - 1. A description of the work for which the bid is being solicited.
 - 2. The date, time, and location where bids are to be submitted.
 - 3. The name of the individual within the owner's organization who will be available to answer questions about the project.
 - 4. Where bid documents may be reviewed.
 - 5. Any special requirements that may exist.
- d. Utilize other media, as appropriate, likely to inform potential minority businesses of the bid being sought.
- e. Maintain documentation of any contacts, correspondence, or conversation with minority business firms made in an attempt to meet the goals.
- f. Review, jointly with the designer, all requirements of G.S. 143-128.2(c) and G.S. 143-128.2(f) – (i.e. bidders' proposals for identification of the minority businesses that will be utilized with corresponding total dollar value of the bid and affidavit listing good faith efforts, or affidavit of self-performance of work, if the contractor will perform work under contract by its own workforce) - prior to recommendation of award to the State Construction Office.
- g. Evaluate documentation to determine good faith effort has been achieved for minority business utilization prior to recommendation of award to State Construction Office.
- h. Review prime contractors' pay applications for compliance with minority business utilization commitments prior to payment.
- i. Make documentation showing evidence of implementation of Owner's responsibilities available for review by State Construction Office and HUB Office, upon request

4. Designer

Under the single-prime bidding, separate prime bidding, construction manager at risk, or alternative contracting method, the designer will:

- a. Attend the scheduled prebid conference to explain minority business requirements to the prospective bidders.
- b. Assist the owner to identify and notify prospective minority business prime and subcontractors of potential contracting opportunities.
- c. Maintain documentation of any contacts, correspondence, or conversation with minority business firms made in an attempt to meet the goals.
- d. Review jointly with the owner, all requirements of G.S. 143-128.2(c) and G.S.143-128.2(f) – (i.e. bidders' proposals for identification of the minority businesses that will be utilized with

corresponding total dollar value of the bid and affidavit listing Good Faith Efforts, or affidavit of self-performance of work, if the contractor will perform work under contract by its own workforce) - prior to recommendation of award.

- e. During construction phase of the project, review “MBE Documentation for Contract Payment” – (Appendix E) for compliance with minority business utilization commitments. Submit Appendix E form with monthly pay applications to the owner and forward copies to the State Construction Office.
- f. Make documentation showing evidence of implementation of Designer’s responsibilities available for review by State Construction Office and HUB Office, upon request.

5. Prime Contractor(s), CM at Risk, and Its First-Tier Subcontractors

Under the single-prime bidding, the separate-prime bidding, construction manager at risk and alternative contracting methods, contractor(s) will:

- a. Attend the scheduled prebid conference.
- b. Identify or determine those work areas of a subcontract where minority businesses may have an interest in performing subcontract work.
- c. At least ten (10) days prior to the scheduled day of bid opening, notify minority businesses of potential subcontracting opportunities listed in the proposal. The notification will include the following:
 - (1) A description of the work for which the subbid is being solicited.
 - (2) The date, time and location where subbids are to be submitted.
 - (3) The name of the individual within the company who will be available to answer questions about the project.
 - (4) Where bid documents may be reviewed.
 - (5) Any special requirements that may exist, such as insurance, licenses, bonds and financial arrangements.

If there are more than three (3) minority businesses in the general locality of the project who offer similar contracting or subcontracting services in the specific trade, the contractor(s) shall notify three (3), but may contact more, if the contractor(s) so desires.

- d. During the bidding process, comply with the contractor(s) requirements listed in the proposal for minority participation.
- e. Identify on the bid, the minority businesses that will be utilized on the project with corresponding total dollar value of the bid and affidavit listing good faith efforts as required by G.S. 143-128.2(c) and G.S. 143-128.2(f).
- f. Make documentation showing evidence of implementation of PM, CM-at-Risk and First-Tier Subcontractor responsibilities available for review by State Construction Office and HUB Office, upon request.
- g. Upon being named the apparent low bidder, the Bidder shall provide one of the following: (1) an affidavit (Affidavit C) that includes a description of the portion of work to be executed by minority businesses, expressed as a percentage of the total contract price, which is equal to or more than the applicable goal; (2) if the percentage is not equal to the applicable goal, then documentation of all good faith efforts taken to meet the goal. Failure to comply with these requirements is grounds for rejection of the bid and award to the next lowest responsible and responsive bidder.
- h. The contractor(s) shall identify the name(s) of minority business subcontractor(s) and corresponding dollar amount of work on the schedule of values. The schedule of values shall be provided as required in Article 31 of the General Conditions of the Contract to facilitate payments to the subcontractors.
- i. The contractor(s) shall submit with each monthly pay request(s) and final payment(s), “MBE Documentation for Contract Payment” – (Appendix E), for designer’s review.
- j. During the construction of a project, at any time, if it becomes necessary to replace a minority business subcontractor, immediately advise the owner, State Construction Office, and the Director of the HUB Office in writing, of the circumstances involved. The prime contractor shall make a good faith effort to replace a minority business subcontractor with another minority business subcontractor.

- k. If during the construction of a project additional subcontracting opportunities become available, make a good faith effort to solicit subbids from minority businesses.
- l. It is the intent of these requirements apply to all contractors performing as prime contractor and first tier subcontractor under construction manager at risk on state projects.

6. **Minority Business Responsibilities**

While minority businesses are not required to become certified in order to participate in the State construction projects, it is recommended that they become certified and should take advantage of the appropriate technical assistance that is made available. In addition, minority businesses who are contacted by owners or bidders must respond promptly whether or not they wish to submit a bid.

SECTION 4: DISPUTE PROCEDURES

It is the policy of this state that disputes that involves a person's rights, duties or privileges, should be settled through informal procedures. To that end, minority business disputes arising under these guidelines should be resolved as governed under G.S. 143-128(g).

SECTION 5: These guidelines shall apply upon promulgation on state construction projects. Copies of these guidelines may be obtained from the Department of Administration, State Construction Office, (physical address) 301 North Wilmington Street, Suite 450, NC Education Building, Raleigh, North Carolina, 27601-2827, (mail address) 1307 Mail Service Center, Raleigh, North Carolina, 27699-1307, phone (919) 807-4100, Website: www.nc-sco.com

SECTION 6: In addition to these guidelines, there will be issued with each construction bid package provisions for contractual compliance providing minority business participation in the state construction program.

MINORITY BUSINESS CONTRACT PROVISIONS (CONSTRUCTION)

APPLICATION:

The **Guidelines for Recruitment and Selection of Minority Businesses for Participation in State Construction Contracts** are hereby made a part of these contract documents. These guidelines shall apply to all contractors regardless of ownership. Copies of these guidelines may be obtained from the Department of Administration, State Construction Office, (physical address) 301 North Wilmington Street, Suite 450, NC Education Building, Raleigh, North Carolina, 27601-2827, (mail address) 1307 Mail Service Center, Raleigh, North Carolina, 27699-1307, phone (919) 807-4100, Website: <http://www.nc-sco.com>

MINORITY BUSINESS SUBCONTRACT GOALS:

The goals for participation by minority firms as subcontractors on this project have been set at 10%.

The bidder must identify on its bid, the minority businesses that will be utilized on the project with corresponding total dollar value of the bid and affidavit (Affidavit A) listing good faith efforts or affidavit (Affidavit B) of self-performance of work, if the bidder will perform work under contract by its own workforce, as required by G.S. 143-128.2(c) and G.S. 143-128.2(f).

The lowest responsible, responsive bidder must provide Affidavit C, that includes a description of the portion of work to be executed by minority businesses, expressed as a percentage of the total contract price, which is equal to or more than the applicable goal.

OR

Provide Affidavit D, that includes a description of the portion of work to be executed by minority businesses, expressed as a percentage of the total contract price, **with documentation of Good Faith Effort, if the percentage is not equal to the applicable goal.**

OR

Provide Affidavit B, which includes sufficient information for the State to determine that the bidder does not customarily subcontract work on this type project.

The above information must be provided as required. Failure to submit these documents is grounds for rejection of the bid.

MINIMUM COMPLIANCE REQUIREMENTS:

All written statements, affidavits or intentions made by the Bidder shall become a part of the agreement between the Contractor and the State for performance of this contract. Failure to comply with any of these statements, affidavits or intentions, or with the minority business Guidelines shall constitute a breach of the contract. A finding by the State that any information submitted either prior to award of the contract or during the performance of the contract is inaccurate, false or incomplete, shall also constitute a breach of the contract. Any such breach may result in termination of the contract in accordance with the termination provisions contained in the contract. It shall be solely at the option of the State whether to terminate the contract for breach.

In determining whether a contractor has made Good Faith Efforts, the State will evaluate all efforts made by the Contractor and will determine compliance in regard to quantity, intensity, and results of these efforts. Good Faith Efforts include:

- (1) Contacting minority businesses that reasonably could have been expected to submit a quote and that were known to the contractor or available on State or local government maintained lists at least 10 days before the bid or proposal date and notifying them of the nature and scope of the work to be performed.
- (2) Making the construction plans, specifications and requirements available for review by prospective minority businesses, or providing these documents to them at least 10 days before the bid or proposals are due.
- (3) Breaking down or combining elements of work into economically feasible units to facilitate minority participation.
- (4) Working with minority trade, community, or contractor organizations identified by the Office for Historically Underutilized Businesses and included in the bid documents that provide assistance in recruitment of minority businesses.
- (5) Attending any prebid meetings scheduled by the public owner.
- (6) Providing assistance in getting required bonding or insurance or providing alternatives to bonding or insurance for subcontractors.
- (7) Negotiating in good faith with interested minority businesses and not rejecting them as unqualified without sound reasons based on their capabilities. Any rejection of a minority business based on lack of qualification should have the reasons documented in writing.
- (8) Providing assistance to an otherwise qualified minority business in need of equipment, loan capital, lines of credit, or joint pay agreements to secure loans, supplies, or letters of credit, including waiving credit that is ordinarily required. Assisting minority businesses in obtaining the same unit pricing with the bidder's suppliers in order to help minority businesses in establishing credit.
- (9) Negotiating joint venture and partnership arrangements with minority businesses in order to increase opportunities for minority business participation on a public construction or repair project when possible.
- (10) Providing quick pay agreements and policies to enable minority contractors and suppliers to meet cash-flow demands.

APPENDIX E

MBE DOCUMENTATION FOR CONTRACT PAYMENTS

Prime Contractor/Architect: _____

Address & Phone: _____

Project Name: _____

Pay Application #: _____ Period: _____

The following is a list of payments made to Minority Business Enterprises on this project for the above-mentioned period.

MBE FIRM NAME	* INDICATE TYPE OF MBE	AMOUNT PAID THIS MONTH	TOTAL PAYMENTS TO DATE	TOTAL AMOUNT COMMITTED

*Minority categories: Black, African American (B), Hispanic (H), Asian American (A), American Indian (I), Female (F), Social and Economically Disadvantage (D)

Date: _____ Approved/Certified By: _____

Name

Title

Signature

SUBMIT WITH EACH PAY REQUEST & FINAL PAYMENT

FORM OF PROPOSAL

Translational Research Facility
NC State University
SCO ID# 21-23162-01A

Contract: _____
Bidder: _____
Date: _____

The undersigned, as bidder, hereby declares that the only person or persons interested in this proposal as principal or principals is or are named herein and that no other person than herein mentioned has any interest in this proposal or in the contract to be entered into; that this proposal is made without connection with any other person, company or parties making a bid or proposal; and that it is in all respects fair and in good faith without collusion or fraud. The bidder further declares that he has examined the site of the work and the contract documents relative thereto, and has read all special provisions furnished prior to the opening of bids; that he has satisfied himself relative to the work to be performed. The bidder further declares that he and his subcontractors have fully complied with NCGS 64, Article 2 in regards to E-Verification as required by Section 2.(c) of Session Law 2013-418, codified as N.C. Gen. Stat. § 143-129(j).

The Bidder proposes and agrees if this proposal is accepted to contract with the

State of North Carolina through NC State University

in the form of contract specified below, to furnish all necessary materials, equipment, machinery, tools, apparatus, means of transportation and labor necessary to complete the construction of

The NC State University Translational Research Facility consists of a freestanding facility of approximately 3610 GSF located in the Laboratory Animal Resources section of the College of Veterinary Medicine and NC State's Biomedical Centennial Campus

in full in complete accordance with the plans, specifications and contract documents, to the full and entire satisfaction of the State of North Carolina, and the

NC State University

with a definite understanding that no money will be allowed for extra work except as set forth in the General Conditions and the contract documents, for the sum of:

SINGLE PRIME CONTRACT:

Base Bid:

_____ Dollars(\$)

General Subcontractor:

_____ Lic _____

Plumbing Subcontractor:

_____ Lic _____

Mechanical Subcontractor:

_____ Lic _____

Electrical Subcontractor:

_____ Lic _____

GS143-128(d) requires all single prime bidders to identify their subcontractors for the above subdivisions of work. A contractor whose bid is accepted shall not substitute any person as subcontractor in the place of the subcontractor listed in the original bid, except (i) if the listed subcontractor's bid is later determined by the contractor to be non-responsible or non-responsive or the listed subcontractor refuses to enter into a contract for the complete performance of the bid work, or (ii) with the approval of the awarding authority for good cause shown by the contractor.

ALTERNATES:

Should any of the alternates as described in the contract documents be accepted, the amount written below shall be the amount to be "added to" or "deducted from" the base bid. (Strike out "Add" or "Deduct" as appropriate.)

GENERAL CONTRACT:

Alternate No. 1 Provide and ADD to furnish and install mortise locks by Best, closers by LCN and cylinders by Schlage.

(Add) ~~(Deduct)~~ _____ Dollars(\$)

Alternate No. 2 Provide an ADD to furnish galvanized painted metal doors as specified in section 08 1113.

(Add) ~~(Deduct)~~ _____ Dollars(\$)

Alternate No. 3 Provide an ADD to furnish and install stainless steel pass through as shown on A410 and specified in 12 3553.

(Add) ~~(Deduct)~~ _____ Dollars(\$)

Alternate No. 4 Provide an ADD to furnish and install casework as shown on A410 and as specified in 12 3553.

(Add) ~~(Deduct)~~ _____ Dollars(\$)

Alternate No. 5 Provide an ADD to provide 316 welded stainless steel exhaust duct for all exhaust ductwork and associated accessories. Accessories include dampers, air valves, and duct access doors.

(Add) ~~(Deduct)~~ _____ Dollars(\$)

Alternate No. 6 Provide an ADD to furnish and install concrete sealant as shown on A130 and as specified in 09 9330.

(Add) ~~(Deduct)~~ _____ Dollars(\$)

Alternate No. 7 Provide and ADD to furnish and install sanitary napkin dispenser and disposals as indicated as basis-of-design product listed in section 10 2800.

(Add) ~~(Deduct)~~ _____ Dollars(\$)

Alternate No. 8 Provide an ADD to replace the material outlined in the Base Bid by furnishing and installing approximately 140 LF of 6" Ductile Iron Pipe, one (1) 2" water service tap and valve assembly, approximately 50 LF of 2" Type K Hard Copper Pipe, one (1) 6" Gate Valve and one (1) 6" Blowoff as shown on Sheet C-300.

(Add) ~~(Deduct)~~ _____ Dollars(\$)

Alternate No. 9 Provide and ADD to include all medical gas equipment, piping, alarms, valves, oxygen switching manifold and accessories associated with the medical gas system. Include backflow preventer and water piping to medical vacuum pump. Include line side and load side power supply to vacuum pump, alarm panel, and oxygen switching manifold.

(Add) *(Deduct)* _____ Dollars(\$)

Alternate No. 10 Provide and ADD to Furnish and install a BACnet based BAS by Johnson Controls Incorporated (JCI).

(Add) *(Deduct)* _____ Dollars(\$)

Alternate No. 11 Provide and ADD to furnish and install a BACnet based BAS by Schneider Electric.

(Add) *(Deduct)* _____ Dollars(\$)

Alternate No. 12 Provide and ADD to provide and install a pilot operated steam regulator model ED2 by Spence.

(Add) *(Deduct)* _____ Dollars(\$)

Alternate No. 13 Provide and ADD to Provide UV disinfection lights and controller as specified in 236000, HVAC Equipment.

(Add) *(Deduct)* _____ Dollars(\$)

Alternate No. 14 Provide and ADD to furnish and install Coffing ECMT2004-10-1 electric chain hoist and motor trolley.

(Add) *(Deduct)* _____ Dollars(\$)

UNIT PRICES

Unit prices quoted and accepted shall apply throughout the life of the contract, except as otherwise specifically noted. Unit prices shall be applied, as appropriate, to compute the total value of changes in the base bid quantity of the work all in accordance with the contract documents.

GENERAL CONTRACT:

No. 1 NONE (Unit) Unit Price (\$)_____

PLUMBING CONTRACT:

No. 1 NONE (Unit) Unit Price (\$)_____

HVAC CONTRACT:

No. 1 NONE (Unit) Unit Price (\$)_____

ELECTRICAL CONTRACT:

No. 1 Provide a unit price for an electrical system (power or telecom) handhole. See electrical drawings for complete description. (Unit) Unit Price (\$)_____

The bidder further proposes and agrees hereby to commence work under this contract on a date to be specified in a written order of the designer and shall fully complete all work thereunder within the time specified in the Supplementary General Conditions Article 23. Applicable liquidated damages amount is also stated in the Supplementary General Conditions Article 23.

MINORITY BUSINESS PARTICIPATION REQUIREMENTS

Provide with the bid - Under GS 143-128.2(c) the undersigned bidder shall identify **on its bid** (Identification of Minority Business Participation Form) the minority businesses that it will use on the project with the total dollar value of the bids that will be performed by the minority businesses. **Also** list the good faith efforts (Affidavit **A**) made to solicit minority participation in the bid effort.

NOTE: A contractor that performs all of the work with its own workforce may submit an Affidavit (**B**) to that effect in lieu of Affidavit (**A**) required above. The MB Participation Form must still be submitted even if there is zero participation.

After the bid opening - The Owner will consider all bids and alternates and determine the lowest responsible, responsive bidder. Upon notification of being the apparent low bidder, the bidder shall then file within 72 hours of the notification of being the apparent lowest bidder, the following:

An Affidavit (**C**) that includes a description of the portion of work to be executed by minority businesses, expressed as a percentage of the total contract price, which is equal to or more than the 10% goal established. This affidavit shall give rise to the presumption that the bidder has made the required good faith effort and Affidavit **D** is not necessary;

*** OR ***

If less than the 10% goal, Affidavit (**D**) of its good faith effort to meet the goal shall be provided. The document must include evidence of all good faith efforts that were implemented, including any advertisements, solicitations and other specific actions demonstrating recruitment and selection of minority businesses for participation in the contract.

Note: Bidders must always submit **with their bid** the Identification of Minority Business Participation Form listing all MB contractors, vendors and suppliers that will be used. If there is no MB participation, then enter none or zero on the form. Affidavit **A** or Affidavit **B**, as applicable, also must be submitted with the bid. Failure to file a required affidavit or documentation with the bid or after being notified apparent low bidder is grounds for rejection of the bid.

Proposal Signature Page

The undersigned further agrees that in the case of failure on his part to execute the said contract and the bonds within ten (10) consecutive calendar days after being given written notice of the award of contract, the certified check, cash or bid bond accompanying this bid shall be paid into the funds of the owner's account set aside for the project, as liquidated damages for such failure; otherwise the certified check, cash or bid bond accompanying this proposal shall be returned to the undersigned.

Respectfully submitted this day of _____

(Name of firm or corporation making bid)

WITNESS:

(Proprietorship or Partnership)

By: _____
Signature

Name: _____
Print or type

Title _____
(Owner/Partner/Pres./V.Pres)

Address _____

ATTEST:

By: _____

Title: _____
(Corp. Sec. or Asst. Sec. only)

License No. _____

Federal I.D. No. _____

Email Address: _____

(CORPORATE SEAL)

Addendum received and used in computing bid:

Addendum No. 1 _____ Addendum No. 3 _____ Addendum No. 5 _____ Addendum No. 6 _____

Addendum No. 2 _____ Addendum No. 4 _____ Addendum No. 6 _____ Addendum No. 7 _____

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State of North Carolina AFFIDAVIT A – Listing of Good Faith Efforts

County of _____

(Name of Bidder)

Affidavit of _____

I have made a good faith effort to comply under the following areas checked:

Bidders must earn at least 50 points from the good faith efforts listed for their bid to be considered responsive. (1 NC Administrative Code 30 I.0101)

- ☐ **1 – (10 pts)** Contacted minority businesses that reasonably could have been expected to submit a quote and that were known to the contractor, or available on State or local government maintained lists, at least 10 days before the bid date and notified them of the nature and scope of the work to be performed.
- ☐ **2 --(10 pts)** Made the construction plans, specifications and requirements available for review by prospective minority businesses, or providing these documents to them at least 10 days before the bids are due.
- ☐ **3 – (15 pts)** Broken down or combined elements of work into economically feasible units to facilitate minority participation.
- ☐ **4 – (10 pts)** Worked with minority trade, community, or contractor organizations identified by the Office of Historically Underutilized Businesses and included in the bid documents that provide assistance in recruitment of minority businesses.
- ☐ **5 – (10 pts)** Attended prebid meetings scheduled by the public owner.
- ☐ **6 – (20 pts)** Provided assistance in getting required bonding or insurance or provided alternatives to bonding or insurance for subcontractors.
- ☐ **7 – (15 pts)** Negotiated in good faith with interested minority businesses and did not reject them as unqualified without sound reasons based on their capabilities. Any rejection of a minority business based on lack of qualification should have the reasons documented in writing.
- ☐ **8 – (25 pts)** Provided assistance to an otherwise qualified minority business in need of equipment, loan capital, lines of credit, or joint pay agreements to secure loans, supplies, or letters of credit, including waiving credit that is ordinarily required. Assisted minority businesses in obtaining the same unit pricing with the bidder's suppliers in order to help minority businesses in establishing credit.
- ☐ **9 – (20 pts)** Negotiated joint venture and partnership arrangements with minority businesses in order to increase opportunities for minority business participation on a public construction or repair project when possible.
- ☐ **10 - (20 pts)** Provided quick pay agreements and policies to enable minority contractors and suppliers to meet cash-flow demands.

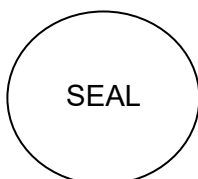
The undersigned, if apparent low bidder, will enter into a formal agreement with the firms listed in the Identification of Minority Business Participation schedule conditional upon scope of contract to be executed with the Owner. Substitution of contractors must be in accordance with GS143-128.2(d) Failure to abide by this statutory provision will constitute a breach of the contract.

The undersigned hereby certifies that he or she has read the terms of the minority business commitment and is authorized to bind the bidder to the commitment herein set forth.

Date: _____ Name of Authorized Officer: _____

Signature: _____

Title: _____



State of _____, County of _____

Subscribed and sworn to before me this _____ day of _____ 20____

Notary Public _____

My commission expires _____

**State of North Carolina --AFFIDAVIT B-- Intent to Perform Contract
with Own Workforce.**

County of _____

Affidavit of _____
(Name of Bidder)

I hereby certify that it is our intent to perform 100% of the work required for the _____
_____ contract.
(Name of Project)

In making this certification, the Bidder states that the Bidder does not customarily subcontract elements of this type project, and normally performs and has the capability to perform and will perform all elements of the work on this project with his/her own current work forces; and

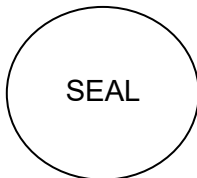
The Bidder agrees to provide any additional information or documentation requested by the owner in support of the above statement. The Bidder agrees to make a Good Faith Effort to utilize minority suppliers where possible.

The undersigned hereby certifies that he or she has read this certification and is authorized to bind the Bidder to the commitments herein contained.

Date: _____ Name of Authorized Officer: _____

Signature: _____

Title: _____



State of _____, County of _____

Subscribed and sworn to before me this _____ day of _____ 20____

Notary Public _____

My commission expires _____

State of North Carolina - AFFIDAVIT C - Portion of the Work to be Performed by HUB Certified/Minority Businesses

County of _____

(Note this form is to be submitted only by the apparent lowest responsible, responsive bidder.)

If the portion of the work to be executed by HUB certified/minority businesses as defined in GS143-128.2(g) and 128.4(a),(b),(e) is equal to or greater than 10% of the bidders total contract price, then the bidder must complete this affidavit.

This affidavit shall be provided by the apparent lowest responsible, responsive bidder within **72 hours** after notification of being low bidder.

Affidavit of _____ I do hereby certify that on the
(Name of Bidder)

(Project Name)
Project ID# _____ Amount of Bid \$ _____

I will expend a minimum of _____% of the total dollar amount of the contract with minority business enterprises. Minority businesses will be employed as construction subcontractors, vendors, suppliers or providers of professional services. Such work will be subcontracted to the following firms listed below.

Attach additional sheets if required

Name and Phone Number	*Minority Category	**HUB Certified Y/N	Work Description	Dollar Value

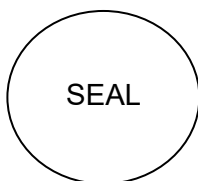
*Minority categories: Black, African American (**B**), Hispanic (**H**), Asian American (**A**) American Indian (**I**), Female (**F**) Socially and Economically Disadvantaged (**D**)

**** HUB Certification with the state HUB Office required to be counted toward state participation goals.**

Pursuant to GS143-128.2(d), the undersigned will enter into a formal agreement with Minority Firms for work listed in this schedule conditional upon execution of a contract with the Owner. Failure to fulfill this commitment may constitute a breach of the contract.

The undersigned hereby certifies that he or she has read the terms of this commitment and is authorized to bind the bidder to the commitment herein set forth.

Date: _____ Name of Authorized Officer: _____



Signature: _____

Title: _____

State of _____, County of _____

Subscribed and sworn to before me this _____ day of _____ 20____

Notary Public _____

My commission expires _____

State of North Carolina AFFIDAVIT D – Good Faith Efforts

County of _____

(Note this form is to be submitted only by the apparent lowest responsible, responsive bidder.)

If the goal of 10% participation by HUB Certified/ minority business **is not** achieved, the Bidder shall provide the following documentation to the Owner of his good faith efforts:

Affidavit of _____ I do hereby certify that on the _____
(Name of Bidder)

Project ID# _____ (Project Name) Amount of Bid \$ _____

I will expend a minimum of _____% of the total dollar amount of the contract with HUB certified/ minority business enterprises. Minority businesses will be employed as construction subcontractors, vendors, suppliers or providers of professional services. Such work will be subcontracted to the following firms listed below. (Attach additional sheets if required)

Name and Phone Number	*Minority Category	**HUB Certified Y/N	Work Description	Dollar Value

*Minority categories: Black, African American (**B**), Hispanic (**H**), Asian American (**A**) American Indian (**I**), Female (**F**) Socially and Economically Disadvantaged (**D**)

**** HUB Certification with the state HUB Office required to be counted toward state participation goals.**

Examples of documentation that may be required to demonstrate the Bidder's good faith efforts to meet the goals set forth in these provisions include, but are not necessarily limited to, the following:

- Copies of solicitations for quotes to at least three (3) minority business firms from the source list provided by the State for each subcontract to be let under this contract (if 3 or more firms are shown on the source list). Each solicitation shall contain a specific description of the work to be subcontracted, location where bid documents can be reviewed, representative of the Prime Bidder to contact, and location, date and time when quotes must be received.
- Copies of quotes or responses received from each firm responding to the solicitation.
- A telephone log of follow-up calls to each firm sent a solicitation.
- For subcontracts where a minority business firm is not considered the lowest responsible sub-bidder, copies of quotes received from all firms submitting quotes for that particular subcontract.
- Documentation of any contacts or correspondence to minority business, community, or contractor organizations in an attempt to meet the goal.
- Copy of pre-bid roster
- Letter documenting efforts to provide assistance in obtaining required bonding or insurance for minority business.
- Letter detailing reasons for rejection of minority business due to lack of qualification.
- Letter documenting proposed assistance offered to minority business in need of equipment, loan capital, lines of credit, or joint pay agreements to secure loans, supplies, or letter of credit, including waiving credit that is ordinarily required.

Failure to provide the documentation as listed in these provisions may result in rejection of the bid and award to the next lowest responsible and responsive bidder.

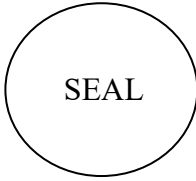
Pursuant to GS143-128.2(d), the undersigned will enter into a formal agreement with Minority Firms for work listed in this schedule conditional upon execution of a contract with the Owner. Failure to fulfill this commitment may constitute a breach of the contract.

The undersigned hereby certifies that he or she has read the terms of this commitment and is authorized to bind the bidder to the commitment herein set forth.

Date: _____ Name of Authorized Officer: _____

Signature: _____

Title: _____



State of _____, County of _____

Subscribed and sworn to before me this _____ day of _____ 20____

Notary Public _____

My commission expires _____

FORM OF BID BOND

KNOW ALL MEN BY THESE PRESENTS THAT _____

_____ as
principal, and _____, as surety, who is
duly licensed to act as surety in North Carolina, are held and firmly bound unto the State of
North Carolina* through _____ as
obligee, in the penal sum of _____ DOLLARS, lawful money of
the United States of America, for the payment of which, well and truly to be made, we bind
ourselves, our heirs, executors, administrators, successors and assigns, jointly and
severally, firmly by these presents.

Signed, sealed and dated this ____ day of ____ 20__

WHEREAS, the said principal is herewith submitting proposal for
and the principal desires to file this bid bond in lieu of making
the cash deposit as required by G.S. 143-129.

NOW, THEREFORE, THE CONDITION OF THE ABOVE OBLIGATION is such, that
if the principal shall be awarded the contract for which the bid is submitted and shall
execute the contract and give bond for the faithful performance thereof within ten days after
the award of same to the principal, then this obligation shall be null and void; but if the
principal fails to so execute such contract and give performance bond as required by G.S.
143-129, the surety shall, upon demand, forthwith pay to the obligee the amount set forth in
the first paragraph hereof. Provided further, that the bid may be withdrawn as provided by
G.S. 143-129.1

_____(SEAL)

_____(SEAL)

_____(SEAL)

_____(SEAL)

_____(SEAL)

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FORM OF CONSTRUCTION CONTRACT

(ALL PRIME CONTRACTS)

THIS AGREEMENT, made the _____ day of _____ in the year of
20__ by _____ and _____ between _____

hereinafter called the Party of the First Part and the State of North Carolina, through
the _____

_____ hereinafter called
the Party of the Second Part.

WITNESSETH:

That the Party of the First Part and the Party of the Second Part for the
consideration herein named agree as follows:

1. Scope of Work: The Party of the First Part shall furnish and deliver all of the
materials, and perform all of the work in the manner and form as provided by the following
enumerated plans, specifications and documents, which are attached hereto and made a
part thereof as if fully contained herein: advertisement; Instructions to Bidders; General
Conditions; Supplementary General Conditions; specifications; accepted proposal;
contract; performance bond; payment bond; power of attorney; workmen's compensation;
public liability; property damage and builder's risk insurance certificates; approval of
attorney general; certificate by the Office of State Budget and Management, and drawings,
titled:

Consisting of the following sheets:

Dated: _____ and the following addenda:

Addendum No. _____ Dated: _____ Addendum No. _____ Dated: _____

Addendum No. _____ Dated: _____ Addendum No. _____ Dated: _____

Addendum No. _____ Dated: _____ Addendum No. _____ Dated: _____

Addendum No. _____ Dated: _____ Addendum No. _____ Dated: _____

2. That the Party of the First Part shall commence work to be performed under this
agreement on a date to be specified in a written order of the Party of the Second Part and
shall fully complete all work hereunder within _____ consecutive calendar days

from said date. For each day in excess thereof, liquidated damages shall be as stated in Supplementary General Conditions. The Party of the First Part, as one of the considerations for the awarding of this contract, shall furnish to the Party of the Second Part a construction schedule setting forth planned progress of the project broken down by the various divisions or part of the work and by calendar days as outlined in Article 14 of the General Conditions of the Contract.

3. The Party of the Second Part hereby agrees to pay to the Party of the First Part for the faithful performance of this agreement, subject to additions and deductions as provided in the specifications or proposal, in lawful money of the United States as follows:

(\$ _____).

Summary of Contract Award:

4. In accordance with Article 31 and Article 32 of the General Conditions of the Contract, the Party of the Second Part shall review, and if approved, process the Party of the First Party's pay request within 30 days upon receipt from the Designer. The Party of the Second Part, after reviewing and approving said pay request, shall make payments to the Party of the First Part on the basis of a duly certified and approved estimate of work performed during the preceding calendar month by the First Party, less five percent (5%) of the amount of such estimate which is to be retained by the Second Party until all work has been performed strictly in accordance with this agreement and until such work has been accepted by the Second Party. The Second Party may elect to waive retainage requirements after 50 percent of the work has been satisfactorily completed on schedule as referred to in Article 31 of the General Conditions.

5. Upon submission by the First Party of evidence satisfactory to the Second Party that all payrolls, material bills and other costs incurred by the First Party in connection with the construction of the work have been paid in full, final payment on account of this agreement shall be made within thirty (30) days after the completion by the First Party of all work covered by this agreement and the acceptance of such work by the Second Party.

6. It is further mutually agreed between the parties hereto that if at any time after the execution of this agreement and the surety bonds hereto attached for its faithful performance, the Second Party shall deem the surety or sureties upon such bonds to be unsatisfactory, or if, for any reason, such bonds cease to be adequate to cover the performance of the work, the First Party shall, at its expense, within five (5) days after the receipt of notice from the Second Party so to do, furnish an additional bond or bonds in such form and amount, and with such surety or sureties as shall be satisfactory to the Second Party. In such event no further payment to the First Party shall be deemed to be due under this agreement until such new or additional security for the faithful performance of the work shall be furnished in manner and form satisfactory to the Second Party.

7. The Party of the First Part attest that it and all of its subcontractors have fully complied with all requirements of NCGS 64 Article 2 in regards to E-Verification as required by Section 2.(c) of Session Law 2013-418, codified as N.C. Gen. Stat. § 143-129(j).

IN WITNESS WHEREOF, the Parties hereto have executed this agreement on the day and date first above written in _____ counterparts, each of which shall without proof or accounting for other counterparts, be deemed an original contract.

Witness:

Contractor: (Trade or Corporate Name)

(Proprietorship or Partnership)

By: _____

Title: _____
(Owner, Partner, or Corp. Pres. or Vice Pres. only)

Attest: (Corporation)

By: _____

Title: _____
(Corp. Sec. or Asst. Sec. only)

The State of North Carolina through*

(CORPORATE SEAL)

(Agency, Department or Institution)

Witness:

By: _____

Title: _____

FORM OF PERFORMANCE BOND

Date of Contract: _____

Date of Execution: _____

Name of Principal
(Contractor) _____

Name of Surety: _____

Name of Contracting
Body: _____

Amount of Bond: _____

Project _____

KNOW ALL MEN BY THESE PRESENTS, that we, the principal and surety above named, are held and firmly bound unto the above named contracting body, hereinafter called the contracting body, in the penal sum of the amount stated above for the payment of which sum well and truly to be made, we bind, ourselves, our heirs, executors, administrators, and successors, jointly and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION IS SUCH, that whereas the principal entered into a certain contract with the contracting body, identified as shown above and hereto attached:

NOW, THEREFORE, if the principal shall well and truly perform and fulfill all the undertakings, covenants, terms, conditions and agreements of said contract during the original term of said contract and any extensions thereof that may be granted by the contracting body, with or without notice to the surety, and during the life of any guaranty required under the contract, and shall also well and truly perform and fulfill all the undertakings, covenants, terms, conditions and agreements of any and all duly authorized modifications of said contract that may hereafter be made, notice of which modifications to the surety being hereby waived, then, this obligation to be void; otherwise to remain in full force and virtue.

IN WITNESS WHEREOF, the above-bounden parties have executed this instrument under their several seals on the date indicated above, the name and corporate seal of each corporate party being hereto affixed and these presents duly signed by its undersigned representative, pursuant to authority of its governing body.

Executed in _____ counterparts.

Witness:

(Proprietorship or Partnership)

Attest: (Corporation)

By: _____

Title: _____
(Corp. Sec. or Asst. Sec. only)

(Corporate Seal)

Witness:

Countersigned:

(N.C. Licensed Resident Agent)

Name and Address-Surety Agency

Surety Company Name and N.C.
Regional or Branch Office Address

Contractor: (Trade or Corporate Name)

By: _____

Title: _____
(Owner, Partner, or Corp. Pres. or Vice
Pres. only)

(Surety Company)

By: _____

Title: _____
(Attorney in Fact)

(Surety Corporate Seal)

FORM OF PAYMENT BOND

Date of Contract: _____

Date of Execution: _____

Name of Principal
(Contractor) _____

Name of Surety: _____

Name of Contracting
Body: _____

Amount of Bond: _____

Project _____

KNOW ALL MEN BY THESE PRESENTS, that we, the principal and surety above named, are held and firmly bound unto the above named contracting body, hereinafter called the contracting body, in the penal sum of the amount stated above for the payment of which sum well and truly to be made, we bind ourselves, our heirs, executors, administrators, and successors, jointly and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION IS SUCH, that whereas the principal entered into a certain contract with the contracting body identified as shown above and hereto attached:

NOW, THEREFORE, if the principal shall promptly make payment to all persons supplying labor/material in the prosecution of the work provided for in said contract, and any and all duly authorized modifications of said contract that may hereafter be made, notice of which modifications to the surety being hereby waived, then this obligation to be void; otherwise to remain in full force and virtue.

IN WITNESS WHEREOF, the above-bounden parties have executed this instrument under their several seals on the date indicated above, the name and corporate seal of each corporate party being hereto affixed and these presents duly signed by its undersigned representative, pursuant to authority of its governing body.

Executed in _____ counterparts.

Witness:

(Proprietorship or Partnership)

Attest: (Corporation)

By: _____

Title: _____
(Corp. Sec. or Asst. Sec.. only)

(Corporate Seal)

Witness:

Countersigned:

(N.C. Licensed Resident Agent)

Name and Address-Surety Agency

Surety Company Name and N.C.
Regional or Branch Office Address

Contractor: (Trade or Corporate Name)

By: _____

Title _____
(Owner, Partner, or Corp. Pres. or Vice
Pres. only)

(Surety Company)

By: _____

Title: _____
(Attorney in Fact)

(Surety Corporate Seal)

Sheet for Attaching Power of Attorney

Sheet for Attaching Insurance Certificates

APPROVAL OF THE ATTORNEY GENERAL

**CERTIFICATION BY THE OFFICE OF STATE
BUDGET AND MANAGEMENT**

Provision for the payment of money to fall due and payable by the

under this agreement has been provided for by allocation made and is available for the purpose of carrying out this agreement.

This _____ day of _____ 20____.

Signed _____
Budget Officer

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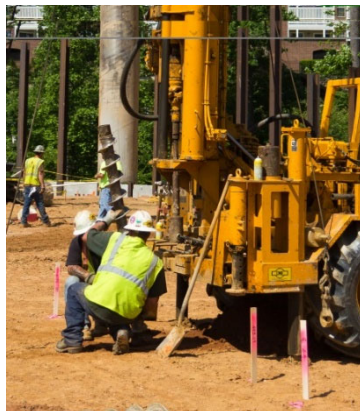
SECTION 003132- GEOTECHNICAL DATA

1.1 GEOTECHNICAL DATA

- A. This Document with its referenced attachments is part of the Procurement and Contracting Requirements for Project. They provide Owner's information for Bidders' convenience and are intended to supplement rather than serve in lieu of Bidders' own investigations. They are made available for Bidders' convenience and information but are not a warranty of existing conditions. This Document and its attachments are not part of the Contract Documents.
- B. A geotechnical investigation report for the original building, prepared by ECS Southeast, LLP, dated September 22, 2022, is available for viewing as appended to this Document
- C. The Owner will engage a Construction Materials Testing firm to test and approve subgrades and verify the presumed allowable soil bearing pressures

END OF SECTION 003132

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ECS Southeast, LLP

Geotechnical Engineering Report

Translational Research Facility NCSU Code 42124

1060 William Moore Drive
Raleigh, NC 27606

ECS Project No. 06:24928

September 22, 2022





ECS SOUTHEAST, LLP

"Setting the Standard for Service"

Geotechnical • Construction Materials • Environmental • Facilities

September 22, 2022

Ms. Laura L. Zaytoun, RA
Design Project Manager
North Carolina State University
Administrative Services Building III
2601 Wolf Village Way, Suite 331
Raleigh, NC 27695-7520

ECS Project No. 06:24928

Reference: Geotechnical Engineering Report
Translational Research Facility NCS Code 42124
1060 William Moore Drive
Raleigh, Wake County, NC 27606

Dear Ms. Zaytoun:

ECS Southeast, LLP (ECS) has completed the subsurface exploration, laboratory testing, and geotechnical engineering analyses for the above-referenced project. Our services were performed in general accordance with our agreed to scope of work. This report presents our understanding of the geotechnical aspects of the project along with the results of the field exploration and laboratory testing conducted, and our design and construction recommendations.

It has been our pleasure to be of service to North Carolina State University during the design phase of this project. We would appreciate the opportunity to remain involved during the continuation of the design phase, and we would like to provide our services during construction phase operations as well to verify subsurface conditions assumed for this report. Should you have any questions concerning the information contained in this report, or if we can be of further assistance to you, please contact us.

Respectfully submitted,

ECS Southeast, LLP

Blake A. Hash, E.I.
Geotechnical Project Manager
Bhash@ecslimited.com

Winslow E. Goins
Principal Engineer
Wgoins@ecslimited.com



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APPENDICES

Appendix A – Drawings & Reports

- Site Location Diagram
- Boring Location Plan
- Generalized Subsurface Profile A-A'

Appendix B – Field Operations

- Reference Notes for Boring Logs
- Subsurface Exploration Procedure: Standard Penetration Testing (SPT)
- Boring Logs

EXECUTIVE SUMMARY

This Executive Summary is intended as a very brief overview of the primary geotechnical conditions that are expected to affect design and construction. Information gleaned from this Executive Summary should not be utilized in lieu of reading the entire geotechnical report.

- The planned building should be supported by conventional shallow foundations consisting of strip footings bearing on engineered fill. The footings should be sized using a net allowable soil bearing pressure of 2,500 psf.
- Based on the existing ground surface elevations and the provided FFE 453.50, the structural fill material required to bring the building pad to design grades (approximately 8 feet to 9 feet of fill) would effectively create the separation distance recommend. Thus, we anticipate no undercutting of the Fat Clay (CH) material would be required.
- Based on the N-values measured in the borings, a Seismic Site Class D designation is appropriate for seismic design of the proposed buildings.
- Provided a base course layer is implemented in the slab section, the slabs may be designed using a modulus of subgrade reaction of 150 psi/in.
- ECS should be retained to review the design documents for conformance with our recommendations and should be retained for construction materials testing and special inspections to facilitate proper implementation of our recommendations.

1.0 INTRODUCTION

1.1 GENERAL

The purpose of this study was to provide geotechnical information for the design of the proposed building foundations and floor slab. According to information provided to ECS, the proposed project consists of a research facility building.

The recommendations developed for this report are based on the results of our subsurface exploration and project information provided by North Carolina State University. This report contains the results of our subsurface exploration and laboratory testing programs, site characterization, engineering analyses, and recommendations for the design and construction of the planned development.

1.2 SCOPE OF SERVICES

The purposes of this exploration were to explore the soil and groundwater conditions at the site and to develop engineering recommendations to guide design and construction of the proposed project.

We accomplished the purposes of the study by:

- Reviewing the available publications concerning local geology of the site and performing a general site reconnaissance.
- Drilling borings to explore the subsurface soil and groundwater conditions.
- Performing laboratory tests on selected representative soil samples from the borings to evaluate pertinent engineering properties.
- Evaluating the field and laboratory data to develop appropriate engineering recommendations.

1.3 AUTHORIZATION

Our services were provided in accordance with our Proposal No. 06:23457, dated August 29, 2022, as authorized by D.G. Morton of NC State University on September 2, 2022, which includes our Terms and Conditions of Service.

2.0 PROJECT INFORMATION

This report is based on the following sources of information:

- Emails between Laura Zaytoun with NC State and Santhosh Mahavadi with ECS on August 29, 2022
- Preliminary Utility Plan C-300 prepared by NV5 Engineers & Consultants, Inc. dated June 3, 2022.
- Google Earth aerial photos dated between December 1985 and March 2022.
- Site and topographic information obtained from the Wake County GIS website.
- United States Geologic Survey Quadrangle Map (Google Earth overlay kmz file).
- Geologic Map of North Carolina.
- Web Soil Survey Soil Map and soils data.

2.1 SITE INFORMATION

The site is located on the north side of Terry Curtin Drive and the east side of Horse Lane in Raleigh, North Carolina. A Site Location Diagram is provided in Appendix A (Figure 1).

ECS understands that the property is currently an undeveloped cleared parcel. The ground surface at the site is relatively level. The site generally slopes downward from the south to the north.

The ESRI imagery below shows the general existing conditions of the site.



Current Site Condition

2.2 PROPOSED CONSTRUCTION

The following information explains our understanding of the planned development including proposed building.

SUBJECT	DESIGN INFORMATION / ASSUMPTIONS
# of Stories	1-story above grade
Usage	Mixed use, office and laboratory, research facility
Framing	Masonry load bearing walls
Wall Loads	3 kips per linear foot (klf), maximum unfactored
Ground Floor Slab Load	150 pounds per square foot (psf), maximum unfactored (assumed)

The structural engineer should verify these assumptions and notify ECS if the actual unfactored foundation design loads exceed or are significantly less than these assumed values. Design grades have not been provided to us.

3.0 FIELD EXPLORATION AND LABORATORY TESTING

To explore the subsurface conditions at this site, a total of 4 soil test borings were performed in the proposed development area. The borings have been performed in the proposed developed areas to depths below existing grades as shown below.

Boring No.	Proposed Structure/Site Feature	Boring Depth (feet)
B-1	Building	25
B-2	Building	25
B-3	Building	25
B-4	Building	25

The borings were located by an ECS representative who used a handheld GPS unit and their approximate locations are shown on the Boring Location Plan (Figure 2) in Appendix A. Our exploration procedures are explained in greater detail in Appendix B including the insert titled Subsurface Exploration Procedure: Standard Penetration Testing (SPT).

3.1 SUBSURFACE CHARACTERIZATION

3.1.1 Regional Geology

The site is located within the Piedmont physiographic province. The Piedmont is characterized by residual overburden soils weathered in place from the underlying igneous and metamorphic rock. The topography and relief of the Piedmont uplands have developed from differential weathering of the bedrock. Because of the continued chemical and physical weathering, the bedrock in the Piedmont is now generally covered with a mantle of soil that has weathered in place from the parent bedrock. These soils have variable

thicknesses and are referred to as residuum or residual soils. The residuum is typically finer grained and has higher clay content near the surface because of the advanced weathering. Similarly, the soils typically become coarser grained with increasing depth because of decreased weathering. As the degree of weathering decreases, the residual soils generally retain the overall appearance, texture, gradation and foliations of the parent rock.

The boundary between soil and rock in the Piedmont is not sharply defined. A transitional zone termed “partially weathered rock” is normally found overlying the parent bedrock. Partially weathered rock (PWR) is defined for engineering purposes as residual material with Standard Penetration Resistances (N-values) exceeding 100 blows per foot. The transition between hard/dense residual soils and partially weathered rock occurs at irregular depths due to variations in degree of weathering. Also, it is not unusual to find lenses and boulders of hard rock and/or zones of partially weathered rock within the soil mantle well above the general bedrock level.

According to the 1985 Geologic Map of North Carolina, the site is underlain by felsic mica gneiss of Cambrian age (Czfg). This formation consists of biotite gneiss and schist intruded by numerous igneous sills and dikes of granite, pegmatite, and aplite.

3.1.2 Soil Conditions

Data from the soil test borings is included in the Appendix. The subsurface conditions discussed in the following paragraphs and those shown on the boring logs represent an estimate of the subsurface conditions based on interpretation of the boring data using normally accepted geotechnical engineering judgments. We note that the transition between different soil strata is usually less distinct than those shown on the boring logs. Please refer to individual boring logs that are contained in Appendix B.

Stratum	Description	Ranges of SPT ⁽¹⁾ N-values (bpf ⁽²⁾)
n/a	Topsoil – The surface layer at all of the boring locations consisted of approximately 3 inches of topsoil at the test locations. Thicknesses are expected to be variable across the project site. Observed topsoil depths do not include root balls which could be significantly deeper and are also not recommended for support of structures.	N/A
I	Residual Soils – Beneath the topsoil soils are residual soils described as firm to very stiff Silt/lean Clay/fat Clay (ML/CL/CH).	7 to 17

Notes: (1) Standard Penetration Testing.
(2) bpf – Blows per foot.

3.2 GROUNDWATER OBSERVATIONS

Groundwater was not encountered at the time of drilling the test borings onsite. Variations in the long-term water table may occur as a result of changes in precipitation, evaporation, surface water runoff, construction activities, and other factors.

3.3 LABORATORY TESTING

Classification and index property tests were performed by ECS on representative soil samples obtained from the test borings in order to aid in classifying soils according to the Unified Soil Classification System. Each sample was visually classified on the basis of texture and plasticity in accordance with ASTM D2488 Standard Practice for Description and Identification of Soils (Visual-Manual Procedures) and including USCS classification symbols, and ASTM D2487 Standard Practice for Classification for Engineering Purposes (Unified Soil Classification System (USCS)). After classification, the samples were grouped in the major zones noted on the boring logs in Appendix B. The group symbols for each soil type are indicated in parentheses along with the soil descriptions.

4.0 DESIGN RECOMMENDATIONS

4.1 IMPACTS ON SITE DEVELOPMENT AND DESIGN

Geotechnical related concerns identified during this study that may impact the project include: 1) the presence of highly plastic fat clay soils (CH). To help mitigate the effect of the highly plastic material with high shrink/swell properties we recommend providing a minimum 24-inch separation between any highly elastic and plastic soils and the bottom of shallow foundations and floor slabs. The separation material could consist of low plasticity structural fill (outlined in this report) or lime treated soils.

We understand that the planned FFE (finished floor elevation) will be EL. 453.50. The structural fill that would be required to bring the building pad to design grades would effectively provide the separation distance recommended. Thus, we do not anticipate undercutting of this material will be required.

4.2 SHALLOW SPREAD FOOTING FOUNDATIONS

Provided subgrades and engineered fills are prepared as discussed herein, and based on the assumed design foundation loads, the proposed building can be supported by conventional shallow spread footing foundations. These include continuous wall footings. The design of the shallow foundations should utilize the following parameters:

Foundation Design

Design Parameter	Wall Footing
Net Allowable Bearing Pressure ⁽¹⁾	2,500 psf
Acceptable Bearing Soil Material	Stiff Silts/Clays, Medium Dense Sands, Engineered fill
Minimum Width	16 inches
Minimum Footing Embedment Depth (below slab or finished grade) ⁽²⁾	12 inches ²
Estimated Total Settlement ⁽³⁾	Less than 1 inch
Estimated Differential Settlement ⁽⁴⁾	Less than 0.5 inches over 50 feet

Notes:

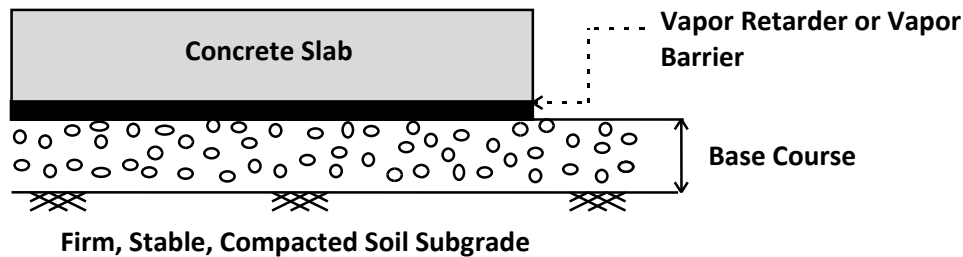
- (1) Net allowable bearing pressure is the applied pressure in excess of the surrounding overburden soils above the base of the foundation.
- (2) For bearing considerations and frost penetration requirements.
- (3) Based on assumed structural loads. If final loads are different, ECS must be contacted to update foundation recommendations and settlement calculations.
- (4) Based on anticipated range of column/wall loads and variability in borings. Differential settlement can be re-evaluated once the foundation plans are more complete.

4.3 SLABS ON GRADE

Floor Slabs Above Exterior Grades: The on-site lower plasticity natural soils and new engineered fill are considered suitable for support of the ground floor slabs, although moisture control during earthwork operations, including the use of diskings or appropriate drying equipment, may be necessary. A minimum separation of 1 foot should be maintained between the floor slab subgrade elevation and Elastic SILT (MH) or Fat CLAY (CH).

We understand that the ground floor slabs-on-grade will be at or above finish exterior grades around the entire building footprints. For this case, the 2018 North Carolina Building Code does not require damproofing or waterproofing of the slab. However, depending on floor coverings and building use, a capillary break layer and vapor retarder should be installed to prevent excessive moisture from coming in contact with the concrete floor slab from the soils below.

The following graphic depicts our soil-supported slab recommendations:



Floor Slab Section

1. Base Course Layer Thickness: 4 inches
2. Base Course Layer Material: A compactable granular fill that will remain stable and support construction traffic. At least 10% to 30% of the material should pass a No. 100 sieve with a maximum aggregate size of ¾ inch. Suitable materials are GRAVEL (ABC, GW, GW-SM), SAND (SP-SM, SW-SM), and SILTY SAND (SM) with less than 30% fines.
3. Base Course Layer Material should be compacted to at least 98% maximum dry density per ASTM D698.
4. Undisturbed natural subgrade should proofroll as firm and stable. Upper 1 foot of engineered fill subgrade should be compacted to at least **98%** maximum dry density per ASTM D698
5. Vapor Barrier or Vapor Retarder – Refer to ACI 302.1R-04 Guide for Concrete Floor and Slab Construction and ASTM E 1643 Standard Practice for Installation of Water Vapor Retarders Used in Contact with Earth or Granular Fill under Concrete Slabs for recommendations on this issue. Additionally, any environmental vapor intrusions considerations should be taken into account by the vapor barrier/vapor retarder material selection and design.

Provided a base course layer is implemented in the slab section, the slabs may be designed using a modulus of subgrade reaction of 150 psi/in. This value is applicable for design of slabs subject to point loads, and should be reduced based on loaded area for uniform sustained distributed loads.

4.5 SEISMIC DESIGN CONSIDERATIONS

Seismic Site Classification: The International Building Code (IBC) requires site classification for seismic design based on the upper 100 feet of a soil profile. Two primary methods are utilized in classifying sites, namely the shear wave velocity (v_s) method and the Standard Penetration Resistance (N-value) method, as indicated in the following table.

The N-value method was used for this project. Based on our exploration, a Seismic Site Class D is recommended for this project.

SEISMIC SITE CLASSIFICATION			
Site Class	Soil Profile Name	Shear Wave Velocity, V_s , (ft./s)	N value (bpf)
A	Hard Rock	$V_s > 5,000$ fps	N/A
B	Rock	$2,500 < V_s \leq 5,000$ fps	N/A
C	Very dense soil and soft rock	$1,200 < V_s \leq 2,500$ fps	>50
D	Stiff Soil Profile	$600 \leq V_s \leq 1,200$ fps	15 to 50
E	Soft Soil Profile	$V_s < 600$ fps	<15

5.0 SITE CONSTRUCTION RECOMMENDATIONS

5.1 SUBGRADE PREPARATION

5.1.1 Stripping and Grubbing

The subgrade preparation should consist of stripping all vegetation, rootmat, topsoil, existing fill, and any soft or unsuitable materials from proposed building footprint. The onsite test borings encountered 3 to 4 inches of topsoil. ECS should be retained to verify that topsoil and unsuitable surficial materials have been removed prior to the placement of structural fill or construction of structures.

5.1.2 Proof-rolling

Prior to fill placement or other construction on subgrades, the subgrades should be evaluated by ECS. The exposed subgrade should be thoroughly proof-rolled with construction equipment having a minimum axle load of 10 tons [e.g. fully loaded tandem-axle dump truck]. Proof-rolling should be traversed in two perpendicular directions with overlapping passes of the vehicle under the observation of ECS. This procedure is intended to assist in identifying any localized yielding materials.

Where proof-rolling identifies areas that are yielding or “pumping” subgrade those areas should be repaired prior to the placement of any subsequent Structural Fill or other construction materials. Methods of stabilization include undercutting, moisture conditioning, or chemical stabilization. The situation should be discussed with ECS to determine the appropriate procedure. Test pits may be excavated to explore the shallow subsurface materials to help in determining the cause of the observed yielding materials, and to assist in the evaluation of appropriate remedial actions to create a firm and unyielding subgrade.

5.2 EARTHWORK OPERATIONS

5.2.1 Excavation Considerations

Excavation Safety: Excavations and slopes should be made and maintained in accordance with OSHA excavation safety standards. The contractor is solely responsible for designing and constructing stable, temporary excavations and slopes and should shore, slope, or bench the sides of the excavations and slopes as required to maintain stability of both the excavation sides and bottom. The contractor’s responsible person, as defined in 29 CFR Part 1926, should evaluate the soil exposed in the excavations

as part of the contractor's safety procedures. In no case should slope height, slope inclination, or excavation depth, including utility trench excavation depth, exceed those specified in local, state, and federal safety regulations. ECS is providing this information solely as a service to our client. ECS is not assuming responsibility for construction site safety or the contractor's activities; such responsibility is not being implied and should not be inferred.

Excavability: Based on the assumed design grades, we anticipate that most of the natural soils encountered in the test borings can be removed with conventional earth excavation equipment such as track-mounted backhoes, loaders, or bulldozers.

5.2.2 High Plasticity Soils

High plasticity soils are those soil materials classified as fat Clay (CH) and elastic Silt (MH). Where high plasticity soils are encountered at design subgrade elevations in floor slabs and shallow foundations, the subgrade should be undercut 1 foot and grades restored with approved non-plastic Engineered Fill.

5.2.3 Engineered Fill

Product Submittals: At least one week prior to placement of engineered fill, representative bulk samples (about 50 pounds) of on-site and/or off-site borrow should be submitted to ECS for laboratory testing, which includes Atterberg limits, natural moisture content, grain-size distribution, and moisture-density relationships for compaction. Import materials should be tested prior to being hauled to the site to determine if they meet project specifications.

Engineered Fill Materials: Materials for use as Engineered Fill should consist of inorganic soils with the following engineering properties and compaction requirements.

ENGINEERED FILL SOIL INDEX PROPERTIES	
Subject	Property
Soil Classification	CL, ML, SM, SC, SW, SP, GW, GM or GC
Max. Particle Size	3 inches
LL and PI for Fill in Building and Pavement Areas	$LL \leq 40$, $PI \leq 20$
Minimum dry unit weight (in place)	≥ 90 pcf
Max. organic content	4% by dry weight

ENGINEERED FILL COMPACTION REQUIREMENTS	
Subject	Requirement
Compaction Standard	Standard Proctor, ASTM D698
Required Compaction	95% of Max. Dry Density (98% in the top 1 foot)
Moisture Content	± 3 % points of the soil's optimum value
Loose Thickness	8 inches prior to compaction

Poor Fill Materials: Poor fill materials include materials which do not satisfy the requirements for engineered materials, such as topsoil, organic materials, debris, debris-laden fill and highly plastic soils such as ELASTIC SILT (ML) and FAT CLAY (CH).

On-Site Borrow Suitability: The on-site soils meeting the classifications for recommended engineered fill, plus meeting the restrictions on separation distances, organic content, and debris, may be used as engineered fill. We anticipate that most of the soils encountered in the borings within the anticipated excavation depths to be suitable for use as engineered fill.

Fill Placement Considerations: Fill materials should not be placed on frozen soils, on frost-heaved soils, and/or on excessively wet soils. Borrow fill materials should not contain frozen materials at the time of placement, and all frozen or frost-heaved soils should be removed prior to placement of Structural Fill or other fill soils and aggregates. Excessively wet soils or aggregates should be scarified, aerated, and moisture conditioned. Fill material should be placed in horizontal lifts. Proper drainage should be maintained during the earthwork phases of construction to avoid ponding of water which can lead to degradation of the subgrade soils.

7.0 CLOSING

ECS has prepared this report to guide the geotechnical-related design and construction aspects of the project. We performed these services in accordance with the standard of care expected of professionals in the industry performing similar services on projects of like size and complexity at this time in the region. No other representation, expressed or implied, and no warranty or guarantee is included or intended in this report. ECS is not responsible for the conclusions, opinions, or recommendations of others based on the data in this report.

The description of the proposed project is based on information provided to ECS. If any of this information is inaccurate or changes, either because of our interpretation of the documents provided or site or design changes that may occur later, ECS should be contacted so we can review our recommendations and provide additional or alternate recommendations that reflect the proposed construction.

We recommend that ECS review the final project plans and specifications so we can confirm that those plans/specifications are in accordance with the recommendations of this geotechnical report.

Field observations, monitoring, and quality assurance testing during earthwork and foundation installation are an extension of and integral to the geotechnical design recommendation. We recommend that the owner retain these quality assurance services and that ECS be allowed to continue our involvement throughout these critical phases of construction to provide general consultation as issues arise. We would be pleased to provide an estimated cost for these services at the appropriate time.

This report is provided for the exclusive use of North Carolina State University and their project specific design team. This report is not intended to be used or relied upon in connection with other projects or by other third parties. ECS disclaims liability for any such third-party use or reliance without express written permission.

APPENDIX A – Diagrams & Reports

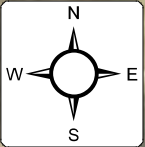
Site Location Diagram
Boring Location Plan
Generalized Subsurface Profile A-A'




SITE LOCATION DIAGRAM
TRANSLATIONAL RESEARCH FACILITY
NCSU CODE 42124
1060 WILLIAM MOORE DR., RALEIGH, NC
NC STATE UNIVERSITY




ENGINEER
SKM1
SCALE
AS NOTED
PROJECT NO.
06:24928
FIGURE
1 OF 1
DATE
9/16/2022



Legend

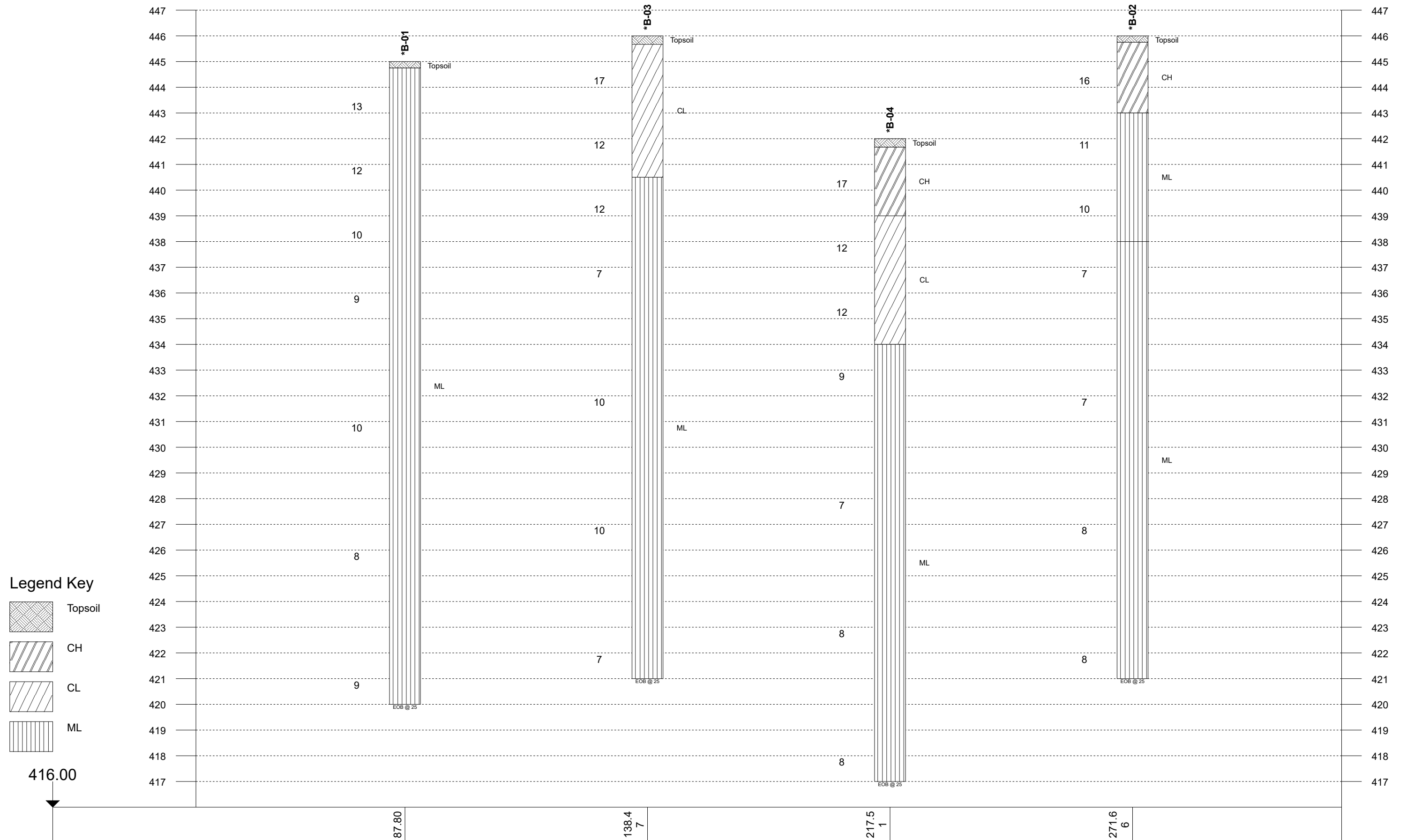
 Approximate Boring Locations

 Generalized Subsurface Profile





BORING LOCATION DIAGRAM
TRANSLATIONAL RESEARCH FACILITY
NCSU CODE 42124
1060 WILLIAM MOORE DR., RALEIGH, NC
NC STATE UNIVERSITY

ENGINEER
SKM1
SCALE
AS NOTED
PROJECT NO.
06:24928
FIGURE
1 OF 1
DATE
9/16/2022



Notes:

- 1- EOB: END OF BORING AR: AUGER REFUSAL SR: SAMPLER REFUSAL.
- 2- THE NUMBER BELOW THE STRIPS IS THE DISTANCE ALONG THE BASELINE.
- 3- SEE INDIVIDUAL BORING LOG AND GEOTECHNICAL INFORMATION.
- 4- STANDARD PENETRATION TEST RESISTANCE (LEFT OF BORING) IN BLOWS PER FOOT (ASTM D1586).

	WL (First Encountered)
	WL (Completion)
	WL (Seasonal High Water)
	WL (Stabilized)



Translational Research Facility NCSU Code 42124

NC State University

1060 William Moore Dr., Raleigh, North Carolina, 27606

Project No:	06:24928
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Date:	09/16/2022
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APPENDIX B – Field Operations

Reference Notes for Boring Logs

Subsurface Exploration Procedure: Standard Penetration Testing (SPT)

Boring Logs



REFERENCE NOTES FOR BORING LOGS

MATERIAL ^{1,2}	
	ASPHALT
	CONCRETE
	GRAVEL
	TOPSOIL
	VOID
	BRICK
	AGGREGATE BASE COURSE
	GW WELL-GRADED GRAVEL gravel-sand mixtures, little or no fines
	GP POORLY-GRADED GRAVEL gravel-sand mixtures, little or no fines
	GM SILTY GRAVEL gravel-sand-silt mixtures
	GC CLAYEY GRAVEL gravel-sand-clay mixtures
	SW WELL-GRADED SAND gravelly sand, little or no fines
	SP POORLY-GRADED SAND gravelly sand, little or no fines
	SM SILTY SAND sand-silt mixtures
	SC CLAYEY SAND sand-clay mixtures
	ML SILT non-plastic to medium plasticity
	MH ELASTIC SILT high plasticity
	CL LEAN CLAY low to medium plasticity
	CH FAT CLAY high plasticity
	OL ORGANIC SILT or CLAY non-plastic to low plasticity
	OH ORGANIC SILT or CLAY high plasticity
	PT PEAT highly organic soils

DRILLING SAMPLING SYMBOLS & ABBREVIATIONS			
SS	Split Spoon Sampler	PM	Pressuremeter Test
ST	Shelby Tube Sampler	RD	Rock Bit Drilling
WS	Wash Sample	RC	Rock Core, NX, BX, AX
BS	Bulk Sample of Cuttings	REC	Rock Sample Recovery %
PA	Power Auger (no sample)	RQD	Rock Quality Designation %
HSA	Hollow Stem Auger		

PARTICLE SIZE IDENTIFICATION		
DESIGNATION	PARTICLE SIZES	
Boulders	12 inches (300 mm) or larger	
Cobbles	3 inches to 12 inches (75 mm to 300 mm)	
Gravel: Coarse	¾ inch to 3 inches (19 mm to 75 mm)	
Fine	4.75 mm to 19 mm (No. 4 sieve to ¾ inch)	
Sand: Coarse	2.00 mm to 4.75 mm (No. 10 to No. 4 sieve)	
Medium	0.425 mm to 2.00 mm (No. 40 to No. 10 sieve)	
Fine	0.074 mm to 0.425 mm (No. 200 to No. 40 sieve)	
Silt & Clay ("Fines")	<0.074 mm (smaller than a No. 200 sieve)	

COHESIVE SILTS & CLAYS		
UNCONFINED COMPRESSIVE STRENGTH, QP ⁴	SPT ⁵ (BPF)	CONSISTENCY ⁷ (COHESIVE)
<0.25	<2	Very Soft
0.25 - <0.50	2 - 4	Soft
0.50 - <1.00	5 - 8	Firm
1.00 - <2.00	9 - 15	Stiff
2.00 - <4.00	16 - 30	Very Stiff
4.00 - 8.00	31 - 50	Hard
>8.00	>50	Very Hard

RELATIVE AMOUNT ⁷	COARSE GRAINED (%) ⁸	FINE GRAINED (%) ⁸
Trace	≤5	≤5
With	10 - 20	10 - 25
Adjective (ex: "Silty")	25 - 45	30 - 45

GRAVELS, SANDS & NON-COHESIVE SILTS	
SPT ⁵	DENSITY
<5	Very Loose
5 - 10	Loose
11 - 30	Medium Dense
31 - 50	Dense
>50	Very Dense

WATER LEVELS ⁶	
	WL (First Encountered)
	WL (Completion)
	WL (Seasonal High Water)
	WL (Stabilized)

FILL AND ROCK			
FILL	POSSIBLE FILL	PROBABLE FILL	ROCK

¹Classifications and symbols per ASTM D 2488-17 (Visual-Manual Procedure) unless noted otherwise.

²To be consistent with general practice, "POORLY GRADED" has been removed from GP, GP-GM, GP-GC, SP, SP-SM, SP-SC soil types on the boring logs.

³Non-ASTM designations are included in soil descriptions and symbols along with ASTM symbol [Ex: (SM-FILL)].

⁴Typically estimated via pocket penetrometer or Torvane shear test and expressed in tons per square foot (tsf).

⁵Standard Penetration Test (SPT) refers to the number of hammer blows (blow count) of a 140 lb. hammer falling 30 inches on a 2 inch OD split spoon sampler required to drive the sampler 12 inches (ASTM D 1586). "N-value" is another term for "blow count" and is expressed in blows per foot (bpf). SPT correlations per 7.4.2 Method B and need to be corrected if using an auto hammer.

⁶The water levels are those levels actually measured in the borehole at the times indicated by the symbol. The measurements are relatively reliable when augering, without adding fluids, in granular soils. In clay and cohesive silts, the determination of water levels may require several days for the water level to stabilize. In such cases, additional methods of measurement are generally employed.

⁷Minor deviation from ASTM D 2488-17 Note 14.

⁸Percentages are estimated to the nearest 5% per ASTM D 2488-17.



SUBSURFACE EXPLORATION PROCEDURE: STANDARD PENETRATION TESTING (SPT) ASTM D 1586 Split-Barrel Sampling

Standard Penetration Testing, or **SPT**, is the most frequently used subsurface exploration test performed worldwide. This test provides samples for identification purposes, as well as a measure of penetration resistance, or N-value. The N-Value, or blow counts, when corrected and correlated, can approximate engineering properties of soils used for geotechnical design and engineering purposes.




SPT Procedure:

- Involves driving a hollow tube (split-spoon) into the ground by dropping a 140-lb hammer a height of 30-inches at desired depth
- Recording the number of hammer blows required to drive split-spoon a distance of 12 inches (in 3 or 4 Increments of 6 inches each)
- Auger is advanced* and an additional SPT is performed
- One SPT typically performed for every two to five feet
- Obtain 1.5-inch diameter soil sample

**Drilling Methods May Vary—* The predominant drilling methods used for SPT are open hole fluid rotary drilling and hollow-stem auger drilling.

**ECS provides Boring
Location Diagrams
and Boring Logs for
each project!**






CLIENT: NC State University				PROJECT NO.: 06:24928		BORING NO.: B-01		SHEET: 1 of 1		
PROJECT NAME: Translational Research Facility NCSU Code 42124				DRILLER/CONTRACTOR: Quantex, Inc.						
SITE LOCATION: 1060 William Moore Dr., Raleigh, North Carolina, 27606								LOSS OF CIRCULATION 		
NORTHING: 746065.6		EASTING: 2088144.9		STATION:		SURFACE ELEVATION: 445		BOTTOM OF CASING 		

DEPTH (FT)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"	STANDARD PENETRATION BLOWS/FT		ROCK QUALITY DESIGNATION & RECOVERY		CALIBRATED PENETROMETER TSF		WATER CONTENT % [FINES CONTENT] %								
									20	40	60	80	100	1	2	3	4	5	10	20	30	40	50
									RQD		REC												
					Topsoil Thickness[3.00"]																		
	S-1	SS	18	12	(ML) SILT, trace gravel, contains significant mica, red, brown and white, moist, firm to stiff			6-6-7 (13)															
5	S-2	SS	18	18			440	4-5-7 (12)															
	S-3	SS	18	18				3-5-5 (10)															
10	S-4	SS	18	18			435	4-5-4 (9)															
	S-5	SS	18	18				3-5-5 (10)															
15							430																
	S-6	SS	18	18				4-4-4 (8)															
20							425																
	S-7	SS	18	18				3-4-5 (9)															
25					END OF BORING AT 25 FT		420																
30							415																

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL

<input checked="" type="checkbox"/> WL (First Encountered)	BORING STARTED: Sep 12 2022	CAVE IN DEPTH: 23.50
<input checked="" type="checkbox"/> WL (Completion) DRY	BORING COMPLETED: Sep 12 2022	HAMMER TYPE: Auto
<input checked="" type="checkbox"/> WL (Seasonal High Water)	EQUIPMENT: ATV	LOGGED BY: EM8
<input checked="" type="checkbox"/> WL (Stabilized)	DRILLING METHOD: 2.25 HSA	

GEOTECHNICAL BOREHOLE LOG




CLIENT: NC State University				PROJECT NO.: 06:24928		BORING NO.: B-02		SHEET: 1 of 1		
PROJECT NAME: Translational Research Facility NCSU Code 42124				DRILLER/CONTRACTOR: Quantex, Inc.						
SITE LOCATION: 1060 William Moore Dr., Raleigh, North Carolina, 27606								LOSS OF CIRCULATION 		
NORTHING: 746015.3		EASTING: 2088205.9		STATION:		SURFACE ELEVATION: 446		BOTTOM OF CASING 		

DEPTH (FT)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"	STANDARD PENETRATION BLOWS/FT		ROCK QUALITY DESIGNATION & RECOVERY		LIQUID LIMIT PLASTIC LIMIT		CALIBRATED PENETROMETER TSF		WATER CONTENT % [FINES CONTENT] %						
									20	40	60	80	100	1	2	3	4	5	10	20	30	40	50
																			RQD		REC		
					Topsoil Thickness[3.00"]																		
5	S-1	SS	18	18	(CH) FAT CLAY, contains significant mica, red, moist, very stiff		441	6-8-8 (16)	⊗ 16														
	S-2	SS	18	18	(ML) SILT WITH SAND, rock fragments contains significant mica, red, moist, stiff			5-5-6 (11)	⊗ 11														
	S-3	SS	18	18				4-5-5 (10)	⊗ 10														
10	S-4	SS	18	18	(ML) SANDY SILT, contains significant mica, red, moist, firm		436	3-3-4 (7)	⊗ 7														
15	S-5	SS	18	18			431	3-3-4 (7)	⊗ 7														
20	S-6	SS	18	18			426	3-3-5 (8)	⊗ 8														
25	S-7	SS	18	18			421	3-4-4 (8)	⊗ 8														
					END OF BORING AT 25 FT																		
30							416																

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL

<input checked="" type="checkbox"/> WL (First Encountered) <input checked="" type="checkbox"/> WL (Completion) DRY <input checked="" type="checkbox"/> WL (Seasonal High Water) <input checked="" type="checkbox"/> WL (Stabilized)	BORING STARTED: Sep 12 2022 BORING COMPLETED: Sep 12 2022 EQUIPMENT: ATV	CAVE IN DEPTH: 23.50 HAMMER TYPE: Auto DRILLING METHOD: 2.25 HSA
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GEOTECHNICAL BOREHOLE LOG




CLIENT: NC State University				PROJECT NO.: 06:24928		BORING NO.: B-03		SHEET: 1 of 1		
PROJECT NAME: Translational Research Facility NCSU Code 42124				DRILLER/CONTRACTOR: Quantex, Inc.						
SITE LOCATION: 1060 William Moore Dr., Raleigh, North Carolina, 27606								LOSS OF CIRCULATION 		
NORTHING: 746013.3		EASTING: 2088144.2		STATION:		SURFACE ELEVATION: 446		BOTTOM OF CASING 		

DEPTH (FT)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"	STANDARD PENETRATION BLOWS/FT		ROCK QUALITY DESIGNATION & RECOVERY		LIQUID LIMIT PLASTIC LIMIT		CALIBRATED PENETROMETER TSF		WATER CONTENT % [FINES CONTENT] %					
									20	40	60	80	100			1	2	3	4	5		
														RQD	REC							
					Topsoil Thickness[4.00"]																	
	S-1	SS	18	18	(CL) LEAN CLAY WITH SAND, contains significant mica rock fragments, red, moist, stiff to very stiff			5-8-9 (17)														
5	S-2	SS	18	18			441	4-6-6 (12)														
	S-3	SS	18	18	(ML) SANDY SILT, contains significant mica, red, moist, firm to stiff			4-5-7 (12)														
10	S-4	SS	18	18			436	3-3-4 (7)														
	S-5	SS	18	18			431	3-5-5 (10)														
15																						
20	S-6	SS	18	18			426	4-4-6 (10)														
	S-7	SS	18	18			421	3-3-4 (7)														
25					END OF BORING AT 25 FT																	
30							416															

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL

<input checked="" type="checkbox"/> WL (First Encountered)	BORING STARTED: Sep 12 2022	CAVE IN DEPTH: 23.50
<input checked="" type="checkbox"/> WL (Completion) DRY	BORING COMPLETED: Sep 12 2022	HAMMER TYPE: Auto
<input checked="" type="checkbox"/> WL (Seasonal High Water)	EQUIPMENT: ATV	LOGGED BY: EM8
<input checked="" type="checkbox"/> WL (Stabilized)	DRILLING METHOD: 2.25 HSA	

GEOTECHNICAL BOREHOLE LOG

CLIENT: NC State University				PROJECT NO.: 06:24928		BORING NO.: B-04		SHEET: 1 of 1		
PROJECT NAME: Translational Research Facility NCSU Code 42124				DRILLER/CONTRACTOR: Quantex, Inc.						
SITE LOCATION: 1060 William Moore Dr., Raleigh, North Carolina, 27606								LOSS OF CIRCULATION 		
NORTHING: 746066.5		EASTING: 2088205.7		STATION:		SURFACE ELEVATION: 442		BOTTOM OF CASING 		

DEPTH (FT)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"	STANDARD PENETRATION BLOWS/FT		ROCK QUALITY DESIGNATION & RECOVERY		CALIBRATED PENETROMETER TSF		WATER CONTENT % [FINES CONTENT] %								
									20	40	60	80	100	1	2	3	4	5	10	20	30	40	50
									RQD		REC												
					Topsoil Thickness[4.00"]																		
	S-1	SS	18	18	(CH) FAT CLAY, contains mica, red, moist, very stiff			7-8-9 (17)															
5	S-2	SS	18	18	(CL) LEAN CLAY WITH SAND, contains significant mica, red, moist, stiff		437	3-5-7 (12)															
	S-3	SS	18	18				3-4-8 (12)															
10	S-4	SS	18	18	(ML) SANDY SILT, contains significant mica, red and brown, moist, firm to stiff		432	3-3-6 (9)															
	S-5	SS	18	18				3-3-4 (7)															
15																							
20	S-6	SS	18	18			427	3-4-4 (8)															
25	S-7	SS	18	18			422	3-3-5 (8)															
					END OF BORING AT 25 FT		417																
30							412																

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL

<input checked="" type="checkbox"/> WL (First Encountered)	BORING STARTED: Sep 12 2022	CAVE IN DEPTH: 23.50
<input checked="" type="checkbox"/> WL (Completion) DRY	BORING COMPLETED: Sep 12 2022	HAMMER TYPE: Auto
<input checked="" type="checkbox"/> WL (Seasonal High Water)	EQUIPMENT: ATV	LOGGED BY: EM8
<input checked="" type="checkbox"/> WL (Stabilized)	DRILLING METHOD: 2.25 HSA	

GEOTECHNICAL BOREHOLE LOG

SECTION 011000 - SUMMARY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Project information.
 - 2. Work covered by Contract Documents.
 - 3. Owner-furnished products.
 - 4. Access to site.
 - 5. Coordination with occupants.
 - 6. Work restrictions.
 - 7. Specification and drawing conventions.

- B. Related Requirements:

- 1. Division 01 Section "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Owner's facilities.

1.3 PROJECT INFORMATION

- A. Project Identification: Translational Research Facility

- 1. Project Location: College of Veterinary, NC State University, Raleigh, NC.

- B. Owner: NC State University

- 1. Owner's Representative: Laura L. Zaytoun RA 919.515.8049 in design, Mark Michaelson, 919.513.2752 for construction.

- C. Architect: Wagner Architecture, pllc. 92 Elam Court, New Hill, NC 27562. Contact Kim Wagner, 919.612.5050; kwagner@wagnerarch.com

- D. Architect's Consultants: The Architect has retained the following design professionals who have prepared designated portions of the Contract Documents:

- 1. MEP&FP Engineering: Kramer Engineering Services, pllc, 5517 Cascade Drive, Chapel Hill, NC 27514. Contact Donna Kramer 919.933.2250 donna@kespllc.com

2. Structural Engineering: LHC Structural Engineers PC, a division of Bennet & Pless, 1331 Sunday Dr#121, Raleigh, NC 27607; 919.832.5587 rstevenson@lhceengineers.com
3. Civil Engineering: NV5 Engineers and Consultants, Inc, 3300 Regency Parkway, Suite 100, Cary NC 27518, 919.851.1912 www.nv5.com

1.4 WORK COVERED BY CONTRACT DOCUMENTS

- A. The Work of Project is defined by the Contract Documents and consists of the following:
 1. The project consists of a new facility of approximately 3991 GSF located in the laboratory animal resources area of the CVM and NC State's Biomedical Centennial Campus.
- B. Type of Contract:
 1. Project will be constructed under a single prime contract.

1.5 OWNER-FURNISHED PRODUCTS

- A. Owner will furnish products indicated. The Work includes receiving, unloading, handling, storing, protecting, and installing Owner-furnished products and making building services connections.
- B. Owner-Furnished Products:
 1. The following bathroom accessories are owner furnished and contractor installed: Toilet paper dispenser, hand soap dispenser, ADA toilet paper dispenser, paper towel dispenser. The owner will furnish and install the trash can & compost bin.
 2. All signage is owner furnished and owner installed.
 3. Surgical lighting is owner furnished and contractor installed.

1.6 ACCESS TO SITE

- A. General: Contractor shall have limited use of Project site for construction operations as indicated on Drawings by the Contract limits and as indicated by requirements of this Section.
- B. Use of Site: Limit use of Project site to areas within the Project Scope limits indicated on the drawings. Do not disturb portions of Project site beyond areas in which the Work is indicated.
 1. Driveways, Walkways and Entrances: Keep driveways, loading areas, and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials.
 - a. Schedule deliveries to minimize use of driveways and entrances by construction operations.
 - b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.

1.7 COORDINATION WITH OCCUPANTS

- A. Full Owner Occupancy: Owner will occupy site and adjacent building(s) during entire construction period. Cooperate with Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform the Work so as not to interfere with Owner's day-to-day operations. Maintain existing exits unless otherwise indicated.
 - 1. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from Owner and approval of authorities having jurisdiction.
 - 2. Notify Owner not less than 7 days in advance of activities that will affect Owner's operations.

1.8 WORK RESTRICTIONS: See NC State Supplementary General Conditions

1.9 SPECIFICATION AND DRAWING CONVENTIONS

- A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
 - 1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
 - 2. Specification requirements are to be performed by Contractor unless specifically stated otherwise.
- B. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.
- C. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:
 - 1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
 - 2. Abbreviations: Materials and products are identified by abbreviations scheduled on Drawings.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 011000

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SECTION 012300 - ALTERNATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for alternates.

1.3 DEFINITIONS

- A. Alternate: An amount proposed by bidders and stated on the Bid Form for certain work defined in the bidding requirements that may be added to or deducted from the base bid amount if Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.
 - 1. Alternates described in this Section are part of the Work only if enumerated in the Agreement.
 - 2. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate alternate into the Work. No other adjustments are made to the Contract Sum.

1.4 PROCEDURES

- A. Coordination: Revise or adjust affected adjacent work as necessary to completely integrate work of the alternate into Project.
 - 1. Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not indicated as part of alternate.
- B. Notification: Immediately following award of the Contract, notify each party involved, in writing, of the status of each alternate. Indicate if alternates have been accepted, rejected, or deferred for later consideration. Include a complete description of negotiated revisions to alternates.
- C. Execute accepted alternates under the same conditions as other work of the Contract.
- D. Schedule: A schedule of alternates is included at the end of this Section. Specification Sections referenced in schedule contain requirements for materials necessary to achieve the work described under each alternate.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCHEDULE OF ALTERNATES

- A. Alternate No. 1
 - 1. Base bid: Provide and install locks, closers and lock cylinders by one of the acceptable manufacturers listed in section 08 7100.
 - 2. Alternate: Provide an ADD to furnish and install mortise locks by Best, closers by LCN and cylinders by Schlage.
- B. Alternate No. 2
 - 1. Base bid: Provide painted metal doors as specified in section 08 1113.
 - 2. Alternate: Provide an ADD to furnish and install galvanized painted metal doors as specified in section 08 1113.
- C. Alternate No. 3
 - 1. Base bid: no scope.
 - 2. Alternate: Provide an ADD to furnish and install stainless steel pass through as shown on A410 and as specified in 12 3553.
- D. Alternate No. 4
 - 1. Base bid: no scope.
 - 2. Alternate: Provide an ADD to furnish and install casework as shown on A410 and as specified in 12 3553.
- E. Alternate No. 5
 - 1. Base Bid: G90 galvanized exhaust duct throughout with the following exceptions: 1. Type 304 stainless steel shall be installed from the exhaust grille through to the air valve and 2. 316 welded stainless steel shall be installed for the exhaust stack.
 - 2. Alternate: Provide 316 stainless steel exhaust duct for all exhaust ductwork and associated accessories. Accessories include dampers, air valves, and duct access doors.
- F. Alternate No. 6
 - 1. Base bid: no scope.
 - 2. Alternate: Provide an ADD to furnish and install concrete sealant as shown on A130 and as specified in 09 9330.
- G. Alternate No. 7
 - 1. Base bid: Provide and install sanitary napkin dispenser and disposals by one of the acceptable manufacturers listed in section 10 2800.
 - 2. Alternate: Provide an ADD to furnish and install sanitary napkin dispenser and disposals indicated as basis-of-design product listed in section 10 2800.
- H. Alternate No. 9
 - 1. Base Bid: Exclude all medical gas equipment, piping, alarms, valves, oxygen switching manifold and accessories associated with the medical gas system. Exclude backflow preventer and water piping to medical vacuum pump. Exclude power supply to vacuum

- pump, alarm panel, and oxygen switching manifold. Retain breakers in electrical panels for future medical gas alarm panel, vacuum pump, and oxygen switching manifold. Retain floor space for future vacuum pump and oxygen switching manifold in vicinity of locations shown on sheet P201.
2. Alternate: Include all medical gas equipment, piping, alarms, valves, oxygen switching manifold and accessories associated with the medical gas system. Include backflow preventer and water piping to medical vacuum pump. Include line side and load side power supply to vacuum pump, alarm panel, and oxygen switching manifold.
- I. Alternate No 10
1. Base Bid: The Building Automations System (BAS) and digital control and communications components provided and installed under this contract shall be an integrated distributed processing system of Johnson Controls, Inc or Schneider Electric. No other vendor's products will be considered as substitutions.
 2. Alternate: Furnish and install a BACnet based BAS by Johnson Controls Incorporated (JCI).
- J. Alternate No 11
1. Base Bid: The Building Automations System (BAS) and digital control and communications components provided and installed under this contract shall be an integrated distributed processing system of Johnson Controls, Inc or Schneider Electric. No other vendor's products will be considered as substitutions.
 2. Alternate: Furnish and install a BACnet based BAS by Schneider Electric.
- K. Alternate No 12
1. Base Bid: Provide and install a pilot operated steam regulator as specified in Specification 231000, HVAC Piping, Valves and Accessories.
 2. Alternate: Provide and install a pilot operated steam regulator model ED2 by Spence.
- L. Alternate No 13:
1. Base Bid: Exclude UV disinfection lights and controls on air handling unit.
 2. Alternate: Provide UV disinfection lights and controller as specified in 236000, HVAC Equipment.
- M. Alternate No 14
1. Base bid: Provide and install electric chain hoist and motor trolley by one of the acceptable manufacturers listed in section 14 6200.
 2. Alternate: Provide an ADD to furnish and install ECMT2004-10-1 listed as basis of design in section 14 6200 by Coffing.

END OF SECTION 012300

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SECTION 012500 - SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for substitutions.

1.3 DEFINITIONS

- A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.
 - 1. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
 - 2. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.

1.4 ACTION SUBMITTALS

- A. Substitution Requests: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
 - 1. Substitution Request Form: Use **CSI Form 13.1A**.
 - 2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
 - a. Statement indicating why specified product or fabrication or installation cannot be provided, if applicable.
 - b. Coordination information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractors, that will be necessary to accommodate proposed substitution.
 - c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.

- d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
 - e. Samples, where applicable or requested.
 - f. Certificates and qualification data, where applicable or requested.
 - g. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners.
 - h. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
 - i. Research reports evidencing compliance with building code in effect for Project, from **ICC-ES**.
 - j. Detailed comparison of Contractor's construction schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
 - k. Cost information, including a proposal of change, if any, in the Contract Sum.
 - l. Contractor's certification that proposed substitution complies with requirements in the Contract Documents except as indicated in substitution request, is compatible with related materials, and is appropriate for applications indicated.
 - m. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
3. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within **seven** days of receipt of a request for substitution. Architect will notify Contractor of acceptance or rejection of proposed substitution within **15** days of receipt of request, or **seven** days of receipt of additional information or documentation, whichever is later.
- a. Forms of Acceptance: Change Order, Construction Change Directive, or Architect's Supplemental Instructions for minor changes in the Work.
 - b. Use product specified if Architect does not issue a decision on use of a proposed substitution within time allocated.

1.5 QUALITY ASSURANCE

- A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage a qualified testing agency to perform compatibility tests recommended by manufacturers.

1.6 PROCEDURES

- A. Coordination: Revise or adjust affected work as necessary to integrate work of the approved substitutions.

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS

- A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than **15** days prior to time required for preparation and review of related submittals.
1. Conditions: 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 is consistent with the Contract Documents and will produce indicated results.
 - b. Substitution request is fully documented and properly submitted.
 - c. Requested substitution will not adversely affect Contractor's construction schedule.
 - d. Requested substitution has received necessary approvals of authorities having jurisdiction.
 - e. Requested substitution is compatible with other portions of the Work.
 - f. Requested substitution has been coordinated with other portions of the Work.
 - g. Requested substitution provides specified warranty.
 - h. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.
- B. Substitutions for Convenience: Not allowed.

PART 3 - EXECUTION (Not Used)

END OF SECTION 012500

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SECTION 013100 - PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
 - 1. General coordination procedures.
 - 2. Coordination drawings.
 - 3. Requests for Information (RFIs).
 - 4. Project meetings.
- B. Each contractor shall participate in coordination requirements. Certain areas of responsibility are assigned to a specific contractor.
- C. Related Requirements:
 - 1. Division 01 Section "Construction Progress Documentation" for preparing and submitting Contractor's construction schedule.
 - 2. Division 01 Section "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.
 - 3. Division 01 Section "Closeout Procedures" for coordinating closeout of the Contract.

1.3 DEFINITIONS

- A. RFI: Request from Owner, Architect, or Contractor seeking information required by or clarifications of the Contract Documents.

1.4 INFORMATIONAL SUBMITTALS

- A. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:
 - 1. Name, address, and telephone number of entity performing subcontract or supplying products.
 - 2. Number and title of related Specification Section(s) covered by subcontract.
 - 3. Drawing number and detail references, as appropriate, covered by subcontract.

- B. Key Personnel Names: Within 15 days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including home, office, and cellular telephone numbers and e-mail addresses. Provide names, addresses, and telephone numbers of individuals assigned as alternates in the absence of individuals assigned to Project.
 - 1. Post copies of list in project meeting room, in temporary field office, and by each temporary telephone. Keep list current at all times.

1.5 GENERAL COORDINATION PROCEDURES

- A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections, that depend on each other for proper installation, connection, and operation.
 - 1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
 - 2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
 - 3. Make adequate provisions to accommodate items scheduled for later installation.
- B. Coordination: Each contractor shall coordinate its construction operations with those of other contractors and entities to ensure efficient and orderly installation of each part of the Work. Each contractor shall coordinate its operations with operations, included in different Sections, that depend on each other for proper installation, connection, and operation.
 - 1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
 - 2. Coordinate installation of different components with other contractors to ensure maximum performance and accessibility for required maintenance, service, and repair.
 - 3. Make adequate provisions to accommodate items scheduled for later installation.
- C. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.
 - 1. Prepare similar memoranda for Owner and separate contractors if coordination of their Work is required.
- D. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
 - 1. Preparation of Contractor's construction schedule.
 - 2. Preparation of the schedule of values.
 - 3. Installation and removal of temporary facilities and controls.

4. Delivery and processing of submittals.
 5. Progress meetings.
 6. Preinstallation conferences.
 7. Project closeout activities.
 8. Startup and adjustment of systems.
- E. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.
1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. See other Sections for disposition of salvaged materials that are designated as Owner's property.

1.6 COORDINATION DRAWINGS

- A. Coordination Drawings, General: Prepare coordination drawings according to requirements in individual Sections, and additionally where installation is not completely shown on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity.
1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:
 - a. Use applicable Drawings as a basis for preparation of coordination drawings. Prepare sections, elevations, and details as needed to describe relationship of various systems and components.
 - b. Coordinate the addition of trade-specific information to the coordination drawings by multiple contractors in a sequence that best provides for coordination of the information and resolution of conflicts between installed components before submitting for review.
 - c. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
 - d. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
 - e. Show location and size of access doors required for access to concealed dampers, valves, and other controls.
 - f. Indicate required installation sequences.
 - g. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Architect indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
- B. Coordination Drawing Organization: Organize coordination drawings as follows:
1. Floor Plans and Reflected Ceiling Plans: Show architectural and structural elements, and mechanical, plumbing, fire-protection, fire-alarm, and electrical Work. Show locations

- of visible ceiling-mounted devices relative to acoustical ceiling grid. Supplement plan drawings with section drawings where required to adequately represent the Work.
 2. Plenum Space: Indicate subframing for support of ceiling and wall systems, mechanical and electrical equipment, and related Work. Locate components within ceiling plenum to accommodate layout of light fixtures indicated on Drawings. Indicate areas of conflict between light fixtures and other components.
 3. Mechanical Rooms: Provide coordination drawings for mechanical rooms showing plans and elevations of mechanical, plumbing, fire-protection, fire-alarm, and electrical equipment.
 4. Structural Penetrations: Indicate penetrations and openings required for all disciplines.
 5. Slab Edge and Embedded Items: Indicate slab edge locations and sizes and locations of embedded items for metal fabrications, sleeves, anchor bolts, bearing plates, angles, door floor closers, slab depressions for floor finishes, curbs and housekeeping pads, and similar items.
 6. Mechanical and Plumbing Work: Show the following:
 - a. Sizes and bottom elevations of ductwork, piping, and conduit runs, including insulation, bracing, flanges, and support systems.
 - b. Dimensions of major components, such as dampers, valves, diffusers, access doors, cleanouts and electrical distribution equipment.
 - c. Fire-rated enclosures around ductwork.
 7. Electrical Work: Show the following:
 - a. Runs of vertical and horizontal conduit 1-1/4 inches (32 mm) in diameter and larger.
 - b. Light fixture, exit light, emergency battery pack, smoke detector, and other fire-alarm locations.
 - c. Panel board, switch board, switchgear, transformer, busway, generator, and motor control center locations.
 - d. Location of pull boxes and junction boxes, dimensioned from column center lines.
 8. Fire-Protection System: Show the following:
 - a. Locations of standpipes, mains piping, branch lines, pipe drops, and sprinkler heads.
 9. Review: Architect will review coordination drawings to confirm that the Work is being coordinated, but not for the details of the coordination, which are Contractor's responsibility. If Architect determines that coordination drawings are not being prepared in sufficient scope or detail, or are otherwise deficient, Architect will so inform Contractor, who shall make changes as directed and resubmit.
 10. Coordination Drawing Prints: Prepare coordination drawing prints according to requirements in Division 01 Section "Submittal Procedures."
- C. Coordination Digital Data Files: Prepare coordination digital data files according to the following requirements:
1. File Preparation Format: Same digital data software program, version, and operating system as original Drawings.
 2. File Preparation Format: DWG Version.

3. File Submittal Format: Submit or post coordination drawing files using format same as file preparation format or Portable Data File (PDF) format.
4. Architect will furnish Contractor one set of digital data files of Drawings for use in preparing coordination digital data files.
 - a. Architect makes no representations as to the accuracy or completeness of digital data files as they relate to Drawings.
 - b. Digital Data Software Program: Drawings are available in Autocad 2010.
 - c. Contractor shall execute a data licensing agreement in the form of Agreement form acceptable to Owner and Architect.

1.7 REQUESTS FOR INFORMATION (RFIs)

- A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
 1. Architect will return RFIs submitted to Architect by other entities controlled by Contractor with no response.
 2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.
- B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
 1. Project name.
 2. Project number.
 3. Date.
 4. Name of Contractor.
 5. Name of Architect
 6. RFI number, numbered sequentially.
 7. RFI subject.
 8. Specification Section number and title and related paragraphs, as appropriate.
 9. Drawing number and detail references, as appropriate.
 10. Field dimensions and conditions, as appropriate.
 11. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
 12. Contractor's signature.
 13. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
 - a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.
- C. RFI Forms: Software-generated form with substantially the same content as indicated above, acceptable to Architect.
 1. Attachments shall be electronic files in Adobe Acrobat PDF format.

- D. Architect's Action: Architect will review each RFI, determine action required, and respond. Allow seven working days for Architect's response for each RFI. RFIs received by Architect after 1:00 p.m. will be considered as received the following working day.
1. The following Contractor-generated RFIs will be returned without action:
 - a. Requests for approval of submittals.
 - b. Requests for approval of substitutions.
 - c. Requests for approval of Contractor's means and methods.
 - d. Requests for coordination information already indicated in the Contract Documents.
 - e. Requests for adjustments in the Contract Time or the Contract Sum.
 - f. Requests for interpretation of Architect's actions on submittals.
 - g. Incomplete RFIs or inaccurately prepared RFIs.
 2. Architect's action may include a request for additional information, in which case Architect's time for response will date from time of receipt of additional information.
 3. Architect's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Division 01 Section "Contract Modification Procedures."
 - a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect in writing within 10 days of receipt of the RFI response.
- E. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log weekly. Software log with not less than the following:
1. Project name.
 2. Name and address of Contractor.
 3. Name and address of Architect.
 4. RFI number including RFIs that were returned without action or withdrawn.
 5. RFI description.
 6. Date the RFI was submitted.
 7. Date Architect's response was received.
- F. On receipt of Architect's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Architect within seven days if Contractor disagrees with response.
1. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.
 2. Identification of related Field Order, Work Change Directive, and Proposal Request, as appropriate.

1.8 PROJECT MEETINGS

- A. General: Attend meetings and conferences at Project site unless otherwise indicated.
1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting.

2. Minutes: Architect responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes internally to everyone concerned within three days of the meeting. Architect to prepare and distribute formal meeting notes.
- B. Preconstruction Conference: Attend a preconstruction conference before starting construction, at a time convenient to Owner and Architect, but no later than 5 days after execution of the Agreement.
1. Attend the conference to review responsibilities and personnel assignments.
 2. Attendees: Authorized representatives of Owner, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
 3. Agenda: Discuss items of significance that could affect progress, including the following:
 - a. Tentative construction schedule.
 - b. Phasing.
 - c. Critical work sequencing and long-lead items.
 - d. Designation of key personnel and their duties.
 - e. Lines of communications.
 - f. Procedures for processing field decisions and Change Orders.
 - g. Procedures for RFIs.
 - h. Procedures for testing and inspecting.
 - i. Procedures for processing Applications for Payment.
 - j. Distribution of the Contract Documents.
 - k. Submittal procedures.
 - l. Preparation of record documents.
 - m. Use of the premises and existing building.
 - n. Work restrictions.
 - o. Working hours.
 - p. Owner's occupancy requirements.
 - q. Responsibility for temporary facilities and controls.
 - r. Procedures for moisture and mold control.
 - s. Procedures for disruptions and shutdowns.
 - t. Construction waste management and recycling.
 - u. Parking availability.
 - v. Office, work, and storage areas.
 - w. Equipment deliveries and priorities.
 - x. First aid.
 - y. Security.
 - z. Progress cleaning.
 4. Minutes: Architect will record and distribute meeting minutes.
- C. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction activity that requires coordination with other construction.
1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and

- installations that have preceded or will follow, shall attend the meeting. Advise Architect 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. Options.
 - c. Related RFIs.
 - d. Related Change Orders.
 - e. Purchases.
 - f. Deliveries.
 - g. Submittals.
 - h. Review of mockups.
 - i. Possible conflicts.
 - j. Compatibility requirements.
 - k. Time schedules.
 - l. Weather limitations.
 - m. Manufacturer's written instructions.
 - n. Warranty requirements.
 - o. Compatibility of materials.
 - p. Acceptability of substrates.
 - q. Temporary facilities and controls.
 - r. Space and access limitations.
 - s. Regulations of authorities having jurisdiction.
 - t. Testing and inspecting requirements.
 - u. Installation procedures.
 - v. Coordination with other work.
 - w. Required performance results.
 - x. Protection of adjacent work.
 - y. Protection of construction and personnel.
 3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
 4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.
 5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.
- D. Project Closeout Conference: Schedule and conduct a project closeout conference, at a time convenient to Owner and Architect, but no later than 10 days prior to the scheduled date of Substantial Completion.
1. Conduct the conference to review requirements and responsibilities related to Project closeout.
 2. Attendees: Authorized representatives of Owner, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the meeting. Participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
 3. Agenda: Discuss items of significance that could affect or delay Project closeout, including the following:

- a. Preparation of record documents.
 - b. Procedures required prior to inspection for Substantial Completion and for final inspection for acceptance.
 - c. Submittal of written warranties.
 - d. Requirements for preparing operations and maintenance data.
 - e. Requirements for delivery of material samples, attic stock, and spare parts.
 - f. Requirements for demonstration and training.
 - g. Preparation of Contractor's punch list.
 - h. Procedures for processing Applications for Payment at Substantial Completion and for final payment.
 - i. Submittal procedures.
 - j. Coordination of separate contracts.
 - k. Owner's partial occupancy requirements.
 - l. Installation of Owner's furniture, fixtures, and equipment.
 - m. Responsibility for removing temporary facilities and controls.
 4. Minutes: Entity conducting meeting will record and distribute meeting minutes.
- E. Progress Meetings: Attend progress meetings at biweekly intervals.
1. Coordinate dates of meetings with preparation of payment requests.
 2. Attendees: In addition to representatives of Owner and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
 3. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
 - 1) Review schedule for next period.
 - b. Review present and future needs of each entity present, including the following:
 - 1) Interface requirements.
 - 2) Sequence of operations.
 - 3) Resolution of BIM component conflicts.
 - 4) Status of submittals.
 - 5) Deliveries.
 - 6) Off-site fabrication.
 - 7) Access.
 - 8) Site utilization.
 - 9) Temporary facilities and controls.
 - 10) Progress cleaning.

- 11) Quality and work standards.
 - 12) Status of correction of deficient items.
 - 13) Field observations.
 - 14) Status of RFIs.
 - 15) Status of proposal requests.
 - 16) Pending changes.
 - 17) Status of Change Orders.
 - 18) Pending claims and disputes.
 - 19) Documentation of information for payment requests.
4. Minutes: Architect will record and distribute the meeting minutes to each party present and to parties requiring information.
 - a. Schedule Updating: Revise Contractor's construction schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.
- F. Coordination Meetings: Conduct Project coordination meetings at regular intervals. Project coordination meetings are in addition to specific meetings held for other purposes, such as progress meetings and preinstallation conferences.
 1. Attendees: In addition to representatives of Owner and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meetings shall be familiar with Project and authorized to conclude matters relating to the Work.
 2. Agenda: Review and correct or approve minutes of the previous coordination meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Combined Contractor's Construction Schedule: Review progress since the last coordination meeting. Determine whether each contract is on time, ahead of schedule, or behind schedule, in relation to combined Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
 - b. Schedule Updating: Revise combined Contractor's construction schedule after each coordination meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with report of each meeting.
 - c. Review present and future needs of each contractor present, including the following:
 - 1) Interface requirements.
 - 2) Sequence of operations.
 - 3) Resolution of BIM component conflicts.
 - 4) Status of submittals.
 - 5) Deliveries.
 - 6) Off-site fabrication.
 - 7) Access.
 - 8) Site utilization.

- 9) Temporary facilities and controls.
 - 10) Work hours.
 - 11) Hazards and risks.
 - 12) Progress cleaning.
 - 13) Quality and work standards.
 - 14) Change Orders.
3. Reporting: Record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013100

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SECTION 013200 - CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:
 - 1. Contractor's construction schedule.
 - 2. Construction schedule updating reports.
 - 3. Daily construction reports.
 - 4. Material location reports.
 - 5. Site condition reports.
 - 6. Special reports.
- B. Related Requirements:
 - 1. Division 01 Section "Submittal Procedures" for submitting schedules and reports.
 - 2. Division 01 Section "Quality Requirements" for submitting a schedule of tests and inspections.

1.3 DEFINITIONS

- A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction project. Activities included in a construction schedule consume time and resources.
 - 1. Critical Activity: An activity on the critical path that must start and finish on the planned early start and finish times.
 - 2. Predecessor Activity: An activity that precedes another activity in the network.
 - 3. Successor Activity: An activity that follows another activity in the network.
- B. Cost Loading: The allocation of the schedule of values for the completion of an activity as scheduled. The sum of costs for all activities must equal the total Contract Sum unless otherwise approved by Architect.
- C. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of Project.
- D. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.

- E. Event: The starting or ending point of an activity.
- F. Float: The measure of leeway in starting and completing an activity.
- G. Resource Loading: The allocation of manpower and equipment necessary for the completion of an activity as scheduled.

1.4 INFORMATIONAL SUBMITTALS

- A. Format for Submittals: Submit required submittals in the following format:
 - 1. PDF electronic file.
- B. Startup construction schedule.
 - 1. Approval of cost-loaded, startup construction schedule will not constitute approval of schedule of values for cost-loaded activities.
- C. Startup Network Diagram: Of size required to display entire network for entire construction period. Show logic ties for activities.
- D. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.
 - 1. Submit a working electronic copy of schedule, using software indicated, and labeled to comply with requirements for submittals. Include type of schedule (initial or updated) and date on label.
- E. CPM Reports: Concurrent with CPM schedule, submit each of the following reports. Format for each activity in reports shall contain activity number, activity description, cost and resource loading, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float in calendar days.
 - 1. Activity Report: List of all activities sorted by activity number and then early start date, or actual start date if known.
 - 2. Logic Report: List of preceding and succeeding activities for all activities, sorted in ascending order by activity number and then early start date, or actual start date if known.
 - 3. Total Float Report: List of all activities sorted in ascending order of total float.
 - 4. Earnings Report: Compilation of Contractor's total earnings from the Notice to Proceed until most recent Application for Payment.
- F. Construction Schedule Updating Reports: Submit with Applications for Payment.
- G. Daily Construction Reports: Submit at monthly intervals.
- H. Material Location Reports: Submit at monthly intervals.
- I. Site Condition Reports: Submit at time of discovery of differing conditions.
- J. Special Reports: Submit at time of unusual event.
- K. Qualification Data: For scheduling consultant.

1.5 QUALITY ASSURANCE

- A. Scheduling Consultant Qualifications: An experienced specialist in CPM scheduling and reporting, with capability of producing CPM reports and diagrams within 24 hours of Architect's request.
- B. Prescheduling Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." Review methods and procedures related to the preliminary construction schedule and Contractor's construction schedule, including, but not limited to, the following:
 - 1. Review software limitations and content and format for reports.
 - 2. Verify availability of qualified personnel needed to develop and update schedule.
 - 3. Discuss constraints, including phasing, area separations, interim milestones.
 - 4. Review delivery dates for Owner-furnished products.
 - 5. Review submittal requirements and procedures.
 - 6. Review time required for review of submittals and resubmittals.
 - 7. Review requirements for tests and inspections by independent testing and inspecting agencies.
 - 8. Review time required for Project closeout and Owner startup procedures.
 - 9. Review and finalize list of construction activities to be included in schedule.
 - 10. Review procedures for updating schedule.

1.6 COORDINATION

- A. Coordinate preparation and processing of schedules and reports with performance of construction activities and with scheduling and reporting of separate contractors.
- B. Coordinate Contractor's construction schedule with the schedule of values, list of subcontracts, submittal schedule, progress reports, payment requests, and other required schedules and reports.
 - 1. Secure time commitments for performing critical elements of the Work from entities involved.
 - 2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

PART 2 - PRODUCTS

2.1 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

- A. Time Frame: Extend schedule from date established for the Notice to Proceed to date of Substantial Completion.
 - 1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.

- B. Activities: Treat each story or separate area as a separate numbered activity for each main element of the Work. Comply with the following:
1. Activity Duration: Define activities so no activity is longer than 20 days, unless specifically allowed by Architect.
 2. Procurement Activities: Include procurement process activities for the following long lead items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
 3. Submittal Review Time: Include review and resubmittal times indicated in Division 01 Section "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's construction schedule with submittal schedule.
 4. Startup and Testing Time: Include no fewer than 15 days for startup and testing.
 5. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Architect's administrative procedures necessary for certification of Final Completion.
 6. Punch List and Final Completion: Include not more than 14 days for completion of punch list items and final completion.
- C. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.
1. Phasing: Arrange list of activities on schedule by phase.
 2. Products Ordered in Advance: Include a separate activity for each product. Include delivery date indicated in Division 01 Section "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
 3. Owner-Furnished Products: Include a separate activity for each product. Include delivery date indicated in Division 01 Section "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
 4. Work Restrictions: Show the effect of the following items on the schedule:
 - a. Coordination with existing construction.
 - b. Limitations of continued occupancies.
 - c. Uninterruptible services.
 - d. Partial occupancy before Final Acceptance.
 - e. Use of premises restrictions.
 - f. Provisions for future construction.
 - g. Seasonal variations.
 - h. Environmental control.
 5. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:
 - a. Subcontract awards.
 - b. Submittals.
 - c. Purchases.
 - d. Mockups.
 - e. Fabrication.
 - f. Sample testing.
 - g. Deliveries.
 - h. Installation.

- i. Tests and inspections.
 - j. Adjusting.
 - k. Curing.
 - l. Building flush-out.
 - m. Startup and placement into final use and operation.
- 6. Construction Areas: Identify each major area of construction for each major portion of the Work. Indicate where each construction activity within a major area must be sequenced or integrated with other construction activities to provide for the following:
 - a. Structural completion.
 - b. Temporary enclosure and space conditioning.
 - c. Permanent space enclosure.
 - d. Completion of mechanical installation.
 - e. Completion of electrical installation.
 - f. Substantial Completion.
- D. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and final completion.
- E. Cost Correlation: Superimpose a cost correlation timeline, indicating planned and actual costs. On the line, show planned and actual dollar volume of the Work performed as of planned and actual dates used for preparation of payment requests.
 - 1. See Division 01 Section "Payment Procedures" for cost reporting and payment procedures.
- F. Upcoming Work Summary: Prepare summary report indicating activities scheduled to occur or commence prior to submittal of next schedule update. Summarize the following issues:
 - 1. Unresolved issues.
 - 2. Unanswered Requests for Information.
 - 3. Rejected or unreturned submittals.
 - 4. Notations on returned submittals.
 - 5. Pending modifications affecting the Work and Contract Time.
- G. Recovery Schedule: When periodic update indicates the Work is 14 or more calendar days behind the current approved schedule, submit a separate recovery schedule indicating means by which Contractor intends to regain compliance with the schedule. Indicate changes to working hours, working days, crew sizes, and equipment required to achieve compliance, and date by which recovery will be accomplished.
- H. Computer Scheduling Software: Prepare schedules using current version of a program that has been developed specifically to manage construction schedules.

2.2 REPORTS

- A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:

1. List of subcontractors at Project site.
 2. List of separate contractors at Project site.
 3. Approximate count of personnel at Project site.
 4. Equipment at Project site.
 5. Material deliveries.
 6. High and low temperatures and general weather conditions, including presence of rain or snow.
 7. Accidents.
 8. Meetings and significant decisions.
 9. Unusual events (see special reports).
 10. Stoppages, delays, shortages, and losses.
 11. Meter readings and similar recordings.
 12. Emergency procedures.
 13. Orders and requests of authorities having jurisdiction.
 14. Change Orders received and implemented.
 15. Change Directives received and implemented.
 16. Services connected and disconnected.
 17. Equipment or system tests and startups.
 18. Partial completions and occupancies.
 19. Substantial Completions authorized.
- B. Material Location Reports: At monthly intervals, prepare and submit a comprehensive list of materials delivered to and stored at Project site. List shall be cumulative, showing materials previously reported plus items recently delivered. Include with list a statement of progress on and delivery dates for materials or items of equipment fabricated or stored away from Project site. Indicate the following categories for stored materials:
1. Material stored prior to previous report and remaining in storage.
 2. Material stored prior to previous report and since removed from storage and installed.
 3. Material stored following previous report and remaining in storage.
- C. Site Condition Reports: Immediately on discovery of a difference between site conditions and the Contract Documents, prepare and submit a detailed report. Submit with a Request for Information. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

2.3 SPECIAL REPORTS

- A. General: Submit special reports directly to Owner within one day(s) of an occurrence. Distribute copies of report to parties affected by the occurrence.
- B. Reporting Unusual Events: When an event of an unusual and significant nature occurs at Project site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, response by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise Owner in advance when these events are known or predictable.

PART 3 - EXECUTION

3.1 CONTRACTOR'S CONSTRUCTION SCHEDULE

- A. Scheduling Consultant: Engage a consultant to provide planning, evaluation, and reporting using CPM scheduling.
 - 1. In-House Option: Owner may waive the requirement to retain a consultant if Contractor employs skilled personnel with experience in CPM scheduling and reporting techniques. Submit qualifications.
 - 2. Meetings: Scheduling consultant shall attend all meetings related to Project progress, alleged delays, and time impact.
- B. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.
 - 1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
 - 2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
 - 3. As the Work progresses, indicate final completion percentage for each activity.
- C. Distribution: Distribute copies of approved schedule to Architect, Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.
 - 1. Post copies in Project meeting rooms and temporary field offices.
 - 2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

END OF SECTION 013200

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SECTION 013233 - PHOTOGRAPHIC DOCUMENTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for the following:
 - 1. Preconstruction photographs.
 - 2. Periodic construction photographs.
 - 3. Final completion construction photographs.
- B. Related Requirements:
 - 1. Division 01 Section "Submittal Procedures" for submitting photographic documentation.
 - 2. Division 01 Section "Closeout Procedures" for submitting photographic documentation as project record documents at Project closeout.

1.3 INFORMATIONAL SUBMITTALS

- A. Key Plan: Submit key plan of Project site and building with notation of vantage points marked for location and direction of each photograph. Indicate elevation or story of construction. Include same information as corresponding photographic documentation.
- B. Digital Photographs: Submit image files within three days of taking photographs.
 - 1. Digital Camera: Minimum sensor resolution of 8 megapixels.
 - 2. Format: Minimum 3200 by 2400 pixels, in unaltered original files, with same aspect ratio as the sensor, uncropped, date and time stamped, in folder named by date of photograph, accompanied by key plan file.
 - 3. Identification: Provide the following information with each image description in file metadata tag:
 - a. Name of Project.
 - b. Name and contact information for photographer.
 - c. Name of Architect
 - d. Name of Contractor.
 - e. Date photograph was taken.
 - f. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.
 - g. Unique sequential identifier keyed to accompanying key plan.
- C. Construction Photographs: Submit electronic files of each photographic view within seven days of taking photographs.
 - 1. Digital Images: Submit a complete set of digital image electronic files with each submittal of prints as a Project Record Document on CD-ROM. Identify electronic

media with date photographs were taken. Submit images that have the same aspect ratio as the sensor, uncropped.

1.4 USAGE RIGHTS

- A. Obtain and transfer copyright usage rights from photographer to Owner for unlimited reproduction of photographic documentation.

PART 2 - PRODUCTS

2.1 PHOTOGRAPHIC MEDIA

- A. Digital Images: Provide images in JPG format, produced by a digital camera with minimum sensor size of 8 megapixels, and at an image resolution of not less than 1600 by 1200 pixels.

PART 3 - EXECUTION

3.1 CONSTRUCTION PHOTOGRAPHS

- A. General: Take photographs using the maximum range of depth of field, and that are in focus, to clearly show the Work. Photographs with blurry or out-of-focus areas will not be accepted.
 - 1. Maintain key plan with each set of construction photographs that identifies each photographic location.
- B. Digital Images: Submit digital images exactly as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software.
 - 1. Date and Time: Include date and time in file name for each image.
 - 2. Field Office Images: Maintain one set of images accessible in the field office at Project site, available at all times for reference. Identify images in the same manner as those submitted to Architect.
- C. Preconstruction Photographs: Before commencement of demolition, take photographs of Project site and surrounding properties, including existing items to remain during construction, from different vantage points, as directed by Architect.
- D. Periodic Construction Photographs: Take 12 photographs weekly, with timing each month adjusted to coincide with the cutoff date associated with each Application for Payment. Select vantage points to show status of construction and progress since last photographs were taken.
- E. Final Completion Construction Photographs: Take 8 color photographs after date of Substantial Completion for submission as project record documents. Architect will inform photographer of desired vantage points.
 - 1. Do not include date stamp.

END OF SECTION 013233

SECTION 013300 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

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

1.3 DEFINITIONS

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

1.4 ACTION SUBMITTALS

- A. Submittal Schedule: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Architect and additional time for handling and reviewing submittals required by those corrections.
 - 1. Coordinate submittal schedule with list of subcontracts, the schedule of values, and Contractor's construction schedule.
 - 2. Initial Submittal: Submit concurrently with startup construction schedule. Include submittals required during the first 60 days of construction. List those submittals required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
 - 3. Final Submittal: Submit concurrently with the first complete submittal of Contractor's construction schedule.
 - a. Submit revised submittal schedule to reflect changes in current status and timing for submittals.
 - 4. Format: Arrange the following information in a tabular format:

- a. Scheduled date for first submittal.
- b. Specification Section number and title.
- c. Submittal category: Action; informational.
- d. Name of subcontractor.
- e. Description of the Work covered.
- f. Scheduled date for Architect's final release or approval.
- g. Scheduled date of fabrication.
- h. Scheduled dates for purchasing.
- i. Scheduled dates for installation.
- j. Activity or event number.

1.5 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
 1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
 2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
 3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
 4. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.
 - a. Architect reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- B. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
 1. Initial Review: Allow 14 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Architect will advise Contractor when a submittal being processed must be delayed for coordination.
 2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
 3. Resubmittal Review: Allow 14 days for review of each resubmittal.
 4. Sequential Review: Where sequential review of submittals by Architect's consultants, Owner, or other parties is indicated, allow 21 days, minimum, for initial review of each submittal. The Architect/Engineer may hold Samples and other submittals used to coordinate finishes, colors, patterns, textures, or other characteristics until submittals for adjacent materials are available. The Architect/Engineer shall issue a written notice to the Contractor stating that the submittal is being held, within 7 days of receiving it.
 5. Concurrent Consultant Review: Where the Contract Documents indicate that submittals may be transmitted simultaneously to Architect and to Architect's consultants, allow 15 days for review of each submittal. Submittal will be returned to Architect before being returned to Contractor.

- C. Electronic Submittals: Identify and incorporate information in each electronic submittal file as follows:
1. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
 2. Name file with submittal number or other unique identifier, including revision identifier.
 - a. File name shall use project identifier and Specification Section number followed by a decimal point and then a sequential number (e.g., LNHS-061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., LNHS-061000.01.A).
 3. Provide means for insertion to permanently record Contractor's review and approval markings and action taken by Architect.
 4. Transmittal Form for Electronic Submittals: Use software-generated form from electronic project management software acceptable to Owner, containing the following information:
 - a. Project name.
 - b. Project number.
 - c. Date.
 - d. Name and address of Architect.
 - e. Name of Contractor.
 - f. Name of firm or entity that prepared submittal.
 - g. Names of subcontractor, manufacturer, and supplier.
 - h. Category and type of submittal.
 - i. Submittal purpose and description.
 - j. Specification Section number and title.
 - k. Specification paragraph number or drawing designation and generic name for each of multiple items.
 - l. Drawing number and detail references, as appropriate.
 - m. Location(s) where product is to be installed, as appropriate.
 - n. Related physical samples submitted directly.
 - o. Indication of full or partial submittal.
 - p. Transmittal number, numbered consecutively.
 - q. Submittal and transmittal distribution record.
 - r. Other necessary identification.
 - s. Remarks.
 5. Metadata: Include the following information as keywords in the electronic submittal file metadata:
 - a. Project name.
 - b. Number and title of appropriate Specification Section.
 - c. Manufacturer name.
 - d. Product name.
- D. Options: Identify options requiring selection by Architect.

- E. Deviations and Additional Information: On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Architect on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same identification information as related submittal.
- F. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
 - 1. Note date and content of previous submittal.
 - 2. Note date and content of revision in label or title block and clearly indicate extent of revision.
 - 3. Resubmit submittals until they are marked with approval notation from Architect's action stamp.
- G. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.
- H. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Architect's action stamp.

PART 2 - PRODUCTS

2.1 SUBMITTAL PROCEDURES

- A. See Section 007216 13.2 for additional information.
- B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
 - 1. If information must be specially prepared for submittal because standard published data are not suitable for use, submit as Shop Drawings, not as Product Data.
 - 2. Mark each copy of each submittal to show which products and options are applicable.
 - 3. Include the following information, as applicable:
 - a. Manufacturer's catalog cuts.
 - b. Manufacturer's product specifications.
 - c. Standard color charts.
 - d. Statement of compliance with specified referenced standards.
 - e. Testing by recognized testing agency.
 - f. Application of testing agency labels and seals.
 - g. Notation of coordination requirements.
 - h. Availability and delivery time information.
 - 4. For equipment, include the following in addition to the above, as applicable:
 - a. Wiring diagrams showing factory-installed wiring.
 - b. Printed performance curves.
 - c. Operational range diagrams.

- d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
 - 5. Submit Product Data before or concurrent with Samples.
- C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.
- 1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
 - a. Identification of products.
 - b. Schedules.
 - c. Compliance with specified standards.
 - d. Notation of coordination requirements.
 - e. Notation of dimensions established by field measurement.
 - f. Relationship and attachment to adjoining construction clearly indicated.
 - g. Seal and signature of professional engineer if specified.
 - 2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches but no larger than 30 by 42 inches.
- D. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.
- 1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
 - 2. Identification: Attach label on unexposed side of Samples that includes the following:
 - a. Generic description of Sample.
 - b. Product name and name of manufacturer.
 - c. Sample source.
 - d. Number and title of applicable Specification Section.
 - e. Specification paragraph number and generic name of each item.
 - 3. For projects where electronic submittals are required, provide corresponding electronic submittal of Sample transmittal, digital image file illustrating Sample characteristics, and identification information for record.
 - 4. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
 - a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
 - b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.
 - 5. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.

- a. Number of Samples: Submit one full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Architect will return submittal with options selected.
- 6. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
 - a. Number of Samples: Submit three sets of Samples. Architect will mark up and retain one returned Sample set as a project record sample.
 - 1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
 - 2) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.
- E. Coordination Drawing Submittals: Comply with requirements specified in Division 00.
- F. Contractor's Construction Schedule: Comply with requirements specified in Division 00..
- G. Application for Payment and Schedule of Values: Comply with requirements specified in Division 00.
- H. Test and Inspection Reports and Schedule of Tests and Inspections Submittals: Comply with requirements specified in Division 00 & 01 Section "Quality Requirements."
- I. Closeout Submittals and Maintenance Material Submittals: Comply with requirements specified in Division 00 & 01 Section "Closeout Procedures."
- J. Maintenance Data: Comply with requirements specified in Division 00 & 01 Section "Operation and Maintenance Data."
- K. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
- L. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
- M. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.

- N. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
- O. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
- P. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
- Q. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
- R. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.
- S. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.

2.2 DELEGATED-DESIGN SERVICES

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
 - 1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.
- B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF electronic file and three paper copies of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.
 - 1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

- A. Action and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect.
- B. Project Closeout and Maintenance Material Submittals: See requirements in Division 01 Section "Closeout Procedures."
- C. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

3.2 ARCHITECT'S ACTION

- A. Action Submittals: Architect will review each submittal, make marks to indicate corrections or revisions required, and return it. Architect will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action.
- B. Informational Submittals: Architect will review each submittal and will not return it, or will return it if it does not comply with requirements. Architect will forward each submittal to appropriate party.
- C. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Architect.
- D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.
- E. Submittals not required by the Contract Documents may be returned by the Architect without action.

END OF SECTION 013300

SECTION 014000 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for quality assurance and quality control.
- B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
 - 1. Specific quality-assurance and -control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
 - 2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and -control procedures that facilitate compliance with the Contract Document requirements.
 - 3. Requirements for Contractor to provide quality-assurance and -control services required by Architect, Owner, Commissioning Authority, or authorities having jurisdiction are not limited by provisions of this Section.
- C. Related Requirements:
 - 1. Divisions 02 through 28 Sections for specific test and inspection requirements.

1.3 DEFINITIONS

- A. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.
- B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Services do not include contract enforcement activities performed by Architect.
- C. Mockups: Full-size physical assemblies that are constructed on-site. Mockups are constructed to verify selections made under Sample submittals; to demonstrate aesthetic effects and, where indicated, qualities of materials and execution; to review coordination, testing, or operation; to show interface between dissimilar materials; and to demonstrate compliance with specified

installation tolerances. Mockups are not Samples. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.

1. Laboratory Mockups: Full-size physical assemblies constructed at testing facility to verify performance characteristics.
 2. Integrated Exterior Mockups: Mockups of the exterior envelope erected separately from the building but on Project site, consisting of multiple products, assemblies, and subassemblies.
 3. Room Mockups: Mockups of typical interior spaces complete with wall, floor, and ceiling finishes, doors, windows, millwork, casework, specialties, furnishings and equipment, and lighting.
- D. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria.
- E. Product Testing: Tests and inspections that are performed by an NRTL, an NVLAP, or a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.
- F. Source Quality-Control Testing: Tests and inspections that are performed at the source, e.g., plant, mill, factory, or shop.
- G. Field Quality-Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.
- H. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.
- I. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.
1. Use of trade-specific terminology in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade(s).
- J. Experienced: When used with an entity or individual, "experienced" means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

1.4 CONFLICTING REQUIREMENTS

- A. Referenced Standards: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to Architect for a decision before proceeding.

- B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.

1.5 ACTION SUBMITTALS

- A. Shop Drawings: For laboratory mockups, provide plans, sections, and elevations, indicating materials and size of mockup construction.
 - 1. Indicate manufacturer and model number of individual components.
 - 2. Provide axonometric drawings for conditions difficult to illustrate in two dimensions.

1.6 INFORMATIONAL SUBMITTALS

- A. Contractor's Quality-Control Plan: For quality-assurance and quality-control activities and responsibilities.
- B. Qualification Data: For Contractor's quality-control personnel.
- C. Contractor's Statement of Responsibility: When required by authorities having jurisdiction, submit copy of written statement of responsibility sent to authorities having jurisdiction before starting work on the following systems:
 - 1. Seismic-force-resisting system, designated seismic system, or component listed in the designated seismic system quality-assurance plan prepared by Architect.
 - 2. Main wind-force-resisting system or a wind-resisting component listed in the wind-force-resisting system quality-assurance plan prepared by Architect.
- D. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.
- E. Schedule of Tests and Inspections: Prepare in tabular form and include the following:
 - 1. Specification Section number and title.
 - 2. Entity responsible for performing tests and inspections.
 - 3. Description of test and inspection.
 - 4. Identification of applicable standards.
 - 5. Identification of test and inspection methods.
 - 6. Number of tests and inspections required.
 - 7. Time schedule or time span for tests and inspections.
 - 8. Requirements for obtaining samples.
 - 9. Unique characteristics of each quality-control service.

1.7 CONTRACTOR'S QUALITY-CONTROL PLAN

- A. Quality-Control Plan, General: Submit quality-control plan within 10 days of Notice to Proceed, and not less than five days prior to preconstruction conference or as indicated in Division 00 of the Project Manual. Submit in format acceptable to Architect. Identify personnel, procedures, controls, instructions, tests, records, and forms to be used to carry out Contractor's quality-assurance and quality-control responsibilities. Coordinate with Contractor's construction schedule.
- B. Quality-Control Personnel Qualifications: Engage qualified full-time personnel trained and experienced in managing and executing quality-assurance and quality-control procedures similar in nature and extent to those required for Project.
 - 1. Project quality-control manager may also serve as Project superintendent.
- C. Submittal Procedure: Describe procedures for ensuring compliance with requirements through review and management of submittal process. Indicate qualifications of personnel responsible for submittal review.
- D. Testing and Inspection: In quality-control plan, include a comprehensive schedule of Work requiring testing or inspection, including the following:
 - 1. Contractor-performed tests and inspections including subcontractor-performed tests and inspections. Include required tests and inspections and Contractor-elected tests and inspections.
 - 2. Special inspections required by authorities having jurisdiction and indicated on the "Statement of Special Inspections."
 - 3. Owner-performed tests and inspections indicated in the Contract Documents, including tests and inspections indicated to be performed by the Commissioning Authority.
- E. Continuous Inspection of Workmanship: Describe process for continuous inspection during construction to identify and correct deficiencies in workmanship in addition to testing and inspection specified. Indicate types of corrective actions to be required to bring work into compliance with standards of workmanship established by Contract requirements and approved mockups.
- F. Monitoring and Documentation: Maintain testing and inspection reports including log of approved and rejected results. Include work Architect has indicated as nonconforming or defective. Indicate corrective actions taken to bring nonconforming work into compliance with requirements. Comply with requirements of authorities having jurisdiction.

1.8 REPORTS AND DOCUMENTS

- A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:
 - 1. Date of issue.
 - 2. Project title and number.
 - 3. Name, address, and telephone number of testing agency.
 - 4. Dates and locations of samples and tests or inspections.

5. Names of individuals making tests and inspections.
 6. Description of the Work and test and inspection method.
 7. Identification of product and Specification Section.
 8. Complete test or inspection data.
 9. Test and inspection results and an interpretation of test results.
 10. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
 11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
 12. Name and signature of laboratory inspector.
 13. Recommendations on retesting and reinspecting.
- B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:
1. Name, address, and telephone number of technical representative making report.
 2. Statement on condition of substrates and their acceptability for installation of product.
 3. Statement that products at Project site comply with requirements.
 4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
 5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 6. Statement whether conditions, products, and installation will affect warranty.
 7. Other required items indicated in individual Specification Sections.
- C. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:
1. Name, address, and telephone number of factory-authorized service representative making report.
 2. Statement that equipment complies with requirements.
 3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 4. Statement whether conditions, products, and installation will affect warranty.
 5. Other required items indicated in individual Specification Sections.
- D. Permits, Licenses, and Certificates: For Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

1.9 QUALITY ASSURANCE

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

- B. **Manufacturer Qualifications:** A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- C. **Fabricator Qualifications:** A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- D. **Installer Qualifications:** A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
- E. **Professional Engineer Qualifications:** A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar in material, design, and extent to those indicated for this Project.
- F. **Specialists:** Certain Specification Sections require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.
 - 1. Requirements of authorities having jurisdiction shall supersede requirements for specialists.
- G. **Testing Agency Qualifications:** An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated, as documented according to ASTM E 329; and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.
 - 1. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
 - 2. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.
- H. **Manufacturer's Technical Representative Qualifications:** An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- I. **Factory-Authorized Service Representative Qualifications:** An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- J. **Preconstruction Testing:** Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:
 - 1. Contractor responsibilities include the following:
 - a. Provide test specimens representative of proposed products and construction.

- b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
 - c. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
 - d. Build site-assembled test assemblies and mockups using installers who will perform same tasks for Project.
 - e. Build laboratory mockups at testing facility using personnel, products, and methods of construction indicated for the completed Work.
 - f. When testing is complete, remove test specimens, assemblies, mockups; do not reuse products on Project.
- 2. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Architect and Commissioning Authority, with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.
- K. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:
 - 1. Build mockups in location and of size indicated or, if not indicated, as directed by Architect.
 - 2. Notify Architect seven days in advance of dates and times when mockups will be constructed.
 - 3. Employ supervisory personnel who will oversee mockup construction. Employ workers that will be employed during the construction at Project.
 - 4. Demonstrate the proposed range of aesthetic effects and workmanship.
 - 5. Obtain Architect's approval of mockups before starting work, fabrication, or construction.
 - a. Allow seven days for initial review and each re-review of each mockup.
 - 6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 - 7. Demolish and remove mockups when directed unless otherwise indicated.
- L. Laboratory Mockups: Comply with requirements of preconstruction testing and those specified in individual Specification Sections in Divisions 02 through 33.

1.10 QUALITY CONTROL

- A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.
 - 1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspecting they are engaged to perform.
 - 2. Payment for these services will be made from testing and inspecting allowances, as authorized by Change Orders.

3. Costs for retesting and reinspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor, and the Contract Sum will be adjusted by Change Order.
- B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities required to verify that the Work complies with requirements, whether specified or not.
1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
 2. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.
 - a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
 3. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.
 4. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
 5. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
 6. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
- C. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Division 01 Section "Submittal Procedures."
- D. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.
- E. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.
- F. Testing Agency Responsibilities: Cooperate with Architect, Commissioning Authority, and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
1. Notify Architect, Commissioning Authority, and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
 2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
 3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.

4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
 5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
 6. Do not perform any duties of Contractor.
- G. Associated Services: Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
1. Access to the Work.
 2. Incidental labor and facilities necessary to facilitate tests and inspections.
 3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
 4. Facilities for storage and field curing of test samples.
 5. Delivery of samples to testing agencies.
 6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
 7. Security and protection for samples and for testing and inspecting equipment at Project site.
- H. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
1. Schedule times for tests, inspections, obtaining samples, and similar activities.
- I. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents as a component of Contractor's quality-control plan. Coordinate and submit concurrently with Contractor's construction schedule. Update as the Work progresses.
1. Distribution: Distribute schedule to Owner, Architect, Commissioning Authority, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

1.11 SPECIAL TESTS AND INSPECTIONS

- A. Special Tests and Inspections: University will engage a qualified testing agency to conduct special tests and inspections required by authorities having jurisdiction as the responsibility of the University.
1. Notifying Architect, the University, and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
 2. Submitting a certified written report of each test, inspection, and similar quality-control service to Architect and the University with copy to Contractor and to authorities having jurisdiction.
 3. Submitting a final report of special tests and inspections at Final Completion, which includes a list of unresolved deficiencies.

4. Interpreting tests and inspections and stating in each report whether tested and inspected work complies with or deviates from the Contract Documents.
5. Retesting and reinspecting corrected work.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

- A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:
 1. Date test or inspection was conducted.
 2. Description of the Work tested or inspected.
 3. Date test or inspection results were transmitted to Architect.
 4. Identification of testing agency or special inspector conducting test or inspection.
- B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Architect's, the University's and the Authority's reference during normal working hours.

3.2 REPAIR AND PROTECTION

- A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
 1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Division 01 Section "Execution."
- B. Protect construction exposed by or for quality-control service activities.
- C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 014000

SECTION 015000 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes requirements for temporary utilities, support facilities, and security and protection facilities, including “NC State University Design and Construction Guidelines Division 01 Temporary Facilities”
- B. Related Requirements:
 - 1. Division 01 Section "Summary" for work restrictions and limitations on utility interruptions.

1.3 USE CHARGES

- A. General: Installation and removal of and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities to use temporary services and facilities without cost, including, but not limited to, Owner's construction forces, Architect, occupants of Project, testing agencies, and authorities having jurisdiction.
- B. Water and Sewer Service from Existing System: Water from Owner's existing water system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.
- C. Electric Power Service from Existing System: Electric power from Owner's existing system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.

1.4 QUALITY ASSURANCE

- A. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.
- B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.
- C. Accessible Temporary Egress: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.2009.

1.5 PROJECT CONDITIONS

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

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Dust-Control Adhesive-Surface Walk-off Mats: Provide mats minimum 36 by 60 inches.
- B. Insulation: Unfaced mineral-fiber blanket, manufactured from glass, slag wool, or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.

2.2 TEMPORARY FACILITIES

- A. Field Offices, General: Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading Coordinate "Storage and Fabrication Sheds" Paragraph below with Owner for use of existing building for storage and protection of materials to be incorporated into Project.
- B. Storage Trailer: Provide storage trailer at building loading dock sized, furnished, and equipped to accommodate materials and equipment for construction operations.
 - 1. Store combustible materials apart from building.

2.3 EQUIPMENT

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

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.
 - 1. Locate facilities to limit site disturbance as specified in Division 01 Section "Summary."
- B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.2 TEMPORARY UTILITY INSTALLATION

- A. General: connect to existing service.
 - 1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.
- B. Water Service: Install water service and distribution piping in sizes and pressures adequate for construction. Sterilize temporary water piping before use.
- C. Water Service: Connect to Owner's existing water service facilities. Clean and maintain water service facilities in a condition acceptable to Owner. At Final Completion, restore these facilities to condition existing before initial use.
- D. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.
- E. Isolation of Work Areas in Occupied Facilities: Prevent dust, fumes, and odors from entering occupied areas.
 - 1. Prior to commencing work, isolate the HVAC system in area where work is to be performed according to coordination drawings.
 - a. Disconnect supply and return ductwork in work area from HVAC systems servicing occupied areas.
 - b. Maintain negative air pressure within work area using HEPA-equipped air-filtration units, starting with commencement of temporary partition construction, and continuing until removal of temporary partitions is complete.
 - 2. Maintain dust partitions during the Work. Use vacuum collection attachments on dust-producing equipment. Isolate limited work within occupied areas using portable dust-containment devices.
 - 3. Perform daily construction cleanup and final cleanup using approved, HEPA-filter-equipped vacuum equipment.
- F. Electric Power Service: Connect to Owner's existing electric power service. Maintain equipment in a condition acceptable to Owner.
- G. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.
 - 1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.

3.3 SUPPORT FACILITIES INSTALLATION

- A. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction. Comply with progress cleaning requirements in Division 01 Section "Execution."

- B. Existing Elevator Use: Use of the University's existing elevators will be permitted, provided elevators are cleaned and maintained in a condition acceptable to the University. At Substantial Completion, restore elevators to condition existing before initial use, including replacing worn cables, guide shoes, and similar items of limited life.
 - 1. Do not load elevators beyond their rated weight capacity.
 - 2. Provide protective coverings, barriers, devices, signs, or other procedures to protect elevator car and entrance doors and frame. If, despite such protection, elevators become damaged, engage elevator Installer to restore damaged work so no evidence remains of correction work. Return items that cannot be refinished in field to the shop, make required repairs and refinish entire unit, or provide new units as required.
- C. Existing Stair Usage: Use of Owner's existing stairs will be permitted, provided stairs are cleaned and maintained in a condition acceptable to Owner. At Final Completion, restore stairs to condition existing before initial use.
 - 1. Provide protective coverings, barriers, devices, signs, or other procedures to protect stairs and to maintain means of egress. If stairs become damaged, restore damaged areas so no evidence remains of correction work.

3.4 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities.
- B. Security Enclosure and Lockup: Install temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security. Lock entrances at end of each work day.
- C. Temporary Egress: Maintain temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction.
- D. Temporary Partitions: The General Contractor shall provide floor-to-ceiling dustproof partitions to limit dust and dirt migration and to separate areas occupied by Owner from fumes and noise.
 - 1. Construct dustproof partitions with gypsum wallboard with joints taped on occupied side, and fire-retardant-treated plywood on construction operations side.
 - a. Construct vestibule and airlock at each entrance through temporary partition with not less than 48 inches between doors. Maintain water-dampened foot mats in vestibule.
 - 2. Insulate partitions to control noise transmission to occupied areas.
 - 3. Seal joints and perimeter. Equip partitions with gasketed dustproof doors and security locks where openings are required.
 - 4. Protect air-handling equipment.
 - 5. Provide walk-off mats at each entrance through temporary partition.

- E. Noise Control: The General Contractor shall schedule and coordinate noise producing activities with the Owner.
- F. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241; manage fire-prevention program.
 - 1. Prohibit smoking in construction areas.
 - 2. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to requirements of authorities having jurisdiction.
 - 3. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.

3.5 OPERATION, TERMINATION, AND REMOVAL

- A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.
- B. Maintenance: Maintain facilities in good operating condition until removal.
 - 1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.
- C. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
 - 1. Materials and facilities that constitute temporary facilities are property of Contractor.
 - 2. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Division 01 Section "Closeout Procedures."

END OF SECTION 015000

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SECTION 016000 - PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.

1.3 DEFINITIONS

- A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
 - 1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature, that is current as of date of the Contract Documents.
 - 2. New Products: Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.
 - 3. Comparable Product: Product that is demonstrated and approved through submittal process to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
- B. Basis-of-Design Product Specification: A specification in which a specific manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of additional manufacturers named in the specification.

1.4 ACTION SUBMITTALS

- A. Basis-of-Design Product Specification Submittal: Comply with requirements in Division 00 and Division 01 Section "Submittal Procedures." Show compliance with requirements.

1.5 QUALITY ASSURANCE

- A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.
 - 1. Each contractor is responsible for providing products and construction methods compatible with products and construction methods of other contractors.
 - 2. If a dispute arises between contractors over concurrently selectable but incompatible products, Architect will determine which products shall be used.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.
- B. Delivery and Handling:
 - 1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
 - 2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
 - 3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
 - 4. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.
- C. Storage:
 - 1. Store products to allow for inspection and measurement of quantity or counting of units.
 - 2. Store materials in a manner that will not endanger Project structure.
 - 3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
 - 4. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
 - 5. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
 - 6. Protect stored products from damage and liquids from freezing.
 - 7. Provide a secure location and enclosure at Project site for storage of materials and equipment by Owner's construction forces. Coordinate location with Owner.

1.7 PRODUCT WARRANTIES

- A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on

product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.

1. Manufacturer's Warranty: Written warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
 2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner.
- B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.
1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
 2. Specified Form: When specified forms are included with the Specifications, prepare a written document using indicated form properly executed.
 3. See Divisions 02 through 33 Sections for specific content requirements and particular requirements for submitting special warranties.
- C. Submittal Time: Comply with requirements in Division 01 Section "Closeout Procedures."

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

- A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.
1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
 2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
 3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
 4. Where products are accompanied by the term "as selected," Architect will make selection.
 5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
 6. Or Equal: For products specified by name and accompanied by the term "or equal," or "or approved equal," or "or approved," comply with requirements in "Comparable Products" Article to obtain approval for use of an unnamed product.
- B. Product Selection Procedures:
1. Products:
 - a. Restricted List: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered unless otherwise indicated.

2. Manufacturers:
 - a. Restricted List: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered unless otherwise indicated.
 3. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.
- C. Visual Matching Specification: Where Specifications require "match Architect's sample", provide a product that complies with requirements and matches Architect's sample. Architect's decision will be final on whether a proposed product matches.
1. If no product available within specified category matches and complies with other specified requirements, comply with requirements in Division 01 Section "Substitution Procedures" for proposal of product.
- D. Visual Selection Specification: Where Specifications include the phrase "as selected by Architect from manufacturer's full range" or similar phrase, select a product that complies with requirements. Architect will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

PART 3 - EXECUTION (Not Used)

END OF SECTION 016000

SECTION 017300 – EXECUTION REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes general administrative and procedural requirements governing execution of the Work including, but not limited to, the following:
 - 1. Construction layout.
 - 2. Field engineering and surveying.
 - 3. Installation of the Work.
 - 4. Cutting and patching.
 - 5. Progress cleaning.
 - 6. Starting and adjusting.
 - 7. Protection of installed construction.
 - 8. Correction of the Work.

1.3 DEFINITIONS

- A. Cutting: Removal of in-place construction necessary to permit installation or performance of other work.
- B. Patching: Fitting and repair work required to restore construction to original conditions after installation of other work.

1.4 QUALITY ASSURANCE

- A. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.
 - 1. Structural Elements: When cutting and patching structural elements, notify Architect of locations and details of cutting and await directions from Architect before proceeding. Shore, brace, and support structural elements during cutting and patching. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection.
 - 2. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety. Operational elements include the following:

- a. Primary operational systems and equipment.
 - b. Fire separation assemblies.
 - c. Air or smoke barriers.
 - d. Mechanical systems piping and ducts.
 - e. Control systems.
 - f. Communication systems.
 - g. Fire-detection and -alarm systems.
 - h. Electrical wiring systems.
 - i. Operating systems of special construction.
3. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety.
4. Visual Elements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: Comply with requirements specified in other Sections.
- B. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
 1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Architect for the visual and functional performance of in-place materials.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
 1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
 2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.

3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- B. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:
1. Description of the Work.
 2. List of detrimental conditions, including substrates.
 3. List of unacceptable installation tolerances.
 4. Recommended corrections.
- C. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- B. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- C. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents caused by differing field conditions outside the control of Contractor, submit a RFI to Architect according to requirements in Divisions 00 & 01.

3.3 INSTALLATION

- A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
1. Make vertical work plumb and make horizontal work level.
 2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
 3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
 4. Maintain minimum headroom clearance of 96 inches in occupied spaces and 90 inches in unoccupied spaces.
- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Final Completion.
- D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.

- E. Sequence the Work and allow adequate clearances to accommodate movement of construction items on site and placement in permanent locations.
- F. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.
- G. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.
- H. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions.
 - 1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect.
 - 2. Allow for building movement, including thermal expansion and contraction.
 - 3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- I. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.
- J. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

3.4 CUTTING AND PATCHING

- A. Cutting and Patching, General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
 - 1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
- B. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.
- C. Temporary Support: Provide temporary support of work to be cut.
- D. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.

- E. Adjacent Occupied Areas: Where interference with use of adjoining areas or interruption of free passage to adjoining areas is unavoidable, coordinate cutting and patching according to requirements in Division 01 Section "Summary."
- F. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to prevent interruption to occupied areas.
- G. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
 - 1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
 - 2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
 - 3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
 - 4. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
 - 5. Proceed with patching after construction operations requiring cutting are complete.
- H. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other work. Patch with durable seams that are as invisible as practicable. Provide materials and comply with installation requirements specified in other Sections, where applicable.
 - 1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
 - 2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will minimize evidence of patching and refinishing.
 - a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
 - b. Restore damaged pipe covering to its original condition.
 - 3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
 - a. Where patching occurs in a painted surface, prepare substrate and apply primer and intermediate paint coats appropriate for substrate over the patch, and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.

4. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
- I. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

3.5 PROGRESS CLEANING

- A. General: Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.
 1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
 2. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
 - a. Use containers intended for holding waste materials of type to be stored.
 3. Coordinate progress cleaning for joint-use areas where Contractor and other contractors are working concurrently.
- B. Site: Maintain Project site free of waste materials and debris.
- C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.
 1. Remove liquid spills promptly.
 2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.
- D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.
- E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.
- F. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Final Completion.
- G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways.
- H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Final Completion.
- I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.

- J. Limiting Exposures: Supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.6 STARTING AND ADJUSTING

- A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
- B. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.
- C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Manufacturer's Field Service: Comply with qualification requirements in Division 01 Section "Quality Requirements."

3.7 PROTECTION OF INSTALLED CONSTRUCTION

- A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Final Completion.
- B. Comply with manufacturer's written instructions for temperature and relative humidity.

3.8 CORRECTION OF THE WORK

- A. Repair or remove and replace defective construction. Restore damaged substrates and finishes. Comply with requirements in Division 01 Section "Cutting and Patching."
 - 1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.
- B. Restore permanent facilities used during construction to their specified condition.
- C. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.
- D. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.
- E. Remove and replace chipped, scratched and broken glass or reflective surfaces.

END OF SECTION 017300

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SECTION 017419 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for the following:
 - 1. Salvaging nonhazardous demolition and construction waste.
 - 2. Recycling nonhazardous demolition and construction waste.
 - 3. Disposing of nonhazardous demolition and construction waste.
 - 4. “NC State University Design and Construction Guidelines – Waste Materials Management – Reuse, Recycling, & Hazardous Waste”.
- B. Related Requirements:
 - 1. Division 02 Section "Selective Demolition" for disposition of waste resulting from partial demolition of buildings, structures, and site improvements.

1.3 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 off-site of demolition and construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.
- D. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.
- E. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.
- F. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.

1.4 PERFORMANCE REQUIREMENTS

- A. General: Achieve end-of-Project rates for salvage/recycling of 50 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 the following:

1. Demolition Waste:
 - a. Concrete.
 - b. Concrete reinforcing steel.
 - c. Brick.
 - d. Concrete masonry units.
 - e. Wood studs.
 - f. Wood joists.
 - g. Plywood and oriented strand board.
 - h. Wood paneling.
 - i. Wood trim.
 - j. Structural and miscellaneous steel.
 - k. Rough hardware.
 - l. Insulation.
 - m. Doors and frames.
 - n. Door hardware.
 - o. Windows.
 - p. Glazing.
 - q. Metal studs.
 - r. Gypsum board.
 - s. Acoustical tile and panels.
 - t. Carpet.
 - u. Carpet pad.
 - v. Demountable partitions.
 - w. Equipment.
 - x. Cabinets.
 - y. Plumbing fixtures.
 - z. Piping.
 - aa. Supports and hangers.
 - bb. Valves.
 - cc. Sprinklers.
 - dd. Mechanical equipment.
 - ee. Refrigerants.
 - ff. Electrical conduit.
 - gg. Copper wiring.
 - hh. Lighting fixtures.
 - ii. Lamps.
 - jj. Ballasts.
 - kk. Electrical devices.
 - ll. Switchgear and panelboards.
 - mm. Transformers.

2. Construction Waste:

- a. Masonry and CMU.
- b. Lumber.
- c. Wood sheet materials.
- d. Wood trim.
- e. Metals.
- f. Roofing.
- g. Insulation.
- h. Carpet and pad.
- i. Gypsum board.
- j. Piping.
- k. Electrical conduit.
- l. Packaging: Regardless of salvage/recycle goal indicated in "General" Paragraph above, salvage or recycle 100 percent of the following uncontaminated packaging materials:
 - 1) Paper.
 - 2) Cardboard.
 - 3) Boxes.
 - 4) Plastic sheet and film.
 - 5) Polystyrene packaging.
 - 6) Wood crates.
 - 7) Plastic pails.

1.5 ACTION SUBMITTALS

- A. Waste Management Plan: Submit plan within 30 days of date established for the Notice to Proceed.

1.6 INFORMATIONAL SUBMITTALS

- A. Waste Reduction Progress Reports: Concurrent with each Application for Payment, submit report and receipts from C&D Recycling facility. Include the following information:
 1. Material category.
 2. Total quantity of waste in tons.
 3. Quantity of waste recycled/salvaged, both estimated and actual in tons.
 4. Total quantity of waste recovered (salvaged plus recycled) as a percentage of total waste.
- B. Waste Reduction Calculations: Before request for Substantial Completion, submit calculated end-of-Project rates for salvage, recycling, and disposal as a percentage of total waste generated by the Work.
- C. Records of Donations: Indicate receipt and acceptance of salvageable waste donated to individuals and organizations. Indicate whether organization is tax exempt.
- D. Records of Sales: Indicate receipt and acceptance of salvageable waste sold to individuals and organizations. Indicate whether organization is tax exempt.

- E. Recycling and Processing Facility Records: Indicate receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.
- F. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

1.7 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with hauling and disposal regulations of authorities having jurisdiction.
- B. Waste Management Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." Review methods and procedures related to waste management including, but not limited to, the following:
 - 1. Review and discuss waste management plan including responsibilities of waste management coordinator.
 - 2. Review requirements for documenting quantities of each type of waste and its disposition.
 - 3. Review and finalize procedures for materials separation and verify availability of containers and bins needed to avoid delays.
 - 4. Review procedures for periodic waste collection and transportation to recycling and disposal facilities.
 - 5. Review waste management requirements for each trade.

1.8 WASTE MANAGEMENT PLAN

- A. General: Develop a waste management plan according to ASTM E 1609 and requirements in this Section. Plan shall consist of waste identification, waste reduction work plan, and cost/revenue analysis. Distinguish between demolition and construction waste. Indicate quantities by weight or volume, but use same units of measure throughout waste management plan.
- B. Waste Identification: Indicate anticipated types and quantities of demolition and construction waste generated by the Work. Include estimated quantities and assumptions for estimates.
- C. Waste Reduction Work Plan: List each type of waste and whether it will be salvaged, recycled, or disposed of in landfill or incinerator. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.
 - 1. Salvaged Materials for Reuse: For materials that will be salvaged and reused in this Project, describe methods for preparing salvaged materials before incorporation into the Work.
 - 2. Salvaged Materials for Sale: For materials that will be sold to individuals and organizations, include list of their names, addresses, and telephone numbers.

3. Salvaged Materials for Donation: For materials that will be donated to individuals and organizations, include list of their names, addresses, and telephone numbers.
 4. Recycled Materials: Include list of local receivers and processors and type of recycled materials each will accept. Include names, addresses, and telephone numbers.
 5. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.
 6. Handling and Transportation Procedures: Include method that will be used for separating recyclable waste including sizes of containers, container labeling, and designated location where materials separation will be performed.
- D. Cost/Revenue Analysis: Indicate total cost of waste disposal as if there was no waste management plan and net additional cost or net savings resulting from implementing waste management plan. Include the following:
1. Total quantity of waste.
 2. Estimated cost of disposal (cost per unit). Include hauling and tipping fees and cost of collection containers for each type of waste.
 3. Total cost of disposal (with no waste management).
 4. Revenue from salvaged materials.
 5. Revenue from recycled materials.
 6. Savings in hauling and tipping fees by donating materials.
 7. Savings in hauling and tipping fees that are avoided.
 8. Handling and transportation costs. Include cost of collection containers for each type of waste.
 9. Net additional cost or net savings from waste management plan.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 PLAN IMPLEMENTATION

- A. General: Implement approved waste management plan. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.
1. Comply with operation, termination, and removal requirements in Division 01 Section "Temporary Facilities and Controls."
- B. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work.
1. Distribute waste management plan to everyone concerned within three days of submittal return.
 2. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.

- C. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
 - 1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged, recycled, reused, donated, and sold.
 - 2. Comply with Division 01 Section "Temporary Facilities and Controls" for controlling dust and dirt, environmental protection, and noise control.

3.2 SALVAGING DEMOLITION 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. Doors and Hardware: Brace open end of door frames. Except for removing door closers, leave door hardware attached to doors.
- D. Equipment: Drain tanks, piping, and fixtures. Seal openings with caps or plugs. Protect equipment from exposure to weather.
- E. Plumbing Fixtures: Separate by type and size.
- F. Lighting Fixtures: Separate lamps by type and protect from breakage.
- G. Electrical Devices: Separate switches, receptacles, switchgear, transformers, meters, panel boards, circuit breakers, and other devices by type.

3.3 RECYCLING DEMOLITION AND CONSTRUCTION WASTE, GENERAL

- A. General: Recycle paper and beverage containers used by on-site workers.
- B. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall accrue to the Contractor.
- C. Preparation of Waste: Prepare and maintain recyclable waste materials according to recycling or reuse facility requirements. Maintain materials free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to the recycling process.

- D. 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. Concrete: Remove reinforcement and other metals from concrete and sort with other metals.
 - 1. Pulverize concrete to meet recycling vendor's requirements.
- B. Masonry: Remove metal reinforcement, anchors, and ties from masonry and sort with other metals.
 - 1. Pulverize masonry to meet recycling vendor's requirements.
- C. Wood Materials: Sort and stack members according to size, type, and length. Separate lumber, engineered wood products, panel products, and treated wood materials.
- D. Metals: Separate metals by type.
 - 1. Structural Steel: Stack members according to size, type of member, and length.
 - 2. Remove and dispose of bolts, nuts, washers, and other rough hardware.
- E. 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.
- F. Acoustical Ceiling Panels and Tile: Stack large clean pieces on wood pallets and store in a dry location.
- G. Metal Suspension System: Separate metal members including trim, and other metals from acoustical panels and tile and sort with other metals.
- H. Piping: Reduce piping to straight lengths and store by type and size. Separate supports, hangers, valves, sprinklers, and other components by type and size.
- I. Conduit: Reduce conduit to straight lengths and store by type and size.

3.5 RECYCLING CONSTRUCTION WASTE

A. 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.

B. Wood Materials:

1. Clean Cut-Offs of Lumber: Grind or chip into small pieces.
2. Clean Sawdust: Bag sawdust that does not contain painted or treated wood.

C. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location.

1. Clean Gypsum Board: Grind scraps of clean gypsum board using small mobile chipper or hammer mill. Screen out paper after grinding.

3.6 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 or incinerator acceptable to authorities having jurisdiction.

1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

B. Burning: Do not burn waste materials.

C. Disposal: Remove waste materials from Owner's property and legally dispose of them.

END OF SECTION 017419

SECTION 017700 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
 - 1. Substantial Completion procedures.
 - 2. Final completion procedures.
 - 3. Warranties.
 - 4. Final cleaning.
 - 5. Project record documents.
 - 6. Repair of the Work.

1.3 ACTION SUBMITTALS

- A. Contractor's List of Incomplete Items: Initial submittal at Final Completion.
- B. Certified List of Incomplete Items: Final submittal at Final Completion.

1.4 CLOSEOUT SUBMITTALS

- A. Certificates of Release: From authorities having jurisdiction.
- B. Certificate of Insurance: For continuing coverage.
- C. Field Report: For pest control inspection.

1.5 MAINTENANCE MATERIAL SUBMITTALS

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

1.6 SUBSTANTIAL COMPLETION PROCEDURES

- A. 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.
- B. Submittals Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Final Completion. List items below that are incomplete at time of request.
 - 1. Certificates of Release: Obtain and submit releases from authorities having jurisdiction permitting University unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
 - 2. Submit closeout submittals specified in other Division 00 & 01 Sections, including project record documents, operation and maintenance manuals, final completion construction photographic documentation, damage or settlement surveys, property surveys, and similar final record information.
 - 3. Submit closeout submittals specified in individual Divisions 02 through 33 Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
 - 4. Submit maintenance material submittals specified in individual Divisions 02 through 33 Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by the University. Label with manufacturer's name and model number where applicable.
 - a. Schedule of Maintenance Material Items: Prepare and submit schedule of maintenance material submittal items, including name and quantity of each item and name and number of related Specification Section. Obtain Architect's signature for receipt of submittals.
 - 5. Submit test/adjust/balance records.
 - 6. Submit changeover information related to University's occupancy, use, operation, and maintenance.
- C. Procedures Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Final Completion. List items below that are incomplete at time of request.
 - 1. Advise the University of pending insurance changeover requirements.
 - 2. Make final changeover of permanent locks and deliver keys to the University. Advise University's personnel of changeover in security provisions.
 - 3. Complete startup and testing of systems and equipment.
 - 4. Perform preventive maintenance on equipment used prior to Final Completion.
 - 5. Instruct University's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video recordings specified in Division 01 Section "Demonstration and Training."
 - 6. Advise University of changeover in heat and other utilities.
 - 7. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
 - 8. Complete final cleaning requirements, including touchup painting.

9. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.
- D. Inspection: Submit a written request for inspection to determine Final Completion. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare the Certificate of Final Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Architect, that must be completed or corrected before certificate will be issued.
 1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
 2. Results of completed inspection will form the basis of requirements for final completion.

1.7 FINAL COMPLETION PROCEDURES

- A. Submittals Prior to Final Completion: Before requesting final inspection for determining final completion, complete the following:
 1. Submit a final Application for Payment according to Division 01 Section "Payment Procedures."
 2. Certified List of Incomplete Items: Submit certified copy of Architect's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect. Certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
 3. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.
 4. Submit pest-control final inspection report.
 5. Instruct University's personnel in operation, adjustment, and maintenance of products, equipment and systems.
- B. Inspection: Submit a written request for final inspection to determine. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.
 1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.8 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

- A. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.
 1. Organize list of spaces in sequential order.
 2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
 3. Include the following information at the top of each page:

- a. Project name.
 - b. Project number.
 - c. Date.
 - d. Name of Architect.
 - e. Name of Contractor.
 - f. Page number.
4. Submit list of incomplete items in the following format:
 - a. MS Excel electronic file. Architect will return annotated file.

1.9 SUBMITTAL OF PROJECT WARRANTIES

- A. Time of Submittal: Submit written warranties on request of Architect for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated, or when delay in submittal of warranties might limit University's rights under warranty.
- B. Partial Occupancy: Submit properly executed warranties of designated portions of the Work that are completed and occupied or used by University during construction period by separate agreement with Contractor.
- C. Organize warranty documents into an orderly sequence based on the table of contents of Project Manual.
 1. Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper.
 2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
 3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.
- D. Provide additional copies of each warranty to include in operation and maintenance manuals.

1.10 PROJECT RECORD DOCUMENTS

- A. General: Do not use Project Record Documents for construction purposes. Protect Project Record Documents from deterioration and loss. Provide access to Project Record Documents for Architect/Engineer's reference during normal working hours.
- B. Record Drawings: Maintain and submit one set of black-line white prints of Contract Drawings and Shop Drawings.
 1. Mark Record Prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to prepare the marked-up Record Prints.

- a. Give particular attention to information on concealed elements that cannot be readily identified and recorded later.
 - b. Record data as soon as possible after obtaining it. Record and check the markup before enclosing concealed installations.
 2. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at the same location.
 3. Note Construction Change Directive numbers, Change Order numbers, alternate numbers, and similar identification where applicable.
 4. Identify and date each Record Drawing; include the designation “PROJECT RECORD DRAWING” in a prominent location. Organize into manageable sets; bind each set with durable paper cover sheets. Include identification on cover sheets.
- C. Record Specifications: Submit one copy of Project’s Specifications, including addenda and contract modifications. Mark copy to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.
1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
 3. Note related Change Orders and Record Drawings, where applicable.
- D. Miscellaneous Record Submittals: Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

PART 2 - PRODUCTS

2.1 MATERIALS

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

PART 3 - EXECUTION

3.1 FINAL CLEANING

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

- B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
 - 1. Complete the following cleaning operations before requesting 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 interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Restore reflective surfaces to their original condition.
 - c. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean according to manufacturer's recommendations if visible soil or stains remain.
 - d. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Polish mirrors and glass, taking care not to scratch surfaces.
 - e. Remove labels that are not permanent.
 - f. Wipe surfaces of mechanical and electrical equipment, elevator equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
 - g. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
 - h. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
 - i. Clean ducts, blowers, and coils if units were operated without filters during construction or that display contamination with particulate matter on inspection.
 - 1) Clean HVAC system in compliance with NADCA Standard 1992-01. Provide written report on completion of cleaning.
 - j. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency.
 - k. Leave Project clean and ready for occupancy.
- C. Construction Waste Disposal: Comply with waste disposal requirements in Division 01 Section "Construction Waste Management and Disposal."

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. Remove and replace chipped, scratched, and broken glass, reflective surfaces, and other damaged transparent materials.

2. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that 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.
3. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.
4. 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.

END OF SECTION 017700

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SECTION 017823 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
 - 1. Operation and maintenance documentation directory.
 - 2. Emergency manuals.
 - 3. Operation manuals for systems, subsystems, and equipment.
 - 4. Product maintenance manuals.
 - 5. Systems and equipment maintenance manuals.

1.3 DEFINITIONS

- A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.
- B. Subsystem: A portion of a system with characteristics similar to a system.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance manuals shall be made available for review during weekly progress meetings. The manuals shall be submitted as equipment and systems are installed, and prior to Demonstration and Training.
- B. Manual Content: Operations and maintenance manual content is specified in individual Specification Sections to be reviewed at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.
 - 1. Architect will comment on whether content of operations and maintenance submittals are acceptable.
 - 2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.
- C. Format: Submit operations and maintenance manuals in the following format:

1. Three (3) paper copies. Include a complete operation and maintenance directory. Enclose title pages and directories in clear plastic sleeves. Architect will return 3 copies to the University.

PART 2 - PRODUCTS

2.1 OPERATION AND MAINTENANCE DOCUMENTATION MANUALS FORMAT

- A. Manuals shall consist of manufacturers' typed or printed operation instructions and maintenance data, shop drawings or catalog cuts, and other data listed herein; all bound in 8 ½" x 11" hard-back binder. Material shall be assembled as follows:
 1. Inside Cover: Title of job, The University of North Carolina, address, date of submittal, name of contractor and name of manufacturer.
 2. Second Page: Index
 3. Third Page: Introduction to first section containing a complete written description of the equipment or system.
 4. First Section: Written description of system contents, where equipment is located in building, how each part functions individually and how system works as a whole, concluded with a list of items requiring service and the service needed or reference to the manufacturer's data in the binder which describes proper service.
 5. Second Section: A copy of each shop drawing with an index at the beginning of the section.
 6. Third Section: A copy of manufacturer's operating instructions with an index at the beginning of the section.
 7. Fourth Section: A list of all equipment incorporated into job, contractor's purchase order numbers, supplier's name and address.
- B. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.

2.2 OPERATION MANUALS

- A. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:
 1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
 2. Performance and design criteria if Contractor has delegated design responsibility.
 3. Operating standards.
 4. Operating procedures.
 5. Operating logs.
 6. Wiring diagrams.
 7. Control diagrams.
 8. Piped system diagrams.
 9. Precautions against improper use.
 10. License requirements including inspection and renewal dates.

B. Descriptions: Include the following:

1. Product name and model number. Use designations for products indicated on Contract Documents.
2. Manufacturer's name.
3. Equipment identification with serial number of each component.
4. Equipment function.
5. Operating characteristics.
6. Limiting conditions.
7. Performance curves.
8. Engineering data and tests.
9. Complete nomenclature and number of replacement parts.

C. Operating Procedures: Include the following, as applicable:

1. Startup procedures.
2. Equipment or system break-in procedures.
3. Routine and normal operating instructions.
4. Regulation and control procedures.
5. Instructions on stopping.
6. Normal shutdown instructions.
7. Seasonal and weekend operating instructions.
8. Required sequences for electric or electronic systems.
9. Special operating instructions and procedures.

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

E. Piped Systems: Diagram piping as installed, and identify color-coding where required for identification.

2.3 PRODUCT MAINTENANCE MANUALS

A. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.

B. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.

C. Product Information: Include the following, as applicable:

1. Product name and model number.
2. Manufacturer's name.
3. Color, pattern, and texture.
4. Material and chemical composition.
5. Reordering information for specially manufactured products.

D. Maintenance Procedures: Include manufacturer's written recommendations and the following:

1. Inspection procedures.
2. Types of cleaning agents to be used and methods of cleaning.
3. List of cleaning agents and methods of cleaning detrimental to product.
4. Schedule for routine cleaning and maintenance.
5. Repair instructions.

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

F. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

1. Include procedures to follow and required notifications for warranty claims.

2.4 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

A. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below.

B. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.

C. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:

1. Standard maintenance instructions and bulletins.
2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
3. Identification and nomenclature of parts and components.
4. List of items recommended to be stocked as spare parts.

D. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:

1. Test and inspection instructions.
2. Troubleshooting guide.
3. Precautions against improper maintenance.
4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
5. Aligning, adjusting, and checking instructions.
6. Demonstration and training video recording, if available.

- E. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
 - 1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
 - 2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.
- F. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.
- G. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.
- H. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
 - 1. Include procedures to follow and required notifications for warranty claims.

2.5 AFFIDAVITS AND GUARANTEES

- A. In addition to the standard forms required by the contract documents, the following are required:
 - 1. Affidavits:
 - a. Carpeting materials – Installer attests that correct materials were installed
 - b. Non-standard resilient – Installer attest that correct materials were floor materials installed.
 - 2. Extended Guarantees:
 - a. Sealants – 5 year guarantee

PART 3 - EXECUTION

3.1 MANUAL PREPARATION

- A. Operation and Maintenance Manuals: Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.
 - 1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
 - 2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.
- B. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a

tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.

1. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.
- C. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.
1. Do not use original project record documents as part of operation and maintenance manuals.
 2. Comply with requirements of newly prepared record Drawings in Division 01 Section "Project Record Documents."
- D. Comply with Division 01 Section "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

END OF SECTION 017823

SECTION 017839 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for project record documents, including the following:
 - 1. Record Drawings.
 - 2. Record Specifications.
 - 3. Record Product Data.
 - 4. Miscellaneous record submittals.
- B. Related Requirements:
 - 1. Division 01 Section "Execution" for final property survey.
 - 2. Division 01 Section "Closeout Procedures" for general closeout procedures.
 - 3. Division 01 Section "Operation and Maintenance Data" for operation and maintenance manual requirements.
 - 4. Divisions 02 through 33 Sections for specific requirements for project record documents of the Work in those Sections.

1.3 CLOSEOUT SUBMITTALS

- A. Record Drawings: Comply with the following:
 - 1. Number of Copies: Submit one set(s) of marked-up record prints.

PART 2 - PRODUCTS

2.1 RECORD DRAWINGS

- A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued.
 - 1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.

- a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
 - b. Accurately record information in an acceptable drawing technique.
 - c. Record data as soon as possible after obtaining it.
 - d. Record and check the markup before enclosing concealed installations.
 - e. Cross-reference record prints to corresponding archive photographic documentation.
 2. Content: Types of items requiring marking include, but are not limited to, the following:
 - a. Dimensional changes to Drawings.
 - b. Revisions to details shown on Drawings.
 - c. Depths of foundations below first floor.
 - d. Locations and depths of underground utilities.
 - e. Revisions to routing of piping and conduits.
 - f. Revisions to electrical circuitry.
 - g. Actual equipment locations.
 - h. Duct size and routing.
 - i. Locations of concealed internal utilities.
 - j. Changes made by Change Order or Change Directive.
 - k. Changes made following Architect's written orders.
 - l. Details not on the original Contract Drawings.
 - m. Field records for variable and concealed conditions.
 - n. Record information on the Work that is shown only schematically.
 3. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
 4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
 5. Mark important additional information that was either shown schematically or omitted from original Drawings.
 6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
- B. Format: Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
1. Record Prints: Organize record prints and newly prepared record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
 2. Identification: As follows:
 - a. Project name.
 - b. Date.
 - c. Designation "PROJECT RECORD DRAWINGS."
 - d. Name of Architect
 - e. Name of Contractor.

2.2 MISCELLANEOUS RECORD SUBMITTALS

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

PART 3 - EXECUTION

3.1 RECORDING AND MAINTENANCE

- A. Recording: Maintain one copy of each submittal during the construction period for project record document purposes. Post changes and revisions to project record documents as they occur; do not wait until end of Project.
- B. Maintenance of Record Documents and Samples: Store record documents and Samples in the field office apart from the Contract Documents used for construction. Do not use project record documents for construction purposes. Maintain record documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project record documents for Architect's reference during normal working hours.

END OF SECTION 017839

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SECTION 017900 - DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:
 - 1. Demonstration of operation of systems, subsystems, and equipment.
 - 2. Training in operation and maintenance of systems, subsystems, and equipment.
 - 3. Demonstration and training video recordings.
- B. Related Requirements:
 - 1. Divisions 02 through 33 Sections for specific requirements for demonstration and training for products in those Sections.

1.3 INFORMATIONAL SUBMITTALS

- A. Instruction Program: Submit outline of instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.
 - 1. Indicate proposed training modules using manufacturer-produced demonstration and training video recordings for systems, equipment, and products in lieu of video recording of live instructional module.
- B. Qualification Data: For instructor.

1.4 QUALITY ASSURANCE

- A. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.
- B. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Division 01 Section "Quality Requirements," experienced in operation and maintenance procedures and training.

1.5 COORDINATION

- A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations and to ensure availability of Owner's personnel.
- B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.
- C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by Architect.

PART 2 - PRODUCTS

2.1 INSTRUCTION PROGRAM

- A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.
 - 1. Basis of System Design, Operational Requirements, and Criteria: Include the following:
 - a. System, subsystem, and equipment descriptions.
 - b. Performance and design criteria if Contractor is delegated design responsibility.
 - c. Operating standards.
 - d. Regulatory requirements.
 - e. Equipment function.
 - f. Operating characteristics.
 - g. Limiting conditions.
 - h. Performance curves.
 - 2. Documentation: Review the following items in detail:
 - a. Emergency manuals.
 - b. Operations manuals.
 - c. Maintenance manuals.
 - d. Project record documents.
 - e. Identification systems.
 - f. Warranties and bonds.
 - g. Maintenance service agreements and similar continuing commitments.
 - 3. Emergencies: Include the following, as applicable:
 - a. Instructions on meaning of warnings, trouble indications, and error messages.
 - b. Instructions on stopping.
 - c. Shutdown instructions for each type of emergency.
 - d. Operating instructions for conditions outside of normal operating limits.
 - e. Sequences for electric or electronic systems.
 - f. Special operating instructions and procedures.

4. Operations: Include the following, as applicable:
 - a. Startup procedures.
 - b. Equipment or system break-in procedures.
 - c. Routine and normal operating instructions.
 - d. Regulation and control procedures.
 - e. Control sequences.
 - f. Safety procedures.
 - g. Instructions on stopping.
 - h. Normal shutdown instructions.
 - i. Operating procedures for emergencies.
 - j. Operating procedures for system, subsystem, or equipment failure.
 - k. Seasonal and weekend operating instructions.
 - l. Required sequences for electric or electronic systems.
 - m. Special operating instructions and procedures.
5. Adjustments: Include the following:
 - a. Alignments.
 - b. Checking adjustments.
 - c. Noise and vibration adjustments.
 - d. Economy and efficiency adjustments.
6. Troubleshooting: Include the following:
 - a. Diagnostic instructions.
 - b. Test and inspection procedures.
7. Maintenance: Include the following:
 - a. Inspection procedures.
 - b. Types of cleaning agents to be used and methods of cleaning.
 - c. List of cleaning agents and methods of cleaning detrimental to product.
 - d. Procedures for routine cleaning
 - e. Procedures for preventive maintenance.
 - f. Procedures for routine maintenance.
 - g. Instruction on use of special tools.
8. Repairs: Include the following:
 - a. Diagnosis instructions.
 - b. Repair instructions.
 - c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 - d. Instructions for identifying parts and components.
 - e. Review of spare parts needed for operation and maintenance.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Division 01 Section "Operations and Maintenance Data."
- B. Set up instructional equipment at instruction location.

3.2 INSTRUCTION

- A. Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and Owner for number of participants, instruction times, and location.
- B. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
 - 1. Owner will furnish Contractor with names and positions of participants.
- C. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.
 - 1. Schedule training with Owner, with at least seven days' advance notice.
- D. Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.
- E. Cleanup: Collect used and leftover educational materials and remove from Project site. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

END OF SECTION 017900

SECTION 024100 - SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Demolition and removal of selected portions of building or structure.
2. Salvage of existing items to be reused or recycled.

1.2 DEFINITIONS

- A. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged or removed and reinstalled.
- B. Remove and Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to Owner ready for reuse.
- C. Remove and Reinstall: Detach items from existing construction, prepare for reuse, and reinstall where indicated.
- D. Existing to Remain: Existing items of construction that are not to be permanently removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.3 PREINSTALLATION MEETINGS

- A. Predemolition Conference: Conduct conference at Project site.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For refrigerant recovery technician.
- B. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician.

1.5 CLOSEOUT SUBMITTALS

- A. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.

1.6 QUALITY ASSURANCE

- A. Refrigerant Recovery Technician Qualifications: Certified by an EPA-approved certification program.

1.7 FIELD CONDITIONS

- A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.
- B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
- C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.
- D. Storage or sale of removed items or materials on-site is not permitted.
- E. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
 - 1. Maintain fire-protection facilities in service during selective demolition operations.

1.8 WARRANTY

- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- B. Standards: Comply with ANSI/ASSE A10.6 and NFPA 241.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that utilities have been disconnected and capped before starting selective demolition operations.

- B. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.
- C. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Architect.
- D. Perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective building demolition operations.
- E. Survey of Existing Conditions: Record existing conditions by use of measured drawings and preconstruction photographs.

3.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

- A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.
 - 1. Comply with requirements for existing services/systems interruptions specified in Divisions 00 & 01.
- B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.
 - 1. Owner will arrange to shut off indicated services/systems when requested by Contractor.
 - 2. Arrange to shut off indicated utilities with utility companies.
 - 3. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
 - 4. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated to be removed.
 - a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
 - c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 - d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 - e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
 - f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
 - g. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.

- C. Refrigerant: Remove refrigerant from mechanical equipment to be selectively demolished according to 40 CFR 82 and regulations of authorities having jurisdiction.

3.3 PREPARATION

- A. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
 - 1. Comply with requirements for access and protection specified in Division 01 Section "Temporary Facilities and Controls."
- B. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
- C. Temporary Shoring: Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

3.4 SELECTIVE DEMOLITION, GENERAL

- A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
 - 1. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
 - 2. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
 - 3. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain fire watch and portable fire-suppression devices during flame-cutting operations.
 - 4. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
 - 5. Dispose of demolished items and materials promptly. Comply with requirements in Division 01 Section "Construction Waste Management and Disposal."
- B. Removed and Reinstalled Items:
 - 1. Clean and repair items to functional condition adequate for intended reuse.
 - 2. Pack or crate items after cleaning and repairing. Identify contents of containers.
 - 3. Protect items from damage during transport and storage.

4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.
- C. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

3.5 DISPOSAL OF DEMOLISHED MATERIALS

- A. General: Except for items or materials indicated to be recycled, reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, remove demolished materials from Project site and legally dispose of them in an EPA-approved landfill.
1. Do not allow demolished materials to accumulate on-site.
 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
 3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
 4. Comply with requirements specified in Division 01 Section "Construction Waste Management and Disposal."
- B. Burning: Do not burn demolished materials.
- C. Disposal: Transport demolished materials off Owner's property and legally dispose of them.

3.6 CLEANING

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

END OF SECTION 024119

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SECTION 033000 - CAST-IN-PLACE

CONCRETE PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section specifies cast-in place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:
 - 1. Slabs on grade.
 - 2. Footings.
 - 3. Mechanical equipment pads and housekeeping pads.
 - 4. Control, expansion and contraction joint devices, Floor pit repairs and in-fill.
 - 5. Slab patching.

1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with fly ash, subject to compliance with requirements.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
 - 1. Indicate amounts of mixing water to be withheld for later addition at Project site.
- C. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.
- D. Material Certificates: For each of the following, signed by manufacturers:
 - 1. Cementitious materials.
 - 2. Aggregates.
 - 3. Admixtures.
 - 4. Steel reinforcement and accessories.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94 requirements for production facilities and equipment.
 - 1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities".
- B. Testing Agency Qualifications: An independent agency qualified according to ASTM C1077 and ASTM E329 for testing indicated, as documented according to ASTM E548.
- C. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from one source, and obtain admixtures through one source from a single manufacturer.
- D. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
 - 1. ACI 301, "Specification for Structural Concrete", Sections 1 through 5, and Section 7, "Lightweight Concrete".
 - 2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials".
- E. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

1.6 DELIVERY, STORAGE, AND HANDLING

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
 - 2. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 FORM-FACING MATERIALS

- A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
 - 1. Plywood, metal, or other approved panel materials.

- B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.
- C. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4-inch, minimum.
- D. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
 - 1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
- E. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

2.3 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A615, Grade 60, deformed.
- B. Plain-Steel Welded Wire Reinforcement: ASTM A185, plain, fabricated from as-drawn steel wire into flat sheets.

2.4 REINFORCEMENT ACCESSORIES

- A. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
 - 1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.

2.5 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
 - 1. Portland Cement: ASTM C150, Type I, gray. Supplement with the following:
 - a. Fly Ash: ASTM C618, Class C or F.
- B. Normal-Weight Aggregates: ASTM C33, Class 3M, coarse aggregate or better, graded. Provide aggregates from a single source.
 - 1. Maximum Coarse-Aggregate Size: 1-1/2 inches nominal, unless otherwise indicated.
- C. Water: ASTM C94 and potable.

2.6 ADMIXTURES

- A. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
 - 1. Water-Reducing Admixture: ASTM C494, Type A.
 - 2. Retarding Admixture: ASTM C494, Type B.
 - 3. Water-Reducing and Retarding Admixture: ASTM C494, Type D.
 - 4. High-Range, Water-Reducing Admixture: ASTM C494, Type F.
 - 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C494, Type G.
 - 6. Plasticizing and Retarding Admixture: ASTM C1017, Type II.

2.7 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
 - 1. Available Products:
 - a. Axim Concrete Technologies; Cimfilm.
 - b. Burke by Edoco; BurkeFilm.
 - c. Conspec Marketing & Manufacturing Co., Inc., a Dayton Superior Company; Aquafilm.
 - d. Dayton Superior Corporation; Sure Film.
 - e. Euclid Chemical Company (The); Eucobar.
 - f. L&M Construction Chemicals, Inc.; E-Con.
 - g. Meadows, W. R., Inc.; Sealtight Evapre.
 - h. Metalcrete Industries; Waterhold.
 - i. Nox-Crete Products Group, Kinsman Corporation; Monofilm.
 - j. Sika Corporation, Inc.; SikaFilm.
 - k. Symons Corporation, a Dayton Superior Company; Finishing Aid.
- B. Absorptive Cover: AASHTO M182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.
- C. Moisture-Retaining Cover: ASTM C171, polyethylene film or white burlap-polyethylene sheet.
- D. Water: Potable.
- E. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C1315, Type 1, Class A.
 - 1. Available Products:
 - a. Burke by Edoco; Cureseal 1315 WB.
 - b. ChemMasters; Polyseal WB.
 - c. Conspec Marketing & Manufacturing Co., Inc., a Dayton Superior Company; Sealcure 1315 WB.
 - d. Euclid Chemical Company (The); Super Diamond Clear VOX.
 - e. L&M Construction Chemicals, Inc.; Lumiseal WB Plus.
 - f. Meadows, W. R., Inc.; Vocomp-30.
 - g. Metalcrete Industries; Metcure 30.

- h. Symons Corporation, a Dayton Superior Company; Cure & Seal 31 Percent E.

2.8 RELATED MATERIALS

- A. Vapor Retarder: ASTM E 1745, Class B, high density rubber modified polyolefin sheet.
 - 1. Properties:
 - a. Maximum Permeance: ASTM E-96, 0.02 perms.
 - b. Water Vapor Retarder: ASTM E-1745, meets or exceeds Class B.
 - c. Puncture Resistance: ASTM D-1709, Method B, 3400 grams.
 - 2. Acceptable Products:
 - a. Stego Wrap Class A Vapor Retarder by Stego Industries, LLC, (877) 464-7834.
 - b. Griffolyn Type 85 by Reef Industries, (800) 231-6074.
 - c. Moistop Ultra 10 by Fortifiber Building Systems Group, (800) 773-4777.
 - d. Perminator 10 Mil by W.R. Meadows, Inc. (800) 342-5976
 - e. Seam Tape and Penetration Tape: Manufacturer's recommended tape.
- B. Bonding Agent: ASTM C1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- C. Epoxy Bonding Adhesive: ASTM C881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:
 - 1. Types I and II, non-load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

2.9 REPAIR MATERIALS

- A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.
 - 1. Cement Binder: ASTM C150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C219.
 - 2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
 - 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by underlayment manufacturer.
 - 4. Compressive Strength: Not less than 4000 psi at 28 days when tested according to ASTM C109.
- B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.
 - 1. Cement Binder: ASTM C150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C219.
 - 2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
 - 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.

4. Compressive Strength: Not less than 5000 psi at 28 days when tested according to ASTM C109.

2.10 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.
 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, for concrete exposed to weather.
- C. Limit water-soluble, chloride-ion content in hardened concrete, measured by percent by weight of cement, as follows:
 1. All Concrete. 0.30.
- D. Admixtures: Use admixtures according to manufacturer's written instructions.
 1. Use water-reducing, high-range water-reducing, or plasticizing admixture in concrete, as required, for placement and workability.
 2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
 3. Use water-reducing admixture in pumped concrete and concrete with a water-cementitious materials ratio below 0.50.

2.11 CONCRETE MIXTURES FOR BUILDING ELEMENTS

- A. Footings: Proportion normal-weight concrete mixture as follows:
 1. Minimum Compressive Strength: 3000 psi at 28 days.
 2. Slump Limit: 4 inches, plus or minus 1 inch.
- B. Slabs-on-Grade, protected from weather: Proportion normal-weight concrete mixture as follows:
 1. Minimum Compressive Strength: 3000 psi at 28 days.
 2. Minimum Cementitious Materials Content: 520 lb/cu. yd. for 1 inch maximum aggregate size or 540 lb/cu. yd. for $\frac{3}{4}$ inch maximum aggregate size.
 3. Slump Limit: 4 inches, plus or minus 1 inch.
 4. Air Content: Do not allow air content of troweled finished floors to exceed 3 percent.
- C. Slabs-on-Grade, exposed to weather: Proportion normal-weight concrete mixture as follows:
 1. Minimum Compressive Strength: 4500 psi at 28 days.
 2. Minimum Cementitious Materials Content: 520 lb/cu. yd. for 1 inch maximum aggregate size; 540 lb/cu. yd. for $\frac{3}{4}$ inch maximum aggregate size.
 3. Slump Limit: 4 inches, plus or minus 1 inch.
 4. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for 1-inch or $\frac{3}{4}$ -inch nominal maximum aggregate size.
 5. Water-Cementitious ratio: 0.40.
- D. Suspended Slabs on Composite Steel Deck: Proportion structural lightweight concrete

mixture as follows:

1. Minimum Compressive Strength: 3500 psi at 28 days.
2. Maximum aggregate size: $\frac{3}{4}$ inch.
3. Calculated Equilibrium Unit Weight: 115 lb/cu. ft., plus or minus 3 lb/cu. ft. as determined by ASTM C567.
4. Slump Limit: 4 inches, plus or minus 1 inch.
5. Air Content: Do not allow air content of troweled finished floors to exceed 3 percent.

2.12 FABRICATING REINFORCEMENT

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

2.13 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C94, and furnish batch ticket information.
 1. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 FORMWORK

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.
- B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
- C. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:
 1. Class A, 1/8 inch for smooth-formed finished surfaces.
 2. Class C, 1/2 inch for rough-formed finished surfaces exposed to view.
 3. Class D, 1 inch for rough-formed finished surfaces permanently concealed.
- D. Construct forms tight enough to prevent loss of concrete mortar.
- E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
 1. Install keyways, reglets, recesses, and the like, for easy removal.
 2. Do not use rust-stained steel form-facing material.
- F. 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.

- G. 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.
- H. Chamfer exterior corners and edges of permanently exposed concrete.
- I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
- J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 EMBEDDED ITEMS

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

3.3 REMOVING AND REUSING FORMS

- A. Formwork for sides of beams, walls, columns, or similar parts of the Work that does not support weight of concrete may be removed if all three of the following conditions are met.
 - 1. Concrete has cured cumulatively for 24 hours after placing concrete at not less than 50 deg F (10 deg C).
 - 2. Concrete is hard enough to not be damaged by form-removal operations.
 - 3. Curing and protection operations are maintained.
- B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.
- C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Engineer.

3.4 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.

- C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.
- D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

3.5 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.
- B. Conduit, pipe, or other non-structural items may not be run within structural concrete components, except where indicated.
- C. Install vapor barrier under interior slabs on grade in accordance with ASTM E1643. Lap joints minimum 6 inches and seal watertight by taping edges and ends.
- D. Repair vapor barrier damaged during placement of concrete reinforcing. Repair with vapor barrier material; lap over damaged areas minimum 6 inches and seal watertight.
- E. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.
 - 1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- F. 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.

3.6 FINISHING FORMED SURFACES

- A. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
 - 1. Apply to concrete surfaces exposed to public view, or to be covered with a coating or covering material applied directly to concrete.

3.7 FINISHING FLOORS AND SLABS

- A. Finishing Operations - General:
 - 1. Do not directly apply water to slab surface or dust with cement.
 - 2. Use hand or powered equipment only as recommended in ACI 302.1R.

3. Screeding: Strikeoff to required grade and within surface tolerances indicated. Verify conformance to surface tolerances. Correct deficiencies while concrete is still plastic.
 4. Bull Floating: Immediately following screeding, bull float or darby before bleed water appears to eliminate ridges, fill in voids, and embed coarse aggregate. Recheck and correct surface tolerances.
 5. Do not perform subsequent finishing until excess moisture or bleed water has disappeared and concrete will support either foot pressure with less than 1/4-inch indentation or weight of power floats without damaging flatness.
 6. Final floating: Float to embed coarse aggregate, to eliminate ridges, to compact concrete, to consolidate mortar at surface, and to achieve uniform, sandy texture. Recheck and correct surface tolerances.
 7. Troweling: Trowel immediately following final floating. Apply first troweling with power trowel except in confined areas, and apply subsequent trowelings with hand trowels. Wait between trowelings to allow concrete to harden. Do not over trowel. Begin final troweling when surface produces a ringing sound as trowel is moved over it. Consolidate concrete surface by final troweling operation. Completed surface shall be free of trowel marks, uniform in texture and appearance, and within surface tolerance specified.
 - a. Grind smooth surface defects which would telegraph through final floor covering system.
- B. Coordinate appearance and texture of required final finishes with the architect before application.
- C. Float Finish: As specified above.
- D. Broomed Float Finish: After floating and when water sheen has practically disappeared, apply uniform transverse corrugations approximately 1/16 inch deep, without tearing surface.
- E. Trowel Finish: As specified above.
- F. Trowel and Fine Broom Finish: Follow trowel finishing operation immediately with fine brooming to achieve slightly scarified surface.
- G. Slab Surface Tolerances:
1. Achieve flat, level planes except where grades are indicated. Slope uniformly to drains.
 2. Floated finishes: Depressions between high spots shall not exceed 1/8 inch under a 10-foot straightedge.
 3. Troweled finishes: Finish surfaces to the following tolerances, according to ASTM E 1155 (ASTM E 1155M), for a randomly trafficked floor surface:
 - a. Floors receiving trowel or trowel and fine broom finish: Specified overall values of flatness, F(F) 25; and of levelness, F(L) 20; with minimum local values of flatness, F(F) 17; and of levelness, F(L) 15.
- H. Slab Finish Schedule: Apply finishes in the following typical locations and as otherwise shown on the drawings:
1. Broomed float:
 - a. Sidewalks.
 - b. Exterior slabs not otherwise scheduled.
 2. Trowel finish:

- a. Exposed interior floors not otherwise scheduled.
 - b. Surfaces to receive resilient tile.
 - c. Surfaces to receive carpet.
 3. Trowel and fine broom:
 - a. Surfaces to receive thinset tile.
- I. Repair of Slab Surfaces: Test slab surfaces for smoothness and to verify surface plane to tolerance specified. Repair defects as follows:
 1. High areas: Correct by grinding after concrete has cured for not less than 14 days.
 2. Low areas: Immediately after completion of surface finishing operations, cut out low areas and replace with fresh concrete. Finish repaired areas to blend with adjacent concrete. Proprietary patching compounds may be used when approved by the architect.
 3. Crazed or cracked areas: Cut out defective areas, except random cracks and single holes not exceeding 1 inch in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts. Dampen exposed concrete and apply bonding compound. Mix, place, compact, and finish patching concrete to match adjacent concrete.
 4. Isolated cracks and holes: Groove top of cracks and cut out holes not over 1 inch in diameter. Dampen cleaned concrete surfaces and apply bonding compound; place dry pack or proprietary repair compound acceptable to architect while bonding compound is still active:
 - a. Dry-pack mix: One-part portland cement to 2-1/2 parts fine aggregate and enough water as required for handling and placing.
 - b. Install patching mixture and consolidate thoroughly, striking off level with and matching surrounding surface. Do not allow patched areas to dry out prematurely.
 5. Underlayment: Leveling of slabs for subsequent application of floor finishes may be achieved by use of specified underlayment material, at contractor's option.
- J. Surface Sealer: Apply to all interior concrete slabs to remain exposed.
 1. Allow concrete to cure for 30 days prior to application of sealer.
 2. Use clear solvent base, 100% solid epoxy sealer similar to Tamms Duraltex 1705. Apply two coats. Follow manufacturer's recommendation for surface preparation.

3.8 MISCELLANEOUS CONCRETE ITEMS

- A. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.
- B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

3.9 CONCRETE PROTECTING AND CURING

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

- B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.
- D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.
- E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
 - 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
 - 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
 - a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
 - b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
 - c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project.
 - 3. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.10 CONCRETE SURFACE REPAIRS

- A. Defective Concrete: Repair and patch defective areas when approved by Engineer. Remove and replace concrete that cannot be repaired and patched to Engineer's approval.
- B. Patching Mortar: Mix dry-pack patching mortar, consisting of one-part portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.
- C. Repairing Formed Surfaces: Surface defects include color and texture irregularities,

cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension in solid concrete, but not less than 1 inch in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush- coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Engineer.

D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
2. After concrete has cured at least 14 days, correct high areas by grinding.
3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
6. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to Engineer's approval, using epoxy
CAST-IN-PLACE CONCRETE

adhesive and patching mortar.

- F. Repair materials and installation not specified above may be used, subject to Engineer's approval.

3.11 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Owner will engage a qualified testing and inspecting agency to perform field tests and prepare test reports.
- B. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C172 shall be performed according to the following requirements:
 - 1. Testing Location: Point of Discharge.
 - 2. Testing Frequency: Obtain at least one composite sample for each 100-cu. yd. or fraction thereof of each concrete mixture placed each day.
 - a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
 - 3. Slump: ASTM C143; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
 - 4. Air Content: ASTM C231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 - 5. Concrete Temperature: ASTM C1064; one test hourly when air temperature is 40 deg F (4.4 deg C) and below and when 80 deg F (27 deg C) and above, and one test for each composite sample.
 - 6. Compression Test Specimens: ASTM C31.
 - a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.
 - 7. Compressive-Strength Tests: ASTM C39; test one set of two laboratory-cured specimens at 7 days and one set of 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 composite sample and tested at age indicated.
 - 8. Strength of each concrete mixture will be satisfactory if every average of any three-consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
 - 9. Test results shall be reported in writing to Engineer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
 - 10. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Engineer but will not be used as sole basis for approval or rejection of concrete.
 - 11. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive

strengths, or other requirements have not been met, as directed by Engineer. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42 or by other methods as directed by Engineer.

12. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
13. Correct deficiencies in the Work that test reports and inspections indicate does not comply with the Contract Documents.

END OF
SECTION

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SECTION 04 2000 - UNIT MASONRY ASSEMBLIES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes unit masonry assemblies consisting of the following:
 - 1. Concrete masonry units (CMUs).
 - 2. Face Brick
 - 3. Mortar and grout.
 - 4. Reinforcing steel.
 - 5. Masonry joint reinforcement.
 - 6. Ties and anchors.
 - 7. Embedded flashing
 - 8. Miscellaneous masonry accessories.
 - 9. Cavity-wall insulation
- B. Related Sections include the following:
 - 1. Division 7 Section "Bituminous Dampproofing" for dampproofing applied to cavity face of backup wythes of cavity walls.
 - 2. Division 7 Section "Sheet Metal Flashing and Trim" for sheet metal flashing.
 - 3. Division 7 Section "Joint Sealants" for sealing control and expansion joints in unit masonry
- C. Products installed, but not furnished, under this Section include the following:
 - 1. Steel lintels for unit masonry, furnished under Division 5 Section "Metal Fabrications."

1.2 DEFINITIONS

- A. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.3 PERFORMANCE REQUIREMENTS

- A. Provide structural unit masonry that develops indicated net-area compressive strengths (f_m) at 28 days.
- B. Determine net-area compressive strength (f_m) of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For the following:
 - 1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes including brick for fabricated masonry lintel.

2. Reinforcing Steel: Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315R, "Details and Detailing of Concrete Reinforcement." Show elevations of reinforced walls.
 3. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.
- C. Samples for Initial Selection: For the following:
1. Face brick, in the form of straps of five or more bricks.
 2. Colored mortar
- D. Samples for Verification: For each type and color of the following:
1. Hollow brick, in the form of straps of five or more bricks.
 2. Exterior grout.
 3. Accessories embedded in masonry.
 4. **Final selection will be made by the architect and NC State's Office of University Architect upon review of an exterior field erected sample panel (48" x 48"). Allow for up to three colors of grout in the sample panel.**
- E. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, model numbers, lot numbers, batch numbers, source of supply, and other information as required to identify materials used. Include mix proportions for mortar and grout and source of aggregates and adjacent materials as detailed on drawings.
1. Submittal is for information only. Neither receipt of list nor approval of mockup constitutes approval of deviations from the Contract Documents unless such deviations are specifically brought to the attention of Architect and approved in writing.
- F. Qualification Data: For testing agency.
- G. Material Certificates: Include statements of material properties indicating compliance with requirements including compliance with standards and type designations within standards. Provide for each type and size of the following:
1. Masonry units.
 - a. Include material test reports substantiating compliance with requirements.
 - b. For bricks, include size-variation data verifying that actual range of sizes falls within specified tolerances.
 - c. For exposed brick, include material test report for efflorescence according to ASTM C 67.
 - d. For masonry units used in structural masonry, include data and calculations establishing average net-area compressive strength of units
 2. Cementitious materials. Include brand, type, and name of manufacturer.
 3. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
 4. Grout mixes. Include description of type and proportions of ingredients.
 5. Reinforcing bars.
 6. Joint reinforcement.
 7. Anchors, ties, and metal accessories.
 8. Face brick cleaner.

- H. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
 - 1. Include test reports, per ASTM C 780, for mortar mixes required to comply with property specification.
 - 2. Include test reports, per ASTM C 1019, for grout mixes required to comply with compressive strength requirement.
- I. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602.
- J. Cold/Hot - Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with cold-weather requirements.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1093 for testing indicated, as documented according to ASTM E 548.
- B. Supplier Qualifications: Supplier of products required for structural masonry load bearing designs shall provide product and services through a quality assurance program NQA-1 over a three year period.
- C. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, through one source from a single manufacturer for each product required.
- D. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from a single manufacturer for each cementitious component and from one source or producer for each aggregate.
- E. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution
 - 1. Build mockups for typical exterior and interior walls in sizes approximately 48 inches long by 48 inches high by full thickness, including face and backup wythes and accessories.
 - a. Include a sealant-filled joint at least 16 inches long in each mockup.
 - b. Include lower corner of window opening at upper corner of exterior wall mockup. Make opening approximately 12 inches wide by 16 inches high.
 - c. Include through-wall flashing installed for a 24-inch length in corner of exterior wall mockup approximately 16 inches down from top of mockup, with a 12-inch length of flashing left exposed to view (omit masonry above half of flashing).
 - d. Include veneer anchors, flashing, and weep holes in exterior masonry-veneer wall mockup.
 - 2. Clean exposed faces of mockups with masonry cleaner as indicated.
 - 3. Protect accepted mockups from the elements with weather-resistant membrane.
 - 4. Approval of mockups is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; and aesthetic qualities of workmanship. Allow for up to three colors of grout and two colors of sealant.

- a. Approval of mockups is also for other material and construction qualities specifically approved by Architect in writing.
 - b. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless such deviations are specifically approved by Architect in writing.
5. Remove and dispose of mock-up panel at the end of the masonry construction when directed to do so by the Architect.
- F. Preinstallation Conference prior to mockup panel: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."
 1. Meeting shall be attended by the General Contractor, masonry subcontractor project manager and foreman, decorative block manufacturer and the Architect.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.
- B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
- D. Deliver preblended, dry mortar mix in moisture-resistant containers designed for lifting and emptying into dispensing silo. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in a metal dispensing silo with weatherproof cover.
- E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.7 PROJECT CONDITIONS

- A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
 1. Extend cover a minimum of 24 inches down both sides and hold cover securely in place.
 2. Where 1 wythe of multiwythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches down face next to unconstructed wythe and hold cover in place.
- B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least 3 days after building masonry walls or columns.
- C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
 1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.

2. Protect sills, ledges, and projections from mortar droppings.
 3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
 4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.
- D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and above and will remain so until masonry has dried, but not less than 7 days after completing cleaning.
- E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

2.2 MASONRY UNITS, GENERAL

- A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to exceed tolerances and to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects, including dimensions that vary from specified dimensions by more than stated tolerances, will be exposed in the completed Work or will impair the quality of completed masonry.

2.3 CONCRETE MASONRY UNITS (CMUs)

- A. Shapes: Provide shapes indicated and as follows:
1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
 2. Provide square-edged units for outside corners, unless otherwise indicated, at locations where CMU is concealed from view in finished state.
- B. Concrete Masonry Units: ASTM C 90.
1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 1900 psi. Load bearing concrete masonry units per ACI 530.1-05 with compressive strength as specified on the structural drawings.
 2. Weight Classification: Normal weight.
 3. Size (Width): Manufactured to dimensions 3/8 inch less than nominal dimensions.

4. Aggregates: fine aggregates for areas to receive epoxy and other high performance coatings, medium aggregates for other coatings.
 - a. All areas shall receive consistent CMU surface texture through out an area with consistent coatings. Texture shall meet the approved sample panel in color, texture and overall surface final condition.
 - b. Bugholes void and chips beyond specified tolerances are not allowed and will be subject to rejection and rebuild of sample panels.

2.4 MASONRY LINTELS

- A. Masonry Lintels: Built-in-place masonry lintels made from bond beam concrete masonry units with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.

2.5 BRICK

- A. General: Provide shapes indicated and as follows:
 1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
 2. Provide solid units where cores and frogs would be exposed to view.
- B. Face Brick: ASTM C 216, Grade , Type FBS.
 1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 6400 psi .
 2. Initial Rate of Absorption: Less than 30 g/30 sq. in. per minute when tested per ASTM C 67.
 3. Efflorescence: Provide brick that has been tested according to ASTM C 67 and is rated "not effloresced."
 4. Size (Actual Dimensions): 3-5/8 inches wide by 3-5/8 inches high by 11-5/8 inches long.
 5. Application: Use where brick is exposed, unless otherwise indicated.
 6. Color and Texture: As selected by Architect. Intent is to match the color and flash pattern of the CVM's existing finger barns adjacent to the site. **Final selection will be made by the architect and NC State upon review of an exterior field erected sample panel.**

2.6 MORTAR AND GROUT MATERIALS

- A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
- B. Hydrated Lime: ASTM C 207, Type S.
- C. Aggregate for Mortar: ASTM C 144. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
 1. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.
- D. Aggregate for Grout: ASTM C 404.

- E. Water: Potable.
- F. Color and texture: Intent is to match the color, texture of the CVM's existing finger barns adjacent to the site. **Final selection will be made by the architect and NC State upon review of an exterior field erected sample panel.**

2.7 REINFORCEMENT

- A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M Grade 60.
- B. Masonry Joint Reinforcement, General: ASTM A 951.
 - 1. Interior Walls: Hot-dip galvanized, carbon steel.
 - 2. Exterior Walls: Hot-dip galvanized, carbon steel.
 - 3. Wire Size for Side Rods: W2.8 or 0.188-inch diameter.
 - 4. Wire Size for Cross Rods: W2.8 or 0.188-inch diameter.
 - 5. Wire Size for Veneer Ties: W2.8 or 0.188-inch diameter.
 - 6. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.
 - 7. Provide in lengths of not less than 10 feet, with prefabricated corner and tee units.
- C. Masonry Joint Reinforcement for Single-Wythe Masonry: Either ladder or truss type with single pair of side rods.
- D. Masonry Joint Reinforcement for Multiwythe Masonry
 - 1. Adjustable (two-piece) type, either ladder or truss design, with one side rod at each face shell of backing wythe and with separate ties that extend into facing wythe. Ties have two hooks that engage eyes or slots in reinforcement and resist movement perpendicular to wall. Ties extend at least halfway through facing wythe but with at least 5/8-inch cover on outside face. Ties have hooks or clips to engage a continuous horizontal wire in the facing wythe

2.8 EMBEDDED FLASHING MATERIALS FOR EXTERIOR WALLS

- A. Flexible Flashing: For flashing not exposed to the exterior, use one of the following, unless otherwise indicated.
 - 1. Copper-Laminated Flashing: 7-oz./sq. ft. copper sheet bonded with asphalt between 2 layers of glass-fiber cloth. Use only where flashing is fully concealed in masonry.
 - a. Products:
 - 1) Advanced Building Products Inc.; Copper Fabric Flashing.
 - 2) AFCO Products Inc.; Copper Fabric.
 - 3) Hohmann & Barnard, Inc.; H & B C-Fab Flashing.
 - 4) Sandell Manufacturing Co., Inc.; Copper Fabric Flashing
 - 2. Rubberized-Asphalt Flashing: Composite flashing product consisting of a pliable, adhesive rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film to produce an overall thickness of not less than 0.040 inch. A
 - a. Products:
 - 1) Advanced Building Products Inc.; Peel-N-Seal.
 - 2) Carlisle Coatings & Waterproofing; CCW-705-TWF Thru-Wall Flashing.
 - 3) Dayton Superior Corporation, Dur-O-Wal Division; Dur-O-Barrier-44.

- 4) Grace Construction Products, a unit of W. R. Grace & Co. - Conn.; Perm-ABarrier Wall Flashing.
 - 5) Heckmann Building Products Inc.; No. 82 Rubberized-Asphalt Thru-Wall Flashing.
 - 6) Hohmann & Barnard, Inc.; Textroflash.
 - 7) Polyguard Products, Inc.; Polyguard 300.
 - 8) Polytite Manufacturing Corp.; Poly-Barrier Self-Adhering Wall Flashing.
 - 9) Williams Products, Inc.; Everlastic MF-40.
- B. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

2.9 TIES AND ANCHORS

- A. Adjustable Anchors for Connecting to Structure: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.
1. Tie Section for Steel Frame or Steel structural members: Triangular-shaped wire tie, sized to extend within 1 inch of masonry face, made from 0.25-inch- diameter, hot-dip galvanized steel wire. Mill-galvanized wire may be used at interior walls, unless otherwise indicated.
 2. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82; with ASTM A 153/A 153M, Class B-2 coating.

2.10 MISCELLANEOUS ANCHORS

- A. Unit Type Inserts in Concrete: Cast-iron or malleable-iron wedge-type inserts.
- B. Anchor Bolts: Headed or L-shaped steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers; hot-dip galvanized to comply with ASTM A 153/A 153M, Class C; of dimensions indicated.
- C. Postinstalled Chemical Anchors: Provide chemical anchors, with capability to sustain, without failure, a load equal to six times the load imposed when installed in solid or grouted unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.
1. Corrosion Protection: Stainless-steel components complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 for bolts and nuts; ASTM A 666 or ASTM A 276, Type 304 or 316, for anchors.
- D. Postinstalled Expansion Anchors: Provide torque-controlled expansion anchors, with capability to sustain, without failure, a load equal to six times the load imposed when installed in solid or grouted unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.
1. Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (5 microns) for Class SC 1 service condition (mild).
 2. Corrosion Protection: Stainless-steel components complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 for bolts and nuts; ASTM A 666 or ASTM A 276, Type 304 or 316, for anchors.

2.11 MISCELLANEOUS MASONRY ACCESSORIES

- A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene, urethane or PVC.
- B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 or PVC, complying with ASTM D 2287, Type PVC-65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.
- C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).
- D. Bond-breaker strips used as slip planes at lintels bearing on masonry.
- E. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.
 - 1. Provide one of the following configurations:
 - a. Strips, full-depth of cavity and 10 inches wide, with dovetail shaped notches 7 inches deep.
 - b. Strips, not less than 1-1/2 inches thick and 10 inches wide, with dimpled surface designed to catch mortar droppings and prevent weep holes from being clogged with mortar.
 - 2. Products:
 - a. Advanced Building Products Inc.; Mortar Break.
 - b. Archovations, Inc.; CavClear Masonry Mat.
 - c. Dayton Superior Corporation, Dur-O-Wal Division; Polytite MortarStop.
 - d. Mortar Net USA, Ltd.; Mortar Net.
- F. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells with loops for holding reinforcing bars in center of cells. Units are formed from 0.142-inch steel wire, hot-dip galvanized after fabrication. Provide units with either two loops or four loops as needed for number of bars indicated.
 - 1. Products:
 - a. Dayton Superior Corporation, Dur-O-Wal Division; D/A 810, D/A 812 or D/A 817.
 - b. Heckmann Building Products Inc.; No. 376 Rebar Positioner.
 - c. Hohmann & Barnard, Inc.; #RB or #RB-Twin Rebar Positioner.
 - d. Wire-Bond; O-Ring or Double O-Ring Rebar Positioner.

2.12 CAVITY WALL INSULATION

- A. Extruded-Polystyrene (XPS) Board Insulation: ASTM C 578, Type IV, closed-cell product extruded with an integral skin.
- B. Adhesive: Type recommended by insulation board manufacturer for application indicated.

2.13 MASONRY CLEANERS

- A. Job-Mixed Detergent Solution: For new laid brick assemblies use a solution of 1/2-cup dry-measure tetrasodium polyphosphate and 1/2-cup dry-measure laundry detergent dissolved in 1 gal. of water.

2.14 MORTAR AND GROUT MIXES

- A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.
 - 1. Do not use calcium chloride in mortar or grout.
 - 2. Limit cementitious materials in mortar to portland cement and lime.
- B. 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 masonry below grade or in contact with earth, use Type S.
 - 2. For reinforced masonry, use Type S.
 - 3. For exterior, above-grade, load-bearing and non-load-bearing walls; for interior load-bearing walls; for interior non-load-bearing partitions; and for other applications where another type is not indicated, use Type S.
- C. Grout for Unit Masonry: Comply with ASTM C 476.
 - 1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
 - 2. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143/C 143M, and a minimum compressive strength of 3000 psi (21 Mpa) at 28 days.
- D. Remove masonry protrusion greater than or equal to 1/2 inch into cells or cavities per TMS 602.

2.15 SOURCE QUALITY CONTROL

- A. Engage a qualified independent testing agency to perform source quality-control testing indicated below:
 - 1. Payment for these services will be made by Owner.
 - 2. Retesting of materials failing to comply with specified requirements shall be done at Contractor's expense.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
 - 1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.

2. Verify that foundations are within tolerances specified.
 3. Verify that reinforcing dowels are properly placed.
- B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Thickness: Build cavity and composite walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.
- B. Build chases and recesses to accommodate items specified in this and other Sections.
- C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.
- D. 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.
- E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.
1. Mix units from several pallets or cubes as they are placed.
- F. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. per minute when tested per ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.
- G. Comply with construction tolerances in ACI 530.1/ASCE 6/TMS 602 and with the following:
1. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
 2. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet, or 1/2 inch maximum.
 3. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
 4. For exposed bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch. Do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.
 5. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch. Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch.
 6. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch except due to warpage of masonry units within tolerances specified for warpage of units.

7. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch from one masonry unit to the next.

3.3 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
- B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.
- C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 4-inches. Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.
- D. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.
- E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
- F. Fill space between steel frames and masonry solidly with mortar, unless otherwise indicated.
- G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below and rod mortar or grout into core.
- H. Fill cores in hollow concrete masonry units with grout 24 inches under bearing plates, beams, lintels, posts, and similar items, unless otherwise indicated.
- I. Build non-load-bearing interior partitions full height of story to underside of solid floor or roof structure above, unless otherwise indicated.
 1. Install compressible filler in joint between top of partition and underside of structure above.
 2. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Division 7 Section "Fire-Resistive Joint Systems."
- J. Chippage, voids and crack in CMU tolerances:
 1. Where CMU wall will be exposed to one side and concealed by furring, the surface to be exposed and coated with high performance coatings shall be free of cracks, chips and voids. All cracks, voids and chips shall be to the only on the side of the wall that is furred.
 2. Walls that are to be exposed to both sides shall utilize only CMU without chips, voids and cracks. Where impractical to avoid this procedures, all chips voids and cracks shall be patched to create an undamaged CMU block.

3.4 MORTAR BEDDING AND JOINTING

- A. Lay hollow brick and concrete masonry units as follows:

1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
 2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
 3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
 4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.
- B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.
- C. Joint Tooling:
1. Typically tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness, unless otherwise indicated.
 2. CMU with high performance coatings in cage wash areas and as indicated that receive a fiberglass reinforced epoxy coating shall have the joints struck and tooled flush to a smooth and flat surface, ready for finish coating system.
 3. Exterior face brick: Match tooling shape of adjacent existing building.

3.5 CAVITY WALLS

- A. Bond wythes of cavity walls together using one of the following methods:
1. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable (two-piece) type ties to allow for differential movement regardless of whether bed joints align.
- B. Keep cavities clean of mortar droppings and other materials during construction. Bevel beds away from cavity, to minimize mortar protrusions into cavity. Cut back mortar fins protruding into cavity and prepare face of wall to receive bituminous damproofing.
- C. Use wood strips temporarily placed in cavity to collect mortar droppings. As work progresses, remove strips, clean off mortar droppings and replace in cavity
- D. Coat cavity face of backup wythe to comply with Division 7 Section "Bituminous Damproofing."
- E. Installing Cavity-Wall Insulation: Place small dabs of adhesive, spaced approximately 12 inches (300 mm) o.c. both ways, on inside face of insulation boards, or attach with plastic fasteners designed for this purpose. Fit courses of insulation between wall ties and other confining obstructions in cavity, with edges butted tightly both ways. Press units firmly against inside wythe of masonry or other construction as shown.
1. Fill cracks and open gaps in insulation with crack sealer compatible with insulation and masonry.

3.6 MASONRY JOINT REINFORCEMENT

- A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.
1. Space reinforcement not more than 16 inches o.c.
 2. Space reinforcement not more than 8 inches o.c. in foundation walls and parapet walls.

3. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings.
 - a. Reinforcement above is in addition to continuous reinforcement.
- B. Interrupt joint reinforcement at control and expansion joints, unless otherwise indicated.
- C. Provide continuity at wall intersections by using prefabricated T-shaped units.
- D. Provide continuity at corners by using prefabricated L-shaped units.
- E. Cut and bend reinforcing units as directed by manufacturer for continuity at returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.7 CONTROL AND EXPANSION JOINTS

- A. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.
- B. Form control joints in concrete masonry as follows: As indicated, otherwise install temporary foam-plastic filler in head joints and remove filler when unit masonry is complete for application of sealant.
- C. Form expansion joints in brick made from clay or shale as indicated, otherwise as follows:
 1. Build flanges of metal expansion strips into masonry. Lap each joint 4 inches in direction of water flow. Seal joints below grade and at junctures with horizontal expansion joints if any.
 2. Build flanges of factory-fabricated, expansion-joint units into masonry.
 3. Build in compressible joint fillers where indicated.
 4. Form open joint full depth of brick wythe and of width indicated, but not less than 3/8 inch for installation of sealant and backer rod specified in Division 7 Section "Joint Sealants."
- D. Provide horizontal, pressure-relieving joints by either leaving an air space or inserting a compressible filler of width required for installing sealant and backer rod specified in Division 7 Section "Joint Sealants," but not less than 3/8 inch.
 1. Locate horizontal, pressure-relieving joints beneath shelf angles supporting masonry.

3.8 FLASHING, WEEP HOLES, CAVITY DRAINAGE, AND VENTS

- A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated.
- B. Install flashing as follows, unless otherwise indicated.
 1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
 2. At multiwythe masonry walls, including cavity walls, extend flashing through outer wythe, turned up a minimum of 8 inches and 1-1/2 inches into the inner wythe. Form 1/4-inch hook in edge of flashing embedded in inner wythe.

3. At lintels and shelf angles, extend flashing a minimum of 6 inches into masonry at each end. At heads and sills, extend flashing 6 inches at ends and turn up not less than 2 inches to form end dams.
- C. Install weep holes in head joints in exterior wythes of first course of masonry immediately above embedded flashing and as follows:
 1. Use open head joints to form weep holes.
 2. Space weep holes 24 inches o.c., unless otherwise indicated.
- D. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in Part 2 "Miscellaneous Masonry Accessories" Article.

3.9 LINTELS

- A. Install steel lintels where indicated.
- B. Provide minimum bearing of 8 inches at each jamb, unless otherwise indicated.

3.10 REINFORCED UNIT MASONRY INSTALLATION

- A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
 1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
 2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other temporary loads that may be placed on them during construction.
- B. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602.
- C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.
 1. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
 2. Limit height of vertical grout pours (lifts) to not more than 60 inches.

3.11 REPAIRING, POINTING, AND CLEANING

- A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.
- B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.
- C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

- D. 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. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
 3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
 4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
 5. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
 6. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.

3.12 MASONRY WASTE DISPOSAL

- A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.
- B. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.
1. Crush masonry waste to less than 4 inches in each dimension.
 2. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste. Fill material is specified in Division 31 Division "Earthwork."
 3. Do not dispose of masonry waste as fill within 18 inches of finished grade.
- C. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 042000

SECTION 051200 – STRUCTURAL STEEL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Structural Steel
 - 2. Fabrication of loose bearing plates for structural steel
 - 3. Steel lintels and shelf angles not attached to the structural steel frame
 - 4. Grout

1.3 DEFINITIONS

- A. Structural Steel: Elements of structural-steel frame, as classified by AISC's "Code of Standard Practice for Steel Buildings and Bridges", that support design loads

1.4 PERFORMANCE REQUIREMENTS

- A. Connections: Provide details of simple shear connections required by the Contract Documents to be selected or completed by structural-steel fabricator to withstand ASD-service loads indicated and comply with other information and restrictions indicated.

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show fabrication of structural-steel components.
 - 1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
 - 2. Include embedment drawings.
 - 3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.
 - 4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical high-strength bolted connections.
- C. Qualification Data: For Fabricator.

- D. Mill Test Reports: Signed by manufacturers certifying that the following products comply with requirements.
 - 1. Structural steel including chemical and physical properties.
 - 2. Bolts, nuts, and washers including mechanical properties and chemical analysis.
 - 3. Shear stud connectors.
 - 4. Nonshrink grout.

1.6 QUALITY ASSURANCE

- A. Fabricator Qualifications: A qualified fabricator who participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD, Standard for Steel Buildings.
- B. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel".
- C. Comply with applicable provisions of the following specifications and documents:
 - 1. AISC's "Code of Standard Practice for Steel Buildings and Bridges".
 - 2. AISC's "Seismic Provisions for Structural Steel Buildings" and "Supplement No. 2".
 - 3. AISC's "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design".
 - 4. AISC's "Specification for the Design of Steel Hollow Structural Sections".
 - 5. AISC's "Specification for Allowable Stress Design of Single-Angle Members".
 - 6. RCSC's "Specification for Structural Joints Using ASTM A325 or A490 Bolts".
- D. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination".

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from erosion and deterioration.
 - 1. Store fasteners in a protected place. Clean and relubricate bolts and nuts that become dry or rusty before use.
 - 2. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

1.8 COORDINATION

- A. Furnish anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

PART 2 - PRODUCTS

2.1 STRUCTURAL-STEEL MATERIALS

- A. W-Shapes: ASTM A992.
- B. Channels, Angles, M, S-Shapes: ASTM A36.
- C. Plate and Bar: ASTM A36.
- D. Cold-Formed Hollow Structural Sections: ASTM A500, Grade B, structural tubing.
- E. Steel Pipe: ASTM A53 Type E or S, Grade B.
 - 1. Weight Class: As Indicated.
 - 2. Finish: Black.
- F. Welding Electrodes: Comply with AWS requirements.

2.2 BOLTS, CONNECTORS, AND ANCHORS

- A. High-Strength Bolts, Nuts, and Washers: ASTM A325, Type 1, heavy hex steel structural bolts; ASTM A563 heavy hex carbon-steel nuts; and ASTM F436 hardened carbon-steel washers.
 - 1. Finish: Plain.
- B. Shear Connectors: ASTM A108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1, Type B.
- C. Anchor Rods: ASTM F1554, Grade 36.
 - 1. Configuration: Straight.
 - 2. Nuts: ASTM A563 heavy hex carbon steel.
 - 3. Plate Washers: ASTM A36 carbon steel.
 - 4. Washers: ASTM F436 hardened carbon steel.
 - 5. Finish: Plain.

2.3 PRIMER

- A. Primer: Fabricator's standard lead- and chromate-free, non-asphaltic, rust-inhibiting primer. . Coordinate primer on steel exposed to view with finish coat specified.
- B. Galvanizing Repair Paint: ASTM A780.

2.4 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.5 FABRICATION

- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC's "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design."
 - 1. Camber structural-steel members where indicated.
 - 2. Identify high-strength structural steel according to ASTM A6 and maintain markings until structural steel has been erected.
 - 3. Mark and match-mark materials for field assembly.
 - 4. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.
- B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
 - 1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1.
- C. Bolt Holes: Cut, drill, mechanically thermal cut, or punch standard bolt holes perpendicular to metal surfaces.
- D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.
- E. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1 and manufacturer's written instructions.
- F. Holes: Provide holes required for securing other work to structural steel and for passage of other work through steel framing members.
 - 1. Cut, drill, or punch holes perpendicular to steel surfaces.
 - 2. Base-Plate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
 - 3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.6 SHOP CONNECTIONS

- A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A325 or A490 Bolts" for type of bolt and type of joint specified.
 - 1. Joint Type: Snug tightened.

- B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.
 - 1. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.
 - 2. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.

2.7 SHOP PRIMING

- A. Shop prime steel surfaces, except the following:
 - 1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
 - 2. Surfaces to be field welded.
 - 3. Surfaces to receive sprayed-on fireproofing.
- B. Surface Preparation: Clean surfaces to be painted. Remove loose rust, loose mill scale, and spatter, slag, or flux deposits. Prepare surfaces according to SSPC specifications as follows:
 - 1. SSPC-SP 2 "Hand Tool Cleaning" for all concealed work.
 - 2. SSPC-SP 6 "Commercial Blast Cleaning" for all work exposed to view, including but not limited to architecturally exposed structural steel.
- C. Priming: Immediately after surface preparation, apply primer according to manufacturer's instructions and at rate recommended by SSPC to provide a dry film thickness of not less than 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
 - 1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
 - 2. Apply 2 coats of shop paint to inaccessible surfaces after assembly or erection. Change color of second coat to distinguish it from first.

2.8 GALVANIZING

- A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A123.
 - 1. Fill vent holes and grind smooth after galvanizing.
 - 2. Galvanize steel lintels and shelf angles located in exterior walls and exposed to weather.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments, with steel erector present, for compliance with requirements.

- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place, unless otherwise indicated.

3.3 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design".
- B. Base and Bearing Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting base and bearing plates. Clean bottom surface of base and bearing plates.
 - 1. Set base and bearing plates for structural members on wedges, shims, or setting nuts as required.
 - 2. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of base or bearing plate before packing with grout.
 - 3. Promptly pack grout solidly between bearing surfaces and base or bearing plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.
- C. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges".
- D. Align and adjust various members forming part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
 - 1. Level and plumb individual members of structure.
 - 2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.
- E. Splice members only where indicated.
- F. Remove erection bolts on welded, architecturally exposed structural steel; fill holes with plug welds; and grind smooth at exposed surfaces.
- G. Do not use thermal cutting during erection unless approved by Architect. Finish thermally cut sections within smoothness limits in AWS D1.1.

- H. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.
- I. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1 and manufacturer's written instructions.

3.4 FIELD CONNECTIONS

- A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A325 or A490 Bolts" for type of bolt and type of joint specified.
 - 1. Joint Type: Snug tightened unless otherwise indicated.
- B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.
 - 1. Comply with AISC's "Code of Standard Practice for Steel Buildings and Bridges" and "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design" for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.
 - 2. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.
 - 3. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a special inspector and a qualified independent testing and inspecting agency to inspect field welds and high-strength bolted connections.
- B. Bolted Connections: Shop-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A325 or A490 Bolts."
- C. Welded Connections: Field welds will be visually inspected according to AWS D1.1.
 - 1. In addition to visual inspection, field welds will be tested according to AWS D1.1 and the following inspection procedures, at testing agency's option:
 - a. Liquid Penetrant Inspection: ASTM E165.
 - b. Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
 - c. Ultrasonic Inspection: ASTM E164.
- D. In addition to visual inspection, test and inspect field-welded shear connectors according to requirements in AWS D1.1 for stud welding and as follows:
 - 1. Perform bend tests if visual inspections reveal either a less-than- continuous 360-degree flash or welding repairs to any shear connector.

- E. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

3.6 REPAIRS AND PROTECTION

- A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A780 and manufacturer's written instructions.

END OF SECTION 05 12 00

SECTION 053100 – STEEL DECK

PART 1 GENERAL

1.1 SCOPE

- A. This work shall consist of furnishing all plant, labor, materials, equipment, and apparatus for the installation of all steel roof decking and composite floor decking with accessories indicated, specified, and/or reasonably implied for a complete, first-quality job.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 033000 – Cast-in-Place Concrete
- B. Section 051200 - Structural Steel

1.3 REFERENCE SPECIFICATIONS

- A. "Specification for the Design of Light Gage Cold-Formed Steel Structure Members" of the American Institute of Steel Construction.
- B. "Code of Recommended Standard Practice" of the Steel Deck Institute.
- C. Specifications and commentary for composite steel floor deck of the Steel Deck Institute.
- D. Specifications and commentary for steel roof deck of the Steel Deck Institute.
- E. Structural Welding Code - Sheet steel of the American Welding Society.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced installer who has completed steel deck similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.
- B. Qualifications of Welding: Use qualified processes and welding operators in conformance with AWS "Welder Qualification" procedures.
- C. Testing Agency Qualifications: An independent agency qualified according to ASTM E 329 for testing indicated
- D. Fire-Test-Response Characteristics: Where indicated, provide steel deck units identical to those tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.
 - 1. Fire-Resistance Ratings: Indicated by design designations of applicable testing and inspecting agency.
 - 2. Steel deck units shall be identified with appropriate markings of applicable testing and inspecting agency
- E. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."
- F. FMG Listing: Provide steel roof deck evaluated by FMG and listed in its "Approval Guide, Building Materials" for Class 1 fire rating and Class 1-90 windstorm ratings.

- G. Welding Inspection: All decking welds shall be inspected by the Architect prior to covering. Notify the Architect in writing forty-eight (48) hours prior to completing welds for each major area.

1.5 SUBMITTALS

- A. Shop and Erection Drawings shall be submitted for all metal decking to the Architect for approval. Drawings shall indicate layout, types of specified materials and accessories, gauges to be supplied, anchorage details, all conditions requiring closure panels, supplementary framing, sump pans, cant strips, cut openings, special jointing or other accessories. Drawings shall include layout for all shear studs to be applied through deck units. Manufacture or fabricating of any materials or the performing of any work prior to the approval of shop drawings will be entirely at the risk of the Contractor.
- B. Product Data: For each type of deck, accessory, and product indicated
- C. The Contractor shall submit the manufacturer's specifications, load tables, and installation instructions for each type specified.
- D. Welding certificates and welding procedures (WPS)
- E. Field quality-control test and inspection reports.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Steel deck units shall be protected against damage in transit to the jobsite.
- B. If site storage is necessary, steel deck units shall be stacked on wood blocking clear of the ground and tilted slightly to insure against the entrapment of water.
- C. The steel deck units shall be hoisted to each individual floor as required and rough spread.

PART 2 PRODUCTS

2.1 COMPOSITE FLOOR DECK

- A. Composite Steel Floor Deck: Fabricate panels, with integrally embossed or raised pattern ribs and interlocking side laps, to comply with "SDI Specifications and Commentary for Composite Steel Floor Deck," in SDI Publication No. 30, with the minimum section properties indicated, and with the following:
 - 1. Galvanized Steel Sheet: ASTM A653, Structural Steel (SS), Grade 50, G60 zinc coating.
 - 2. Profile Depth: 3"
 - 3. Design Uncoated-Steel Thickness: 18 gauge.
 - 4. Span Condition: Triple span or more.

2.2 ROOF DECK

- A. Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 30, and with the following:
 - 1. Galvanized Steel Sheet: ASTM A653, Structural Steel (SS), Grade 50.
 - 2. Galvanizing: ASTM A 525, G60.
 - 3. Deck Profile: As indicated in drawings.
 - 4. Profile Depth: As indicated in drawings.
 - 5. Design Uncoated-Steel Thickness: As indicated in drawings.

6. Span Condition: Triple span or more unless noted in drawings.
7. Side Laps: Overlapped.

2.3 ACCESSORIES

- A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.
- B. Weld Washers: Mild steel, uncoated, sized as recommended by manufacturer of steel deck units.
- C. Mechanical Fasteners: Stainless steel, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.
- D. Side-Lap Fasteners: Stainless steel, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 minimum diameter.
- E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi, not less than 0.0359-inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.
- F. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of 33,000 psi, of same material and finish as deck, and of thickness and profile indicated.
- G. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck, unless otherwise indicated.
- H. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.
- I. Galvanizing Repair Paint: High zinc-dust content paint formulated specifically for repair of damaged galvanized surfaces. Prepare surfaces and repair in accordance with procedures specified in ASTM A 780.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

3.2 INSTALLATION, GENERAL

- A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 30, manufacturer's written instructions, and requirements in this Section.
- B. Install temporary shoring before placing deck panels, if required to meet deflection limitations.
- C. Locate deck bundles to prevent overloading of supporting members.
- D. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.
- E. Place deck panels flat and square and fasten to supporting frame without warp or deflection.
- F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.

- G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.
- H. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.
- I. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to deck manufacturer's written instructions.
- J. Holes for openings: Deck shall be cut by the Contractor to fit large framed openings which are located by dimension on the structural design drawings. Holes required by other trades shall be supplied at the expense of those trades. The trade involved shall notify the Architect/Engineer regarding the size, location and number of holes so that the structural adequacy of the steel deck units and/or composite slab can be checked. Holes shall be cut in floor deck units only after concrete has been placed and 75% of design strength attained.

3.3 FLOOR DECK INSTALLATION

- A. Erect metal deck in accordance with SDI 29 Manual.
- B. Bear deck on steel supports with 1-1/2 inch minimum bearing. Align and level.
- C. Fasten deck to steel support members at ends and intermediate supports with 5/8" diameter fusion welds as indicated on the drawings.
- D. Weld in accordance with AWS D1.1.
- E. Mechanically clinch male/female side laps as indicated on the drawings.
- F. Reinforce steel deck openings from 6 to 18 inches in size with 2 x 2 x 1/4 inch steel angles. Place angles perpendicular to flutes; extend minimum two flutes beyond each side of opening and mechanically attach to deck at each flute.
- G. Install 6 inch minimum wide sheet steel cover plates, of same thickness as deck, where deck changes direction. Mechanically attach 12 inches o.c. maximum.
- H. Install wet concrete stops at floor edge upturned to top surface of slab, to contain wet concrete. Install stops of sufficient strength to remain stationary without distortion.
- I. Install sheet steel closures and angle flashings to close openings between deck and walls, columns, and openings.
- J. Position floor drain pans with flange bearing on top surface of deck. Fusion weld at each deck flute.
- K. Welding washers shall be used on all deck units with metal thickness less than 0.028 inches (22 gage). Welding washers shall be a minimum thickness of 0.0598 inches and have a nominal 3/8 inch diameter hole.
- L. Immediately after welding deck and other metal components in position, coat welds, burned areas, and damaged surface coating, with touch-up prime paint.

3.4 ROOF-DECK INSTALLATION

- A. Fasten roof-deck panels to steel supporting members as indicated on the drawings
- B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports as indicated on the drawings.

- C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches, with end joints as follows:
 - 1. End Joints: Lapped 2 inches minimum.
- D. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Weld or mechanically fasten to substrate to provide a complete deck installation.
 - 1. Weld cover plates at changes in direction of roof-deck panels, unless otherwise indicated.
- E. Flashing: The steel deck manufacturer shall furnish sheet metal flashings to close openings between deck units and columns, deck units and girders, and openings which occur where deck abut. These flashings shall be welded in position by the steel deck installer.
- F. Roof Sump Pans: Place over openings provided in roof decking and weld to top decking surface. Space welds not more than 12" with at least one weld at each corner.
- G. Closure Strips: Provide flexible closure strips at open uncovered ends and edges of roof decking also in voids between decking and other construction. Install with adhesive in accordance with manufacturer's instructions.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Field welds will be subject to inspection.
- C. Additional testing will be performed to determine compliance of corrected work with specified requirements.
- D. Testing agency will report inspection results promptly and in writing to Contractor and Architect.
- E. Remove and replace work that does not comply with specified requirements.
- F. Additional inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

3.6 REPAIRS AND PROTECTION

- A. Repair Painting: Wire brushing, cleaning, and repair painting of rust spots, welds, and abraded areas of both deck surfaces are included in Division 9 Section "Interior Painting."
- B. Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at time of Substantial Completion.

END OF SECTION

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SECTION 05 40 00 - COLD FORMED STEEL FRAMING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Interior non-load-bearing framing
 - 2. Ceiling joist framing.
 - 3. Roof trusses.
- B. Related Sections include the following:
 - 1. Division 5 Section "Metal Fabrications" for masonry shelf angles and connections.
 - 2. Division 9 Section "Gypsum Board Assemblies" for interior non-load-bearing, metal-stud framing and ceiling-suspension assemblies.

1.3 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide cold-formed metal framing capable of withstanding design loads within limits and under conditions indicated.
 - 1. Design Loads, Trusses: As indicated.
 - 2. Design Loads, Ceiling Joist Framing: As Follows:
 - a. Dead Loads: Weights of material and construction.
 - b. Live Loads: Differential Air Pressure of +/- 15 PSF
 - 3. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:
 - a. Ceiling Joist Framing: Vertical live load deflection of 1/360 of the span and total load deflection of 1/240 of the span.
 - b. Roof Trusses: Vertical deflection of 1/360 of the span.
 - 4. Design framing systems to provide for movement of framing members without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F.
 - 5. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure as follows:
 - a. Upward and downward movement of 1/2 inch.
- B. Cold-Formed Steel Framing, General: Design according to AISI's "Standard for Cold-Formed Steel Framing - General Provisions."
 - 1. Headers: Design according to AISI's "Standard for Cold-Formed Steel Framing – Header Design."
 - 2. Roof Trusses: Design according to AISI's "Standard for Cold-Formed Steel Framing - Truss Design."

1.4 SUBMITTALS

- A. Product Data: For each type of cold-formed metal framing product and accessory indicated.
- B. Shop Drawings: Show layout, spacings, sizes, thicknesses, and types of cold-formed metal framing; fabrication; and fastening and anchorage details, including mechanical fasteners.

Show reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.

1. For cold-formed metal framing indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 2. Coordinate and show all ceiling mounted devices.
- C. Welding certificates.
- D. Qualification Data: For professional engineer.
- E. Product Test Reports: From a qualified testing agency, unless otherwise stated, indicating that each of the following complies with requirements, based on evaluation of comprehensive tests for current products:
1. Steel sheet.
 2. Expansion anchors.
 3. Power-actuated anchors.
 4. Mechanical fasteners.
 5. Vertical deflection clips.
 6. Horizontal drift deflection clips
 7. Miscellaneous structural clips and accessories.
- F. Research/Evaluation Reports: For cold-formed metal framing.

1.5 QUALITY ASSURANCE

- A. Engineering Responsibility: Preparation of Shop Drawings, design calculations, and other structural data by a qualified professional engineer.
- B. Professional Engineer Qualifications: A professional engineer registered in the State of North Carolina and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of cold-formed metal framing that are similar to those indicated for this Project in material, design, and extent.
- C. Product Tests: Mill certificates or data from a qualified independent testing agency, or in-house testing with calibrated test equipment indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.
- D. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code--Steel," and AWS D1.3, "Structural Welding Code--Sheet Steel."
- E. AISI Specifications and Standards: Comply with AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members" and its "Standard for Cold-Formed Steel Framing - General Provisions."
1. Comply with AISI's "Standard for Cold-Formed Steel Framing - Truss Design."
 2. Comply with AISI's "Standard for Cold-Formed Steel Framing - Header Design."
- F. Comply with AISI's "Standard for Cold-Formed Steel Framing - Prescriptive Method for One and Two Family Dwellings."
- G. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.6 DELIVERY, STORAGE AND HANDLING

- A. Protect cold-formed metal framing from corrosion, deformation, and other damage during delivery, storage, and handling.

- B. Store cold-formed metal framing, protect with a waterproof covering, and ventilate to avoid condensation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering cold-formed metal framing that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Allied Studco.
 - 2. AllSteel Products, Inc.
 - 3. California Expanded Metal Products Company.
 - 4. Clark Steel Framing.
 - 5. Consolidated Fabricators Corp.; Building Products Division.
 - 6. Craco Metals Manufacturing, LLC.
 - 7. Custom Stud, Inc.
 - 8. Dale/Incor.
 - 9. Design Shapes in Steel.
 - 10. Dietrich Metal Framing; a Worthington Industries Company.
 - 11. Formetal Co. Inc. (The).
 - 12. Innovative Steel Systems.
 - 13. MarinoWare; a division of Ware Industries.
 - 14. Quail Run Building Materials, Inc.
 - 15. SCAFCO Corporation.
 - 16. Southeastern Stud & Components, Inc.
 - 17. Steel Construction Systems.
 - 18. Steeler, Inc.
 - 19. Super Stud Building Products, Inc.
 - 20. United Metal Products, Inc.

2.2 MATERIALS

- A. Steel Sheet: ASTM A1003, Structural Grade, Type H, metallic coated, of grade and coating weight as follows:
 - 1. Grade: ST33H or as required by structural performance.
 - 2. Coating: G60 or equivalent.
- B. Steel Sheet for Vertical Deflection and Drift Clips: ASTM A653, structural steel, zinc coated, of grade and coating as follows:
 - 1. Grade: 50, Class 1 or 2.
 - 2. Coating: G90.

2.3 ROOF TRUSSES

- A. Roof Truss Members: Manufacturer's standard-shape steel sections.

2.4 NON-LOAD-BEARING PARTITION FRAMING

- A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, complying with ASTM C 955, and as follows:
 - 1. Minimum Uncoated-Steel Thickness: as required by design.
 - 2. Flange Width: as required by design.

- B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, complying with ASTM C 955, and as follows:
 - 1. Minimum Uncoated-Steel Thickness: as required by design.
 - 2. Flange Width: as required by design.

2.5 CEILING JOIST FRAMING

- A. Steel Ceiling Joists: Manufacturer's standard C-shaped steel sections, of web depths indicated, unpunched, with stiffened flanges, and as follows:
 - 1. Minimum Base-Metal Thickness: as required by design.
 - 2. Flange Width: as required by design.

2.6 FRAMING ACCESSORIES

- A. Fabricate steel-framing accessories from steel sheet, ASTM A1003, Structural Grade, Type H, metallic coated, of same grade and coating weight used for framing members.
- B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:
 - 1. Supplementary framing.
 - 2. Bracing, bridging, and solid blocking.
 - 3. Web stiffeners.
 - 4. Anchor clips.
 - 5. End clips.
 - 6. Foundation clips.
 - 7. Gusset plates.
 - 8. Stud kickers, knee braces, and girts.
 - 9. Joist hangers and end closures.
 - 10. Hole reinforcing plates.
 - 11. Backer plates.

2.7 ANCHORS, CLIPS, AND FASTENERS

- A. Steel Shapes and Clips: ASTM A36, zinc coated by hot-dip process according to ASTM A123.
- B. Anchor Bolts: ASTM F1554, Grade 36, threaded carbon-steel; carbon-steel nuts; and flat, hardened-steel washers; zinc coated by hot-dip process according to ASTM A153, Class C.
- C. Expansion Anchors: Fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 5 times design load, as determined by testing per ASTM E488 conducted by a qualified independent testing agency.
- D. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 10 times design load, as determined by testing per ASTM E1190 conducted by a qualified independent testing agency.
- E. Mechanical Fasteners: ASTM C1513, corrosion-resistant-coated, self-drilling, self-tapping steel drill screws.
 - 1. Head Type: Low-profile head beneath sheathing, manufacturer's standard elsewhere.
- F. Welding Electrodes: Comply with AWS standards.

2.8 MISCELLANEOUS MATERIALS

- A. Galvanizing repair paint: SSPC-Paint 20 or DOD-P-21035.

- B. Nonmetallic, Nonshrink Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, and plasticizing and water-reducing agents, complying with ASTM C1107, with fluid consistency and 30-minute working time.
- C. Shims: Load bearing, high-density multimonomer plastic, nonleaching.
- D. Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to match width of bottom track or rim track members.

2.9 FABRICATION

- A. Fabricate cold-formed metal framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.
 - 1. Fabricate framing assemblies using jigs or templates.
 - 2. Cut framing members by sawing or shearing; do not torch cut.
 - 3. Fasten cold-formed metal framing members by welding, screw fastening, clinch fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.
 - a. Comply with AWS D1.3 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
 - b. Locate mechanical fasteners and install according to Shop Drawings, with screw penetrating joined members by not less than three exposed screw threads.
 - 4. Fasten other materials to cold-formed metal framing by welding, bolting, or screw fastening, according to Shop Drawings.
- B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies to prevent damage or permanent distortion.
- C. Fabrication Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:
 - 1. Spacing: Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
 - 2. Squareness: Fabricate each cold-formed metal framing assembly to a maximum out-of-square tolerance of 1/8 inch.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine supporting substrates and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Before sprayed fire-resistive materials are applied, attach continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed fire-resistive materials.
- B. After applying sprayed fire-resistive materials, remove only as much of these materials as needed to complete installation of cold-formed framing without reducing thickness of fire-

resistive materials below that are required to obtain fire-resistance rating indicated. Protect remaining fire-resistive materials from damage.

- C. Install load bearing shims or grout between the underside of wall bottom track or rim track and the top of foundation wall or slab at stud or joist locations to ensure a uniform bearing surface on supporting concrete or masonry construction.
- D. Install sealer gaskets to isolate the underside of wall bottom track or rim track and the top of foundation wall or slab at stud or joist locations.

3.3 INSTALLATION, GENERAL

- A. Cold-formed metal framing may be shop or field fabricated for installation, or it may be field assembled.
- B. Install cold-formed metal framing according to AISI's "Standard for Cold-Formed Steel Framing - General Provisions" and to manufacturer's written instructions unless more stringent requirements are indicated.
- C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.
 - 1. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch.
- D. Install cold-formed metal framing and accessories plumb, square, and true to line, and with connections securely fastened.
 - 1. Cut framing members by sawing or shearing; do not torch cut.
 - 2. Fasten cold-formed metal framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.
 - a. Comply with AWS D1.3 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
 - b. Locate mechanical fasteners and install according to Shop Drawings, and complying with requirements for spacing, edge distances, and screw penetration.
- E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.
- F. Install temporary bracing and supports to secure framing and support loads comparable in intensity to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.
- G. Do not bridge building expansion and control joints with cold-formed metal framing. Independently frame both sides of joints.
- H. Install insulation, specified in Division 7 Section "Building Insulation," in built-up exterior framing members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.
- I. Fasten hole reinforcing plate over web penetrations that exceed size of manufacturer's standard punched openings.
- J. Erection Tolerances: Install cold-formed metal framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:

1. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.4 NON-LOAD-BEARING WALL INSTALLATION

- A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure as indicated.
- B. Fasten both flanges of studs to top and bottom track, unless otherwise indicated. Space studs as follows:
 1. Stud Spacing: 16 inches (406 mm).
- C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.
- D. Indicate isolation details on Drawings or insert detailed description here.
- E. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.
 1. Install single-leg deflection tracks and anchor to building structure.
 2. Install double deep-leg deflection tracks and anchor outer track to building structure.
 3. Connect vertical deflection clips to studs and anchor to building structure.
- F. Install horizontal bridging in wall studs, spaced in rows indicated on Shop Drawings but not more than 48 inches (1220 mm) apart. Fasten at each stud intersection.
 1. Top Bridging for Single Deflection Track: Install row of horizontal bridging within 12 inches (305 mm) of single deflection track. Install a combination of flat, taut, steel sheet straps of width and thickness indicated and stud or stud-track solid blocking of width and thickness matching studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
 2. Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
- G. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, fasteners, and stud girts, to provide a complete and stable wall-framing system.

3.5 JOIST INSTALLATION

- A. Install perimeter joist track sized to match joists. Align and securely anchor or fasten track to supporting structure at corners, ends, and spacings indicated on Shop Drawings.
- B. Install joists bearing on supporting frame, level, straight, and plumb; adjust to final position, brace, and reinforce. Fasten joists to both flanges of joist track.
 1. Install joists over supporting frame with a minimum end bearing of 1-1/2 inches (38 mm).
 2. Reinforce ends and bearing points of joists with web stiffeners, end clips, joist hangers, steel clip angles, or steel-stud sections as indicated on Shop Drawings.
- C. Frame openings with built-up joist headers consisting of joist and joist track, nesting joists, or another combination of connected joists if indicated.
- D. Install joist reinforcement at interior supports with single, short length of joist section located directly over interior support, with lapped joists of equal length to joist reinforcement, or as indicated on Shop Drawings.
- E. Install bridging at each end of joists and at intervals indicated on Shop Drawings. Fasten bridging at each joist intersection as follows:

1. Bridging: Cold-rolled steel channel, welded to bottom flange of joists.

- F. Secure joists to load-bearing interior walls to prevent lateral movement of bottom flange.
- G. Install miscellaneous joist framing and connections, including web stiffeners, closure pieces, clip angles, continuous angles, hold-down angles, anchors, and fasteners, to provide a complete and stable joist framing assembly.

3.6 TRUSS INSTALLATION

- A. Install, bridge, and brace trusses according to Shop Drawings and requirements in this Section.
- B. Truss Spacing: As indicated.
- C. Do not alter, cut, or remove framing members or connections of trusses.
- D. Erect trusses with plane of truss webs plumb and parallel to each other, align, and accurately position at spacings indicated.
- E. Erect trusses without damaging framing members or connections.
- F. Align webs of bottom chords and load-bearing studs or continuously reinforce track to transfer loads to structure. Anchor trusses securely at all bearing points.
- G. Install continuous bridging and permanently brace trusses as indicated on Shop Drawings and designed according to LGSEA's Technical Note 551e, "Design Guide for Permanent Bracing of Cold-Formed Steel Trusses".

3.7 FIELD QUALITY CONTROL

- A. Testing: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Field and shop welds will be subject to testing and inspecting.
- C. Testing agency will report test results promptly and in writing to Contractor and Architect.
- D. Remove and replace work where test results indicate that it does not comply with specified requirements.
- E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.8 REPAIRS AND PROTECTION

- A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and installer, that ensure that cold-formed metal framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION

SECTION 055000 - METAL FABRICATIONS

PART 1 - **GENERAL**

1.1 SUMMARY

A. This Section includes the following:

1. Trench grate support angles
2. Miscellaneous framing.

PERFORMANCE REQUIREMENTS

- B. Structural Performance of Ladders: Provide ladders capable of withstanding the effects of loads and stresses within limits and under conditions specified in ANSI A14.3.
- C. Thermal Movements: Provide exterior metal fabrications that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

1.2 SUBMITTALS

- A. Product data or manufacturer's specifications and installation instructions for the following products. Include laboratory test reports and other data to show compliance with specifications (including specified standards).
1. Structural steel (each type), including mill test reports signed by manufacturers certifying that their products comply with requirements.
 2. Bolts, nuts, and washers, including mechanical properties and chemical analysis.
 3. Structural steel primer.
- B. Shop Drawings detailing fabrication of structural steel components.
1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
 2. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.
 3. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify high-strength bolted slip-critical, direct-tension, or tensioned shear/bearing connections.
- C. Shop Drawings for ships ladder and roof ladder: Drawings prepared for this specific project, showing ladder configuration, dimensions, location and method of anchorage.
- D. Qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

1.3 QUALITY ASSURANCE

- A. Fabricator Qualifications: A firm experienced in producing metal fabrications similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- B. Comply with applicable provisions of the following specifications and documents:
 - 1. AISC's "2010 Specification for Structural Steel Buildings" (ANSI/AISC 360-05).
 - 2. ASTM A 6 "Specification for General Requirements for Rolled Steel Plates, Shapes, Sheet Piling, and Bars for Structural Use."
 - 3. ASTM A 276 "Standard Specification for Stainless Steel Bars and Shapes."
 - 4. Research Council on Structural Connections' (RCSC) "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
 - 5. ASTM F 593 "Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs."
- C. Welding Standards:
 - 1. Structural Steel: Comply with applicable provisions of AWS D1.1 "Structural Welding Code-Steel."
 - 2. Structural Steel: Comply with applicable provisions of AWS D1.6 "Structural Welding Code-Stainless Steel."
 - 3. Present evidence that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

1.4 PROJECT CONDITIONS

- A. Field Measurements: Where metal fabrications are indicated to fit walls and other construction, verify dimensions by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1.5 COORDINATION

- A. Coordinate installation of anchorages for metal fabrications. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver structural steel to Project site in such quantities and at such times to ensure continuity of installation.
- B. Store materials to permit easy access for inspection and identification. Keep steel members off ground by using pallets, platforms, or other supports. Protect steel members and packaged materials from erosion and deterioration.
 - 1. Store fasteners in a protected place. Clean and relubricate bolts and nuts that become dry or rusty before use.
 - 2. Do not store materials on structure in a manner that might cause distortion or damage to members or supporting structures. Repair or replace damaged materials or structures as directed.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

- A. Metal Surfaces, General: For metal fabrications 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.

2.2 FERROUS METALS

- A. Stainless Steel Shapes, ASTM A 276, Type 304..
- B. Structural Steel Channels, Angles, Plates, and Bars: Carbon Steel, ASTM A 36.
- C. W-Shapes: ASTM A 992/A 992M.
- D. Cold-Formed Structural Steel Tubing: ASTM A 500, Grade B.
- E. Steel Pipe: ASTM A 53, standard weight (Schedule 40), unless another weight is indicated or required by structural loads.

2.3 BOLTS, CONNECTORS AND ANCHORS

- A. Shear Connectors: ASTM F593, Type 304, headed-stud type, cold-finished stainless steel; AWS D1.6, Type A.
- B. Threaded Anchor Rods: ASTM F 1554, Grade 36 or Grade 55, as indicated on Drawings.
 - 1. Configuration: Straight.
 - 2. Nuts: ASTM A 563 (ASTM A 563M) heavy hex carbon steel.
 - 3. Plate Washers: ASTM A 36/A 36M carbon steel.
 - 4. Washers: ASTM F 436 (ASTM F 436M) hardened carbon steel.
 - 5. Finish, Interior Framing: Plain.
 - 6. Finish, Exterior Framing: Hot-dip zinc coating, ASTM A 153/A 153M, Class C or mechanically deposited zinc coating, ASTM B 695, Class 50.
- C. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy hex steel structural bolts, heavy hex carbon-steel nuts, and hardened carbon-steel washers.
 - 1. Finish, Interior Framing: Plain, uncoated.
 - 2. Finish, Exterior Framing: Mechanically deposited zinc coating, ASTM B 695, Class 50.
 - 3. Direct-Tension Indicators: ASTM F 959, Type 325.
 - a. Finish, Interior Framing: Plain.
 - b. Finish, Exterior Framing: Mechanically deposited zinc coating, ASTM B 695, Class 50.
- D. Welding Electrodes: Comply with AWS requirements.

2.4 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage compensating agents, plasticizing and water-reducing agents, complying with ASTM C 1107, of consistency suitable for application, and a 30-minute working time.

2.5 METAL FRAMING FABRICATION

- A. Fabricate and assemble structural steel in shop to greatest extent possible. Fabricate structural steel according to AISC specifications referenced in this Section and in Shop Drawings.
 - 1. Camber structural steel members where indicated.
 - 2. Mark and match-mark materials for field assembly.
 - 3. Fabricate for delivery a sequence that will expedite erection and minimize field handling of structural steel.
 - 4. Complete structural steel assemblies, including welding of units, before starting shop-priming operations.
 - 5. Comply with fabrication tolerance limits of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for structural steel.
- B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
 - 1. Plane thermally cut edges to be welded.
- C. Finishing: Accurately mill ends of columns and other members transmitting loads in bearing.
- D. Holes: Provide holes required for securing other work to structural steel framing and for passage of other work through steel framing members, as shown on Shop Drawings.
 - 1. Cut, drill, or punch holes perpendicular to metal surfaces. Do not flame-cut holes or enlarge holes by burning. Drill holes in bearing plates.
 - 2. Weld threaded nuts to framing and other specialty items as indicated to receive other work.

2.6 METAL FRAMING SHOP CONNECTIONS

- A. Shop install and tighten high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- B. Weld Connections: Comply with AWS D1.1 for procedures, appearance and quality of welds, and methods used in correcting welding work.
 - 1. Assemble and weld built-up sections by methods that will maintain true alignment of axes without warp.
 - 2. Verify that weld sizes, fabrication sequence, and equipment used for architecturally exposed structural steel will limit distortions to allowable tolerances. Prevent surface bleeding of back-side welding on exposed steel surfaces. Grind smooth exposed fillet welds 1/2 inch and larger. Grind flush butt welds. Dress exposed welds.

2.7 COATINGS

- A. Shop Primer for Ferrous Metal: Organic zinc-rich primer, complying with SSPC-Paint 20 and compatible with topcoat, unless otherwise noted.
- B. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with ASTM A 780.

2.8 STEEL FINISHES

- A. Galvanizing: Hot-dip galvanize items as indicated to comply with applicable standard listed below:
 - 1. ASTM A 123, for galvanizing steel products.

2. ASTM A 153/A 153M, for galvanizing steel hardware.
- B. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface-preparation specifications and environmental exposure conditions of installed metal fabrications:
 1. Exteriors (SSPC Zone 1B): SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 2. Interiors (SSPC Zone 1A): SSPC-SP 3, "Power Tool Cleaning."
- C. Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finishes and those to be embedded in concrete, sprayed-on fireproofing, or masonry, unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1," for shop painting.
 1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
- D. Finish Schedule: As indicated on Drawings or as otherwise noted below.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Before erection proceeds, and with the steel erector present, verify elevations of concrete and masonry bearing surfaces and locations of anchorages for compliance with requirements.
- B. Do not proceed with erection until unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place, unless otherwise indicated.
 1. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

3.3 METAL FRAMING ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and according to AISC specifications referenced in this Section.
- B. Base and Bearing Plates: Clean concrete and masonry bearing surfaces of bond-reducing materials and roughen surfaces prior to setting base and bearing plates. Clean bottom surface of base and bearing plates.
 1. Set base and bearing plates for structural members on wedges, shims, or setting nuts as required.
 2. Tighten anchor bolts after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of base or bearing plate prior to packing with grout.
 3. Pack grout solidly between bearing surfaces and plates so no voids remain. Finish exposed surfaces, protect installed materials, and allow to cure.
 - a. Comply with manufacturer's instructions for proprietary grout materials.

- C. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."
 - 1. Maintain erection tolerances of architecturally exposed structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."
- D. Align and adjust various members forming part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
 - 1. Level and plumb individual members of structure.
 - 2. Establish required leveling and plumbing measurements on mean operating temperature of structure. Make allowances for difference between temperature at time of erection and mean temperature at which structure will be when completed and in service.
- E. Splice members only where indicated.
- F. Remove erection bolts on welded structural steel exposed to public view; fill holes with plug welds; and grind smooth at exposed surfaces.
- G. Do not use thermal cutting during erection.
- H. Finish sections thermally cut during erection equal to a sheared appearance.
- I. Do not enlarge unfair holes in members by burning or by using drift pins. Ream holes that must be enlarged to admit bolts.

3.4 METAL FRAMING FIELD CONNECTIONS

- A. Install and tighten high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- B. Weld Connections: Comply with AWS D1.1 for procedures, appearance and quality of welds, and methods used in correcting welding work.
 - 1. Comply with AISC specifications referenced in this Section for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.
 - 2. Assemble and weld built-up sections by methods that will maintain true alignment of axes without warp.
 - 3. Verify that weld sizes, fabrication sequence, and equipment used for architecturally exposed structural steel will limit distortions to allowable tolerances. Prevent surface bleeding of back-side welding on exposed steel surfaces. Grind smooth exposed fillet welds 1/2 inch and larger. Grind flush butt welds. Dress exposed welds.

3.5 FIELD QUALITY CONTROL

- A. Provide access to all framing for periodic visual inspections by the Designer.
 - 1. Notify Architect at least 48 hours prior to concealing steel framing.
- B. Correct deficiencies in or remove and replace structural steel that inspections indicate do not comply with specified requirements.
- C. Additional testing, at Contractor's expense, will be performed to determine compliance of corrected Work with specified requirements.

3.6 REPAIRS AND PROTECTION

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - 1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.
- B. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

END OF SECTION

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SECTION 055100- Metal Stairs

PART 1 – GENERAL

1.1 SCOPE OF WORK

- A. Fabricate and install metal stair assemblies in accordance with the requirements set forth in this section.

1.2 ADDITIONAL WORK INCLUDED IN THIS SECTION

- A. Field measurements of stair installation sites, and verification of vertical drop between floors.

1.3 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. Section 055000 - Metal Fabrications.

1.4 SUMMARY:

- A. Provide all material, labor, equipment and services; and perform all operations necessary or required for the work of this section, in accordance with the Drawings and Specifications, and including fabrication and installation of Metal Stairs.

1.5 REFERENCES

American Institute of Steel Construction (AISC)

- A. Manual of Steel Construction
- B. Code of Standard Practice

American National Standards Institute (ANSI)

- A. ANSI/NAAMM MBG 531-00 Metal Bar Grating Manual- 6th edition

American Society for Testing and Materials (ASTM)

- A. ASTM A108 - Standard Specification for Steel Bars, Carbon, Cold-Finished, Standard Quality
- B. ASTM A123 - Standard Specification for Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products. ASTM A193/A193M - Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
- C. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
- D. ASTM A276 Standard Specification for Stainless Steel Bars and Shapes
- E. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
- F. ASTM A500 – Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
- G. ASTM A513 - Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing.

- H. ASTM A563 - Standard Specification for Carbon and Alloy Steel Nuts.
- I. ASTM A568/A568M – Standard Specification for Steel Sheet, Carbon and High Strength, Low Alloy, Hot-Rolled and Cold Rolled, General Requirements for
- J. ASTM A780 - Standard Practice for Repair of Damaged and Un-coated Areas of Hot-Dip Galvanized Coatings
- K. ASTM A786/A786M Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low- Alloy, and Alloy Steel Floor Plates
- L. ASTM A1011/A1011M Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability
- M. ASTM F844 Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use

Code of Federal Regulations 29CFR1910 (OHSa)

- A. 29CFR1910.24; Fixed Industrial Stairs

National Association of Architectural Metal Manufacturers (NAAMM)

- A. NAAMM STANDARD AMP 510-92 Metal Stairs Manual 5th Edition

Society of Automotive Engineers

- A. SAE J403 Chemical Compositions of SAE Carbon Steels
- B. SAE J429 Mechanical and Material Requirements for Externally Threaded Fasteners

All References are the latest edition unless noted otherwise.

1.6 PERFORMANCE REQUIREMENTS:

- A. Stair Treads: shall be capable of withstanding 100 pounds per square foot or a 300 pound load on an area of 4 square inches without exceeding the allowable working stress of the material; or a single concentrated 1000 pound load without permanent deformation. Treads shall also be designed to withstand all required design loads (i.e. wind, snow, seismic, etc.) in accordance with the required codes of the applicable project.
- B. Stair railings: shall be capable of withstanding a single concentrated load of 200 pounds or a uniform load of 50 pounds per linear foot applied in any direction at any point on the rail without exceeding the design working stress of the materials.
- C. Stair Stringers: shall be capable of withstanding a uniform live loading of 100 pounds per square foot applied in a downward direction to all installed tread surfaces or a 300 pound load on an area of 4 square inches without exceeding the allowable working stress of the material; or a single concentrated load of 1000 pounds at any point on the stair without permanent deformation. Stringers shall also be designed to withstand all required design loads (i.e. wind, snow, seismic, etc.) in accordance with the required codes of the applicable project.

- D. Guard Railings: shall be capable of withstanding a single concentrated load of 200 pounds or a uniform load of 50 pounds per linear foot applied in any direction at any point on the rail without exceeding the design working stress of the materials.

1.7 CONSTRUCTION REQUIREMENTS:

- A. Treads: shall be attached to stringers by bolting.
- B. Stringer Mounting Flanges: where applicable shall be welded to the ends of the stringers.
- C. Riser Spacing: shall be equally spaced to within 3/16" for adjacent risers and to within 3/8" for any two non-adjacent risers on a stair.
- D. Stair railings & baluster tubes: shall be attached to the stringers by bolting, and shall be capped with a solid cap at each end or by a press punch closure method. No tubes having open ends shall be permitted. All closed tubes for hot dip galvanizing will have drain holes.
- E. Bar grate treads: shall be constructed in accordance with NAAMM MBG 533

1.8 DIMENSIONS:

- A. Stair Angle: from 30 to 50 degrees from horizontal as specified in the drawings.
- B. Vertical Drop: the change in elevation, as shown in the drawings, between the upper finished floor surface where the stair will be attached and the lower finished floor surface where the base of the stair will be secured.
- C. Stair Width: The distance transverse to the walking direction available for use as a walking surface, as shown in the drawings. (I.e. the length of the tread).

1.9 SUBMITTALS:

- A. Submit under provisions of Section 013300.
- B. Product Data: Provide manufacturer's installation instructions.
- C. Stair Design: Stairs shall be designed and engineered by the manufacturer, incorporating specified criteria, and employing a professional civil or structural engineer currently registered in the State of North Carolina to perform the design engineering. Include design data along with Shop Drawings. Drawings and design data shall be stamped and signed by the manufacturer's professional engineer.
- D. Shop Drawings: Submit fully detailed Shop Drawings of metal stairs and railings, showing sizes, details of fabrication and construction, methods of assembly, handrail brackets, locations of hardware, anchors, and accessories, and installation details.

1.10 DELIVERY, STORAGE AND HANDLING

Reference AISC Code of Standard Practice, Sections 6 and 7

- A. Deliver materials to the job-site in good condition and properly protected against damage to

finished surfaces.

- B. Store material in a location and manner to avoid damage. Do not stack stair components. Lay out components on firm foundation material such that bending cannot occur.
- C. Store metal components in a clean dry location, away from uncured concrete, cement, or masonry products, acids, oxidizers, rain water, or any other chemical or substance that might damage the stair material or finish.
- D. Plan work and storage locations to keep on-site handling to a minimum.
- E. Exercise particular care to avoid damage to material finishes or unprotected surfaces when handling.

PART 2- PRODUCTS

2.1 MATERIALS:

- A. Carbon Steel Stairs:
 - 1. Tread fasteners:
 - a. Bolts: Hex Head SAE J429 Grade 5. ½" Φ x 13 TPI (stair to landing or structure)
Carriage Head ASTM A307
 - b. Nuts: ASTM A563 Grade A, B, C, D or O
 - c. Washers: ASTM F844 or F436
 - 2. Bar Grating Treads: all materials will conform to ANSI/NAAMM MBG 531
 - 3. See Drawings for further information.

2.2 FINISHES:

- A. Carbon Steel:
 - 1. Hot-Dip Galvanized: See Section 055000 Metal Fabrications for specifications of Hot-Dip Galvanizing.

2.3 FABRICATION:

General: Fabricate metal stair components to conform with performance and construction requirements, and in accordance with approved shop drawings or dimensional prints.

- A. Carbon Steel: gas metal arc weld stringer mounting flanges to stringer ends; tread mounting flanges to tread ends; and stair rail mounting tabs to stair rails using the specified materials; permanently mark stringers for association with the aforementioned documentation.

2.4 PACKING & PACKAGING

Package stairs in a way to minimize the potential for damage during shipping and handling.

PART 3- EXECUTION:

3.1 PREPARATIONS:

- A. Coordination: Coordinate start and installation of steel stairs with all other related and adjacent work. Installation shall not start until the construction has progressed to the point that weather conditions and remaining construction operations will not damage stair installation.

- B. Verification: Verify that dimensions and angle are correct and that substrate is in proper condition for stair installation. Do not proceed to install until all necessary corrections have been made.

3.2 INSTALLATION:

- A. Field Check and verify that all components of the structure required for installation are in place per the approved shop drawings. Report any discrepancies to the Architect or contractor for corrective action by responsible parties prior to erection of stair.
- B. Insure that stair-well or mounting location is clear of obstructions.
- C. Unload and handle material in a manner that will not strain, bend, deform or otherwise damage it.
- D. Inspect stringers for damage during shipment; if either stringer is pierced, creased, bent or permanently deformed do not erect the stair until replacement stringers are obtained. Slight bowing or crowning of stringers is acceptable if it is corrected by the assembly process.
- E. Inspect stair rails and balusters for damage during shipment. Stair rails that are damaged, bent, defaced, or deformed, that are still functional, (or can be made to be functional) and can be assembled, may be utilized on a temporary basis until replacement components are obtained. If any stair rail components are found to be damaged beyond the ability to function per the stair rail requirements, the stair may be erected but must be roped off or otherwise protected from use until such components are replaced.
- F. Where possible retain cardboard packing material or obtain other suitable material and use it to cover any rough concrete floor surface that might damage the stair surface during pre-assembly; or it may be used to protect any soft floor surface that might be damaged during the stair pre-assembly process.
- G. Pre-assemble all treads to stringers, utilizing the fasteners shipped with the unit. Place all treads with fasteners loose prior to tightening any single tread so as to maintain assembly clearance until all treads are placed. Top and bottom tread may be left out at pre-assembly to allow clearance for installation of stair mounting fasteners during erection.
- H. All carriage bolt heads should be installed such that heads are visible and appear on the outside/outboard sides of the stair stringer, except the baluster clamp bolts whose heads should appear on the top surface of the stringer.

- I. All tread, stair rail, cross brace, and/or back pan fasteners should be tightened to a minimum torque value of 25 foot-pounds, they should never be tightened to any torque in excess of 35 foot-pounds.
- J. Pre-assemble stair rail components, utilizing the fasteners shipped with the unit. Place all carriage bolts for baluster clamps in the rectangular slots next to each baluster hole in the stringer, from the top surface, prior to inserting balusters in the holes.
- K. If supplied, back pan sheets should be bolted to stringers prior to erection.
- L. Balusters with an extra tab welded to the side should be placed in the two top most and two bottom most baluster holes in the stringers with the tab parallel to the stringers and pointing away from the stair in the direction of approach to the stair.
- M. Prepare mounting holes.
- N. Position stair with top landing tread at same elevation as upper finished floor or roof surface.
- O. Erect stairs square, plumb, straight, true to line and level.
- P. Secure stair assembly with the required hardware but with never less than two fasteners at the top mounting surface and never less than two fasteners at the bottom mounting surface. A minimum of one fastener at each end of each respective stringer.
- Q. Remove top or bottom tread if required to access bolts or nuts for tightening.
- R. Install and fasten any cross bracing components. Insure the installation is secure and rigid.
- S. Re-install top and bottom tread at their respective locations if removed for installation. A spreader jack may be used to gain some assembly clearance for reinstallation of top and bottom treads but great care must be taken not to scar or permanently deform the stringers.
- T. Touch up any damage to galvanized surfaces using galvanized repair paint in accordance with ASTM A780.

3.3 CLEAN-UP:

Leave work area clean and free of debris.

END OF SECTION 055100

SECTION 055210 - PIPE AND TUBE RAILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Steel pipe railings.
- B. Related Sections include the following:
 - 1. Division 3 Section "Cast-in-Place Concrete" for installing anchor bolts, steel pipe sleeves, wedge-type inserts and other items indicated to be cast into concrete.
 - 2. Division 5 Section "Metal Fabrications."
 - 3. Division 9 Section "High Performance Coatings" for primer compatible for finish coatings

1.3 PERFORMANCE REQUIREMENTS

- A. General: In engineering railings to withstand structural loads indicated, determine allowable design working stresses of railing materials based on the following:
 - 1. Steel: 72 percent of minimum yield strength.
- B. Structural Performance: Provide railings capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 - 1. Handrails:
 - a. Uniform load of 50 lbf/ ft. applied in any direction.
 - b. Concentrated load of 200 lbf applied in any direction.
 - c. Uniform and concentrated loads need not be assumed to act concurrently.
 - 2. Top Rails of Guards:
 - a. Uniform load of 50 lbf/ ft. applied in any direction.
 - b. Concentrated load of 200 lbf applied in any direction.
 - c. Uniform and concentrated loads need not be assumed to act concurrently.
 - 3. Infill of Guards:
 - a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft..
 - b. Infill load and other loads need not be assumed to act concurrently.
- C. Thermal Movements: Provide exterior railings that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.
- D. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Manufacturer's product lines of mechanically connected railings.
 - 2. Grout, anchoring cement, and paint products.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - C. Samples for Verification: For each type of exposed finish required.
 1. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters.
 2. Fittings and brackets.
 3. Assembled Sample of railing system, made from full-size components, including top rail, post, handrail, and infill. Sample need not be full height.
 - a. Show method of finishing and connecting members at intersections.
 - D. Welding certificates.
 - E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, according to ASTM E 894 and ASTM E 935.
- 1.5 QUALITY ASSURANCE
- A. Source Limitations: Obtain each type of railing through one source from a single manufacturer.
 - B. Welding: Qualify procedures and personnel according to the following:
 1. AWS D1.1, "Structural Welding Code--Steel."
- 1.6 PROJECT CONDITIONS
- A. Field Measurements: Verify actual locations of walls and other construction contiguous with railings by field measurements before fabrication and indicate measurements on Shop Drawings.
 1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating railings without field measurements. Coordinate wall and other contiguous construction to ensure that actual dimensions correspond to established dimensions.
 2. Provide allowance for trimming and fitting at site.
- 1.7 COORDINATION AND SCHEDULING
- A. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
 - B. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not satisfy structural performance requirements.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

- A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.
- B. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails, unless otherwise indicated.

2.2 STEEL AND IRON

- A. Tubing: ASTM A 500 (cold formed) .
- B. Pipe: ASTM A 53/A 53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless otherwise noted or unless another grade and weight are required by structural loads.
 1. Provide galvanized finish for exterior installations and where indicated.
- C. Plates, Shapes, and Bars: ASTM A 36/A 36M.

- D. Castings: Either gray or malleable iron, unless otherwise indicated.
 - 1. Malleable Iron: ASTM A 47/A 47M.

2.3 FASTENERS

- A. General: Provide the following:
 - 1. Steel Railings: Plated steel fasteners complying with ASTM B 633, Class Fe/Zn 25 for electrodeposited zinc coating.
- B. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads.
- C. Fasteners for Interconnecting Railing Components:
 - 1. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless otherwise indicated.
 - 2. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless exposed fasteners are unavoidable or are the standard fastening method for railings indicated.
 - 3. Provide square or hex socket flat-head machine screws for exposed fasteners, unless otherwise indicated.
- D. Anchors: Provide chemical or torque-controlled expansion anchors, fabricated from corrosion-resistant materials with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.

2.4 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- B. Shop Primers: Provide primers that comply with Division 9 Section "High-Performance Coatings."
- C. Zinc-Rich Primer: Complying with SSPC-Paint 20 or SSPC-Paint 29 and compatible with topcoat.
 - 1. Use primer with a VOC content of 420 g/L (3.5 lb/gal.) or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - 3. Products: Subject to compliance with requirements, provide one of the following:
 - a. Benjamin Moore & Co.; Epoxy Zinc-Rich Primer CM18/19.
 - b. Carboline Company; Carbozinc 621.
 - c. ICI Devoe Coatings; Catha-Coat 313.
 - d. International Coatings Limited; Interzinc 315 Epoxy Zinc-Rich Primer.
 - e. PPG Architectural Finishes, Inc.; Aquapon Zinc-Rich Primer 97-670.
 - f. Sherwin-Williams Company (The); Corothane I GalvaPac Zinc Primer.
 - g. Tnemec Company, Inc.; Tneme-Zinc 90-97.
- D. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.
- E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.
- F. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

- G. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.
 - 1. Water-Resistant Product: At exterior locations and where indicated provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

2.5 FABRICATION

- A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.
- B. Assemble railings in the 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 reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.
- C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch, unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- D. Form work true to line and level with accurate angles and surfaces.
- E. Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.
- G. Connections: Fabricate railings with welded connections, unless otherwise indicated.
- H. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.
 - 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 flux immediately.
 - 4. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.
 - 5. Fabricate splice joints for field connection using an epoxy structural adhesive if this is manufacturer's standard splicing method.
- I. Form changes in direction as follows:
 - 1. As detailed.
 - 2. By bending.
- J. Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
- K. Close exposed ends of railing members with prefabricated end fittings.
- L. Provide wall returns at ends of wall-mounted handrails, unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is 1/4 inch or less.
- M. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work, unless otherwise indicated.
 - 1. At brackets and fittings fastened to plaster or gypsum board partitions, provide fillers made from crush-resistant material, or other means to transfer wall loads through wall finishes to structural supports and prevent bracket or fitting rotation and crushing of substrate.

- N. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.
- O. For railing posts set in concrete, provide steel sleeves not less than 6 inches long with inside dimensions not less than 1/2 inch greater than outside dimensions of post, with steel plate forming bottom closure.
- P. Toe Boards: Where indicated, provide toe boards at railings around openings and at edge of open-sided floors and platforms. Fabricate to dimensions and details indicated.

2.6 FINISHES, GENERAL

- 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: Variations in appearance of abutting or 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. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- D. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.

2.7 STEEL AND IRON FINISHES

- A. Galvanized Railings:
 - 1. Hot-dip galvanize exterior steel and iron railings, including hardware, after fabrication.
 - 2. Hot-dip galvanize interior steel and iron railings in mechanical and electrical rooms, including hardware, after fabrication.
 - 3. Comply with ASTM A 123/A 123M for hot-dip galvanized railings.
 - 4. Comply with ASTM A 153/A 153M for hot-dip galvanized hardware.
- B. Fill vent and drain holes that will be exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.
- C. For galvanized railings, provide hot-dip galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.
- D. Preparation for Priming: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with metallic-phosphate process.
- E. All steel railings to receive special coatings. See Division 9, "High Performance Coatings" for preparation and priming.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine plaster and gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements have been clearly marked for Installer. Locate reinforcements and mark locations if not already done.

3.2 INSTALLATION, GENERAL

- A. Fit exposed connections together to form tight, hairline joints.
- B. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

1. Do not weld, cut, or abrade surfaces of railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
 2. Set posts plumb within a tolerance of 1/16 inch in 3 feet.
 3. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.
- C. Adjust railings before anchoring to ensure matching alignment at abutting joints.
- D. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.
- 3.3 RAILING CONNECTIONS
- A. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in Part 2 "Fabrication" Article whether welding is performed in the shop or in the field.
- B. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 2 inches beyond joint on either side, fasten internal sleeve securely to 1 side, and locate joint within 6 inches of post.
- 3.4 ADJUSTING AND CLEANING
- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
- B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 9 painting Sections.
- C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.
- 3.5 PROTECTION
- A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.
- B. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION 05521

SECTION 055300 - GRATINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Glass-fiber-reinforced plastic gratings.

1.3 PERFORMANCE REQUIREMENTS

- A. Structural Performance of Gratings: Provide gratings capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 - 1. Design Live (Pedestrian) Load: uniform load of 100lb/sq ft minimum; concentrated load of 300 lbs.
 - 2. Maximum Allowable Deflection under Live Load: 1/240; size components by single support design.
 - 3. Maximum spacing between bars as scheduled.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Glass-fiber-reinforced plastic gratings.
 - 2. Clips and anchorage devices for gratings.
 - 3. Provide span and deflection tables
- B. LEED Submittal:
 - 1. Product Data for Credit MR 4.1 For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
 - a. Include statement indicating costs for each product having recycled content.
- C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
- D. Samples: Submit two samples, 12x12inch in size illustrating surface finish, color and texture.
- E. Manufacturer's Installation Instructions: Indicate special requirements for opening and perimeter framing.

1.5 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with gratings by field measurements before fabrication and indicate measurements on Shop Drawings.

1.6 COORDINATION

- A. Coordinate installation of anchorages for gratings, grating frames, and supports. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Glass-Fiber-Reinforced Plastic Gratings:
 - a. Browning-Campbell Company
 - b. Fibergrate Composite Structures, inc
 - c. Strongwell
 - 2. Basis of design: Browning-Campbell Company 2" Pultruded T-Bar Fiberglass Grating

2.2 FASTENERS

- A. General: Unless otherwise indicated, provide Type **304** stainless-steel fasteners for exterior use. Select fasteners for type, grade, and class required.
- B. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, nuts, and, where indicated, flat washers; ASTM F 593 (ASTM F 738M) for bolts and ASTM F 594 (ASTM F 836M) for nuts, Alloy Group [**1 (A1)**] [**2 (A4)**].
- C. Plain Washers: Round, ASME B18.22.1 (ASME B18.22M).
- D. Lock Washers: Helical, spring type, ASME B18.21.1 (ASME B18.21.2M).
- E. Anchors: Provide **cast-in-place** anchors with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.

1. Material for Anchors in Interior Locations: Alloy Group **[1 (A1)] [2 (A4)]** stainless-steel bolts complying with ASTM F 593 (ASTM F 738M) and nuts complying with ASTM F 594 (ASTM F 836M).

2.3 FABRICATION

- A. Shop Assembly: Fabricate grating sections in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Cut, drill, and punch material cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm), unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form from materials of size, thickness, and shapes indicated, but not less than that needed to support indicated loads.
- D. Fit exposed connections accurately together to form hairline joints.
- E. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space the anchoring devices to secure gratings, frames, and supports rigidly in place and to support indicated loads.

2.4 GLASS-FIBER-REINFORCED PLASTIC GRATINGS

- A. Pultruded Glass-Fiber-Reinforced Gratings: Bar gratings assembled from components made by simultaneously pulling glass fibers and extruding thermosetting plastic resin through a heated die under pressure to produce a product without voids and with a high glass-fiber content.
 1. Configuration: **T3320; 2-inch (51-mm) T-bars spaced 1-1/2 inches (38 mm) o.c. (33 percent open.**
 2. Weight: 3.7 lbs/square foot.
 3. Resin Type: **Vinylester**
 - a. Flame-Spread Index: 25 or less when tested according to ASTM E 84.
 - b. U.S.D.A. Acceptance: Accepted for food processing applications.
 4. Color: **Gray**
 5. Traffic Surface: **Applied abrasive finish**
- B. Fabricate cutouts in grating sections for penetrations. Arrange cutouts to permit grating removal without disturbing items penetrating gratings.

2.5 GRATING FRAMES AND SUPPORTS

- A. Frames and Supports for Glass-Fiber-Reinforced Plastic Gratings: Fabricate from glass-fiber-reinforced plastic shapes of sizes, shapes, and profiles indicated and as necessary to receive

gratings. Miter connections for perimeter angle frames. Cut, drill, and tap units to receive hardware and similar items.

1. Unless otherwise indicated, use shapes made from same resin as gratings.
2. Equip units indicated to be cast into concrete or built into masonry with integral anchors.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing gratings to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.
- B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing gratings. Set units accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.
- C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete or masonry.
- D. Fit exposed connections accurately together to form hairline joints.

3.2 INSTALLING GLASS-FIBER-REINFORCED PLASTIC GRATINGS

- A. Comply with manufacturer's written instructions for installing gratings. Use manufacturer's standard stainless-steel anchor clips and hold-down devices for bolted connections.

3.3 ADJUSTING AND CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 requirements for touching up shop-painted surfaces.
 1. Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.
- B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 09 painting Sections.
- C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION 055300

- 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:
 - 1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.

2.3 FIRE-RETARDANT-TREATED MATERIALS

- A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.
- B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.
 - 1. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D 3201 at 92 percent relative humidity. Use where exterior type is not indicated.
- C. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent.
- D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.
- E. Application:
 - 1. Concealed blocking.

2.4 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 of Type 304 stainless steel.
- 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.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry to other construction; scribe and cope as needed for accurate fit. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.
- B. Install fire-retardant treated plywood backing panels with classification marking of testing agency exposed to view.
- C. Comply with AWWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.
- D. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.
- E. 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 PROTECTION

- A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.
- B. Protect rough carpentry from weather. If, despite protection, rough carpentry becomes sufficiently wet that moisture content exceeds that specified, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 061000

SECTION 071150- BITUMINOUS DAMPPROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes cold-applied, emulsified- asphalt dampproofing applied to the following surfaces:
 - 1. Exterior face of inner wythe of exterior masonry cavity walls.
 - 2. Exterior face of concrete or concrete masonry foundation walls.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include recommendations for method of application, primer, number of coats, coverage or thickness, and protection course.
- B. Material Certificates: For each product, signed by manufacturers.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain primary dampproofing materials and primers through one source from a single manufacturer. Provide secondary materials recommended by manufacturer of primary materials.

1.5 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit asphalt dampproofing to be performed according to manufacturers' written instructions.
- B. Ventilation: Provide adequate ventilation during application of dampproofing in enclosed spaces. Maintain ventilation until dampproofing has thoroughly cured.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cold-Applied, Emulsified-Asphalt Dampproofing:
 - a. Euclid Chemical Company (The).
 - b. Karnak Corporation.
 - c. Koppers Industries, Inc.
 - d. Meadows, W. R., Inc.
 - e. Sonneborn, Div. of ChemRex, Inc.

2.2 BITUMINOUS DAMPPROOFING

- A. Cold-Applied, Emulsified-Asphalt Dampproofing:
 - 1. Roll and Spray Coats: ASTM D 1227, Type III, Class 1.

2.3 MISCELLANEOUS MATERIALS

- A. Emulsified-Asphalt Primer: ASTM D 1227, Type III, Class 1, except diluted with water as recommended by manufacturer.
- B. Asphalt-Coated Glass Fabric: ASTM D 1668, Type I.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Applicator present, for compliance with requirements for surface smoothness and other conditions affecting performance of work.
 - 1. Begin dampproofing application only after substrate construction and penetrating work have been completed and unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Protection of Other Work: Mask or otherwise protect adjoining exposed surfaces from being stained, spotted, or coated with dampproofing. Prevent dampproofing materials from entering and clogging weep holes and drains.
- B. Clean substrates of projections and substances detrimental to work; fill voids, seal joints, and apply bond breakers if any, as recommended by prime material manufacturer.

3.3 APPLICATION, GENERAL

- A. Comply with manufacturer's written recommendations unless more stringent requirements are indicated or required by Project conditions to ensure satisfactory performance of dampproofing.
 - 1. Apply additional coats if recommended by manufacturer or required to achieve coverages indicated.
 - 2. Allow each coat of dampproofing to cure 24 hours before applying subsequent coats.
- B. Apply dampproofing to provide continuous plane of protection on exterior face of inner wythe of exterior masonry cavity walls.
- C. Apply dampproofing to provide continuous plane of protection on exterior face of building retaining walls.
 - 1. Lap dampproofing at least 1/4 inch onto flashing, masonry reinforcement, veneer ties, and other items that penetrate inner wythe.
 - 2. Extend dampproofing over outer face of structural members and concrete slabs that interrupt inner wythe, and lap dampproofing at least 1/4 inch onto shelf angles supporting veneer.
 - 3. Install flashings and corner protection stripping at internal and external corners, changes in plane, construction joints, cracks, and where shown as "reinforced," by embedding an 8-inch- wide strip of asphalt-coated glass fabric in a heavy coat of dampproofing. Dampproofing coat required for embedding fabric is in addition to other coats required.

3.4 COLD-APPLIED, EMULSIFIED-ASPHALT DAMPPROOFING

- A. On Exterior Face of Inner Wythe of Cavity Walls: Apply primer and one brush or spray coat at not less than 1 gal./100 sq. ft.

3.5 CLEANING

- A. Remove dampproofing materials from surfaces not intended to receive dampproofing.

END OF SECTION 07115

SECTION 072113 - PERIMETER INSULATION UNDER SLABS-ON-GRADE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Perimeter insulation under slabs-on-grade.
- B. Related Sections include the following:
 - 1. Division 4 Section "Unit Masonry Assemblies" for insulation installed in cavity walls and masonry cells.
 - 2. Division 7 Section "Metal Roof Panel System" for insulation specified as part of roofing construction.
 - 3. Division 9 Section "Gypsum Board" for installation in metal-framed assemblies of insulation specified by referencing this Section.
 - 4. Division 23 Section "Hvac Insulation."

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples for Verification: Full-size units for each type of exposed insulation indicated.
- C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency for insulation products.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of building insulation through one source from a single manufacturer.
- B. Fire-Test-Response Characteristics: Provide insulation and related materials with the fire-test-response characteristics indicated, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.
 - 1. Surface-Burning Characteristics: ASTM E 84.
 - 2. Fire-Resistance Ratings: ASTM E 119.
 - 3. Combustion Characteristics: ASTM E 136.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect insulation materials from physical damage and from deterioration by 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 plastic insulation as follows:
 - 1. Do not expose to sunlight, except to extent necessary for period of installation and concealment.
 - 2. Protect against ignition at all times. Do not deliver plastic insulating materials to Project site before installation time.
 - 3. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 FOAM-PLASTIC BOARD INSULATION

- A. Extruded-Polystyrene Board Insulation: ASTM C 578, of type and density indicated below, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively:
 - 1. Available Manufacturers:
 - a. DiversiFoam Products.
 - b. Dow Chemical Company.
 - c. Owens Corning.
 - d. Pactiv Building Products Division.
 - 2. Type IV, 1.60 lb/cu. ft. unless otherwise indicated.
 - 3. Install at perimeter walls and slabs and where indicated on the drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements of Sections in which substrates and related work are specified and for other conditions affecting performance.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean substrates of substances harmful to insulation or vapor retarders, including removing projections capable of puncturing vapor retarders or of interfering with insulation attachment.

3.3 INSTALLATION, GENERAL

- A. Comply with insulation manufacturer's written instructions applicable to products and application indicated.
- B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed at any time to ice, rain, and snow.
- C. Extend insulation in thickness indicated to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
- D. For preformed insulating units, provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

3.4 INSTALLATION OF PERIMETER AND UNDER-SLAB INSULATION

- A. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.

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.

END OF SECTION 07210

SECTION 074113 - METAL ROOF PANEL SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Metal roofing system
 - 2. Roof insulation
 - 3. Underlayment Sheet
 - 4. Cover board
 - 5. Roofing system accessories
 - 6. Metal flashings and trim

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. Shop Drawings: Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
- C. Samples: For each type of metal panel indicated.

1.4 INFORMATIONAL SUBMITTALS

- A. Product test reports.
- B. Warranties: Sample of special warranties.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. UL-Certified, Portable Roll-Forming Equipment: UL-certified, portable roll-forming equipment capable of producing metal panels warranted by manufacturer to be the same as factory- formed products. Maintain UL certification of portable roll-forming equipment for duration of work.

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Two years from date of Final Completion.
- B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory- applied finishes within specified warranty period.
 - 1. Finish Warranty Period: 20 years from date of Final Completion.
- C. Special Weathertightness Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that fail to remain weathertight, including leaks, within specified warranty period.
 - 1. Warranty Period: 20 years from date of Final Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Energy Performance:
 - 1. Provide roof panels that are listed on the EPA/DOE's ENERGY STAR "Roof Product List".
- B. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E1592:
 - 1. Wind Loads: As indicated on Drawings.
 - 2. Other Design Loads: As indicated on Drawings .
 - 3. Deflection Limits: For wind loads, no greater than 1/180 of the span.
- C. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E1646 or ASTM E331 at the following test-pressure difference:
 - 1. Test-Pressure Difference: **6.24 lbf/sq. ft.**
- D. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind- uplift-resistance class indicated.
 - 1. Uplift Rating: UL 60 .
- E. FM Global Listing: Provide metal roof panels and component materials that comply with requirements in FM Global 4471 as part of a panel roofing system and that are listed in FM Global's "Approval Guide" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Global markings.
 - 1. Fire/Windstorm Classification: Class 1A- 90 .
 - 2. Hail Resistance: SH.
- F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing 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.
 - 1. Temperature Change (Range): **120 deg F** , ambient; **180 deg F** , material surfaces .

2.2 STANDING-SEAM METAL ROOF PANELS

- A. Provide factory-formed metal roof panels designed to be installed by lapping and interconnecting raised side edges of adjacent panels with joint type indicated and mechanically attaching panels to supports using concealed clips in side laps. Include clips, cleats, pressure plates, and accessories required for weathertight installation.
 - 1. Steel Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E1514.
 - 2. Aluminum Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E1637.
- B. Vertical-Rib, Seamed-Joint, Standing-Seam Metal Roof Panels : Formed with vertical ribs at panel edges and a flat pan between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels, engaging opposite edge of adjacent panels, and mechanically seaming panels together.
 - 1. Basis of Design Product: DMI Double-Lock DL15.
 - 2. Manufacturers:
 - a. ATAS International, Inc
 - b. Berridge Manufacturing Company
 - c. Centria Architectural Systems
 - d. Dimensional Metals, Inc (DMI)
 - e. MCBi Metal Wall and Roof Systems
 - f. Metal Sales Manufacturing, LLC
 - g. Petersen Aluminum Corporation (PAC-CLAD)
 - 3. Metallic-Coated Steel Sheet: Galvalume steel sheet complying with ASTM A653/A653M,

G90 coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A792/A792M, **Class AZ50** coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

- a. Nominal Thickness: **0.028 inch**.
- b. Exposed Finish: Polyvinylidene fluoride (PVDF) multi-coat organic coatings system including at least 70 percent PVDF resin and having a minimum total dry film thickness (TDFT) of 1.1 mil when measured in accordance with ASTM D1790.
- c. Unexposed Finish: Manufacturer's standard coating, minimum 0.5 mil total dry film thickness.
- d. Color: As selected by Architect from manufacturer's full range, but intent is to match the green color of the neighboring existing metal roofing on the adjacent building (Finger Barn 1) to the west.
4. Clips: Two-piece floating to accommodate thermal movement.
5. Material:
 - a. **0.064-inch**- nominal thickness, zinc-coated (galvanized) or aluminum-zinc alloy- coated steel sheet.
6. Joint Type: Double folded.
7. Panel Coverage: 17 inches.
8. Panel Height: **1.5 inches**.
9. Panel Texture: Striated for added stiffness.
10. Panel length: Full length from gable peak to eave.

2.3 UNDERLAYMENT MATERIALS

- A. Self-Adhering, High-Temperature Underlayment: Provide self-adhering, cold-applied, sheet underlayment, a minimum of **30 mils** thick, consisting of slip-resistant, polyethylene-film top surface laminated to a layer of butyl or SBS-modified asphalt adhesive, with release-paper backing. Provide primer when recommended by underlayment manufacturer.
 1. Thermal Stability: Stable after testing at **240 deg F**; ASTM D1970.
 2. Low-Temperature Flexibility: Passes after testing at minus **20 deg F**; ASTM D1970.
 3. **Manufacturers**: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ATAS International, Inc.
 - b. Carlisle WIP Products; a brand of Carlisle Construction Materials.
 - c. GCP Applied Technologies Inc.
- B. Slip Sheet: Manufacturer's recommended slip sheet, of type required for application.

2.4 INSULATION MATERIALS AND COVER BOARD

- A. Polyisocyanurate (ISO) Insulation Board: Rigid closed-cell foam panels, complying with ASTM C1289.
 1. Basis of Design: Johns Manville - Energy 3.
 2. Type II:
 - a. Class 1 - Faced with glass fiber reinforced cellulosic felt facers on both major surfaces of core foam.
 - 1) Compressive Strength:
 - a) Grade 2: 20 psi (138 kPa), minimum.
 - 2) Long Term Thermal Resistance at 1.5 Inch Thick: 8.4 (1.48) LTTR, minimum when tested at 75 degrees F (24 degrees C) in accordance with ASTM C1306/C1306M or CAN/ULC-S770.
 3. Flame Spread Index (FSI): Class B - 26 to 75; per ASTM E84.
 4. Smoke Developed Index (SDI): 450 or less; per ASTM E84.
 5. Tensile Strength: 500 psf, minimum per ASTM C209.

6. Water Absorption: 1 percent, maximum by volume per ASTM C209.
7. Water Vapor Permeance: 1 perm, maximum per ASTM E96.
8. Board Size: Largest size applicable, but not less than 48 x 96 inches.
9. Board Thickness: As indicated on Drawings.
10. Number of Layers: As indicated on Drawings.
11. Board Edges: Square.

B. INSULATION ACCESSORIES

A. Insulation for miscellaneous voids:

1. Spray Polyurethane Foam Insulation: ASTM C1029, Type II, closed cell, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E84.
2. Sill Sealer: Closed-cell unfaced flexible polyethylene foam gasketing strip to reduce air infiltration and wicking between concrete slab and sill plate.
3. Urethane foam at deck flutes and all other gaps in wall framing. Ensure envelope insulation is continuous throughout.

B. Insulation Anchors, Spindles, and Standoffs: As recommended by manufacturer.

C. Adhesive for Bonding Insulation: Product compatible with insulation and air and water barrier materials, and with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.

C. COVER BOARD

1. Fiber-Reinforced Gypsum Roof Board: ASTM C1278/C1278M, cellulosic-fiber reinforced, water-resistant gypsum board.
2. Thickness: 1/2 inch.

2.5 MISCELLANEOUS MATERIALS

- A. Miscellaneous Metal Subframing and Furring: ASTM C645; cold-formed, metallic-coated steel sheet, ASTM A653/A653M, **G90** hot-dip galvanized coating designation or ASTM A792/A792M, **Class AZ50** coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.
- B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.
 1. Closures: Provide closures at eaves and ridges, fabricated of same metal as metal panels.
 2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
 3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum **1-inch** thick, flexible closure strips; cut or pre-molded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
- C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.
- D. Panel Fasteners: Self-tapping screws designed to withstand design loads.
- E. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.
 1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing; **1/2 inch** wide and **1/8 inch** thick.

2. Joint Sealant: ASTM C920; as recommended in writing by metal panel manufacturer.
3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C1311.

2.6 FABRICATION

- A. Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
- B. On-Site Fabrication: Subject to compliance with requirements of this Section, metal panels may be fabricated on-site using UL-certified, portable roll-forming equipment if panels are of same profile and warranted by manufacturer to be equal to factory-formed panels. Fabricate according to equipment manufacturer's written instructions and to comply with details shown.
- C. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.
- D. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.
- E. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's 7th edition of "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.

2.7 FINISHES

- A. Panels and Accessories:
 1. Two-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat.
 2. Concealed Finish: White or light-colored acrylic or polyester backer finish.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C754 and metal panel manufacturer's written recommendations.

3.2 INSTALLATION OF UNDERLAYMENT

- A. Self-Adhering Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation. Apply at locations indicated below, wrinkle free, in shingle fashion to shed water, and with end laps of not less than 6 inches staggered 24 inches between courses. Overlap side edges not less than 3-1/2 inches. Extend underlayment into gutter trough. Roll laps with roller. Cover underlayment within 14 days.
 1. Apply over the roof area indicated below:
 - a. Roof perimeter for a distance up from eaves of 24 inches beyond interior wall line.
 - b. Valleys, from lowest point to highest point, for a distance on each side of 18 inches. Overlap ends of sheets not less than 6 inches.
 - c. Rake edges for a distance of 18 inches.
 - d. Hips and ridges for a distance on each side of 12 inches.
 - e. Roof-to-wall intersections for a distance from wall of 18 inches.
 - f. Around dormers, chimneys, skylights, and other penetrating elements for a distance from element of 18 inches.
- B. Slip Sheet: Apply slip sheet over underlayment before installing metal roof panels. No slip

sheet needed at areas of high-temperature underlayments.

3.3 INSTALLATION OF STANDING-SEAM METAL ROOF PANELS

- A. Standing-Seam Metal Roof Panel Installation: Fasten metal roof panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended in writing by manufacturer.
 - 1. Install clips to supports with self-tapping fasteners.
 - 2. Install pressure plates at locations indicated in manufacturer's written installation instructions.
 - 3. Snap Joint: Nest standing seams and fasten together by interlocking and completely engaging factory-applied sealant.
 - 4. Seamed Joint: Crimp standing seams with manufacturer-approved, motorized seamer tool so clip, metal roof panel, and factory-applied sealant are completely engaged.
 - 5. Watertight Installation:
 - a. Apply a continuous ribbon of sealant or tape to seal joints of metal panels, using sealant or tape as recommend in writing by manufacturer as needed to make panels watertight.
 - b. Provide sealant or tape between panels and protruding equipment, vents, and accessories.
 - c. At panel splices, nest panels with minimum 6-inch end lap, sealed with sealant and fastened together by interlocking clamping plates.
- B. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.
- C. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

3.4 CLEANING AND PROTECTION

- A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

END OF SECTION 074113

SECTION 074646 – FIBER-CEMENT SIDING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes fiber-cement siding and soffit.
- B. Related Requirements:
 - 1. Section 054000 "Cold Formed Steel Framing"

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For each finish and for each color and texture required.

1.3 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of fiber-cement siding and soffit.
- B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for fiber-cement siding.
- C. Research/Evaluation Reports: For each type of fiber-cement siding required, from ICC-ES.

PART 2 - PRODUCTS

2.1 FIBER-CEMENT SIDING

- A. General: ASTM C 1186, Type A, Grade II, fiber-cement board, noncombustible when tested according to ASTM E 136; with a flame-spread index of 25 or less when tested according to ASTM E 84:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corporation.
 - b. GAF
 - c. James Hardie Building Products, Inc
- B. Labeling: Provide fiber-cement siding that is tested and labeled according to ASTM C 1186 by a qualified testing agency acceptable to authorities having jurisdiction.
- C. Nominal Thickness: Not less than 5/16 inch(8 mm).
- D. Panel Texture: Smooth.
- E. Factory Priming: Manufacturer's standard acrylic primer.

2.2 ACCESSORIES

- A. Siding Accessories, Provide j-mold aluminum edge trim at all panel edges.
- B. Fasteners: For fastening fiber cement, use stainless-steel fasteners.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of fiber-cement siding and soffit and related accessories.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean substrates of projections and substances detrimental to application.

3.3 INSTALLATION

- A. General: Comply with manufacturer's written installation instructions applicable to products and applications indicated unless more stringent requirements apply.
 - 1. Do not install damaged components.
 - 2. Install fasteners no more than 16 inches o.c.
- B. Install joint sealants as specified in Section 079200 "Joint Sealants" and to produce a weathertight installation.

3.4 ADJUSTING AND CLEANING

- A. Remove damaged, improperly installed, or otherwise defective materials and replace with new materials complying with specified requirements.
- B. Clean finished surfaces according to manufacturer's written instructions and maintain in a clean condition during construction.

END OF SECTION 074646

SECTION 076200 - SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following sheet metal flashing and trim:
 - 1. Formed low-slope roof flashing and trim.
- B. Related Sections include the following:
 - 1. Division 4 Section "Unit Masonry Assemblies" for installing through-wall flashing, reglets, and other sheet metal flashing and trim.
 - 2. Division 7 Section "Modified Bitumen Roofing" for installing sheet metal flashing and trim integral with roofing membrane.
 - 3. Division 7 Section "Joint Sealants" for field-applied sheet metal flashing and trim sealants.

1.3 PERFORMANCE REQUIREMENTS

- A. General: Install sheet metal flashing and trim to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failing, rattling, leaking, and fastener disengagement.
- B. Fabricate and install roof edge flashing and copings capable of resisting the following forces according to recommendations in FMG Loss Prevention Data Sheet 1-49:
 - 1. Wind Zone 1: For velocity pressures of 10 to 20 lbf/sq. ft.: 40-lbf/sq. ft. perimeter uplift force, 60-lbf/sq. ft. corner uplift force, and 20-lbf/sq. ft. outward force.
 - 2. Wind Zone 1: For velocity pressures of 21 to 30 lbf/sq. ft. : 60-lbf/sq. ft. perimeter uplift force, 90-lbf/sq. ft. corner uplift force, and 30-lbf/sq. ft. outward force.
 - 3. Wind Zone 2: For velocity pressures of 31 to 45 lbf/sq. ft.: 90-lbf/sq. ft. perimeter uplift force, 120-lbf/sq. ft. corner uplift force, and 45-lbf/sq. ft. outward force.
 - 4. Wind Zone 3: For velocity pressures of 46 to 104 lbf/sq. ft.: 208-lbf/sq. ft. perimeter uplift force, 312-lbf/sq. ft. corner uplift force, and 104-lbf/sq. ft. outward force.
- C. Thermal Movements: Provide sheet metal flashing and trim that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of sheet metal and trim thermal movements. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F material surfaces.
- D. Water Infiltration: Provide sheet metal flashing and trim that do not allow water infiltration to building interior.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: Show layouts of sheet metal flashing and trim, including plans and elevations. Distinguish between shop- and field-assembled work. Include the following:
 - 1. Identify material, thickness, weight, and finish for each item and location in Project.

2. Details for forming sheet metal flashing and trim, including profiles, shapes, seams, and dimensions.
 3. Details for fastening, joining, supporting, and anchoring sheet metal flashing and trim, including fasteners, clips, cleats, and attachments to adjoining work.
 4. Details of expansion-joint covers, including showing direction of expansion and contraction.
 - C. Samples for Initial Selection: For each type of sheet metal flashing and trim indicated with factory-applied color finishes.
 1. Include similar Samples of trim and accessories involving color selection.
 - D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below:
 1. Sheet Metal Flashing: 12 inches long. Include fasteners, cleats, closures, and other attachments.
 2. Trim: 12 inches long. Include fasteners and other exposed accessories.
 3. Accessories: Full-size Sample.
- 1.5 QUALITY ASSURANCE
- A. Sheet Metal Flashing and Trim Standard: Comply with SMACNA's "Architectural Sheet Metal Manual." Conform to dimensions and profiles shown unless more stringent requirements are indicated.
 - B. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."
 1. Meet with Owner, Architect, Owner's insurer if applicable, Installer, and installers whose work interfaces with or affects sheet metal flashing and trim including installers of roofing materials, roof accessories, unit skylights, and roof-mounted equipment.
 2. Review methods and procedures related to sheet metal flashing and trim.
 3. Examine substrate conditions for compliance with requirements, including flatness and attachment to structural members.
 4. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.
- 1.6 DELIVERY, STORAGE, AND HANDLING
- A. Deliver sheet metal flashing materials and fabrications undamaged. Protect sheet metal flashing and trim materials and fabrications during transportation and handling.
 - B. Unload, store, and install sheet metal flashing materials and fabrications in a manner to prevent bending, warping, twisting, and surface damage.
 - C. Stack materials on platforms or pallets, covered with suitable weathertight and ventilated covering. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage.
- 1.7 COORDINATION
- A. Coordinate installation of sheet metal flashing and trim with interfacing and adjoining construction to provide a leak-proof, secure, and non-corrosive installation.

PART 2 - PRODUCTS

2.1 SHEET METALS

- A. Aluminum Sheet: ASTM B 209, Alloy 3003, 3004, 3105, or 5005, Temper suitable for forming and structural performance required, but not less than H14, finished as follows:
 1. Anodized Finish: Apply the following coil-anodized finish:

- a. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
 - B. Zinc Sheet: Electrolytic, 99 percent pure zinc alloyed with 1 percent titanium and copper.
 - 1. Finish: Preweathered.
- 2.2 UNDERLAYMENT MATERIALS
- A. Polyethylene Sheet: 6-mil- thick polyethylene sheet complying with ASTM D 4397.
 - B. Felts: ASTM D 226, Type II (No. 30), asphalt-saturated organic felt, non-perforated.
 - C. Slip Sheet: Rosin-sized paper, minimum 3 lb/100 sq. ft.
- 2.3 MISCELLANEOUS MATERIALS
- A. General: Provide materials and types of fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation.
 - B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads.
 - 1. Fasteners for Flashing and Trim: Blind fasteners or self-drilling screws, gasketed, with hex washer head.
 - 2. Blind Fasteners: High-strength aluminum or stainless-steel rivets.
 - 3. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.
 - C. Solder for Zinc: ASTM B 32, 60 percent lead and 40 percent tin with low antimony, as recommended by manufacturer.
 - D. Sealing Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealing tape with release-paper backing. Provide permanently elastic, non-sag, nontoxic, non-staining tape.
 - E. Elastomeric Sealant: ASTM C 920, elastomeric polyurethane polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
 - F. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant, polyisobutylene plasticized, heavy bodied for hooked-type expansion joints with limited movement.
 - G. Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.
 - H. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat. Provide inert-type non-corrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.
 - I. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.
- 2.4 FABRICATION, GENERAL
- A. General: Custom fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated. Shop fabricate items where practicable. Obtain field measurements for accurate fit before shop fabrication.
 - B. 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.
 - C. Fabricate sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.

1. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
 2. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
 - D. Sealed Joints: Form non-expansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA recommendations.
 - E. Expansion Provisions: Where lapped or bayonet-type expansion provisions in the Work cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with elastomeric sealant concealed within joints.
 - F. Conceal fasteners and expansion provisions where possible on exposed-to-view sheet metal flashing and trim, unless otherwise indicated.
 - G. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, non-corrosive metal.
 1. Thickness: As recommended by SMACNA's "Architectural Sheet Metal Manual" for application but not less than thickness of metal being secured.
- 2.5 LOW-SLOPE ROOF SHEET METAL FABRICATIONS
- A. Roof Edge Flashing (Gravel Stop) and Fascia Caps: Fabricate in minimum 96-inch- long, but not exceeding 10-foot- long, sections. Furnish with 6-inch- wide joint cover plates.
 1. Joint Style: Lap, 4 inches wide.
 - B. Copings: Fabricate in minimum 96-inch- long, but not exceeding 10-foot- long, sections. Fabricate joint plates of same thickness as copings. Furnish with continuous cleats to support edge of external leg and interior leg. Miter corners, seal, and solder or weld watertight.
 1. Joint Style: Butt, with 12-inch- wide concealed backup plate .
 2. Fabricate copings from the following material:
 - a. Aluminum: 0.050 inch thick.
- 2.6 FINISHES
- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
 - C. Appearance of Finished Work: Variations in appearance of abutting or 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. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions and other conditions affecting performance of work.
 1. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
 2. 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, solder, welding

rods, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.

1. Torch cutting of sheet metal flashing and trim is not permitted.
- B. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by fabricator or manufacturers of dissimilar metals.
- C. Install exposed sheet metal flashing and trim without excessive oil canning, buckling, and tool marks.
- D. Install sheet metal flashing and trim true to line and levels indicated. Provide uniform, neat seams with minimum exposure of solder, welds, and elastomeric sealant.
- E. 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.
 1. Space cleats not more than 12 inches (300 mm) apart. Anchor each cleat with two fasteners. Bend tabs over fasteners.
- F. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (600 mm) of corner or intersection. Where lapped or bayonet-type expansion provisions cannot be used or would not be sufficiently watertight, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with butyl sealant concealed within joints.
- G. Fasteners: Use fasteners of sizes that will penetrate substrate not less than 1-1/4 inches (32 mm) for nails and not less than 3/4 inch (19 mm) for wood screws.
 1. Aluminum: Use aluminum or stainless-steel fasteners.
- H. Seal joints with elastomeric sealant as required for watertight construction.
 1. Where sealant-filled joints are used, embed hooked flanges of joint members not less than 1 inch (25 mm) into sealant. Form joints to completely conceal sealant. When ambient temperature at time of installation is moderate, between 40 and 70 deg F (4 and 21 deg C), set joint members for 50 percent movement either way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant-type joints at temperatures below 40 deg F (4 deg C).
 2. Prepare joints and apply sealants to comply with requirements in Division 7 Section "Joint Sealants."

3.3 ROOF FLASHING INSTALLATION

- A. General: Install sheet metal roof flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, set units true to line, and level as indicated. Install work with laps, joints, and seams that will be permanently watertight.
- B. Roof Edge Flashing: Anchor to resist uplift and outward forces according to recommendations in FMG Loss Prevention Data Sheet 1-49 for specified wind zone and as indicated.
 1. Interlock bottom edge of roof edge flashing with continuous cleats anchored to substrate at 16-inch centers.
- C. Copings: Anchor to resist uplift and outward forces according to recommendations in FMG Loss Prevention Data Sheet 1-49 for specified wind zone and as indicated.
 1. Interlock exterior bottom edge of coping with continuous cleats anchored to substrate at 16-inch centers.
 2. Anchor interior leg of coping with screw fasteners and washers at 18-inch centers.

3.4 CLEANING AND PROTECTION

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. Clean and neutralize flux materials. Clean off excess solder and sealants.

- C. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain in a 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.

END OF SECTION 076200

SECTION 076310 - METAL GUTTERS AND DOWNSPOUTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Rough carpentry for roofing (Section 061010).

1.2 SUMMARY:

- A. Provide and install gutters and downspouts related to roofing system as shown on Drawings, and as specified herein.
- B. Color shall be approved by Project Designer prior to fabrication.

1.3 QUALITY ASSURANCE:

- A. Standard References:
 - 1. As published by SMACNA:
"Architectural Sheet Metal Manual", Seventh Edition; hereinafter referred to as "SMACNA Manual". Manual may be obtained from Sheet Metal and Air Conditioning Contractors National Assn., Inc., 8224 Old Court House Road, Tysons Corner, Vienna VA 22180.
- B. Contractor shall be responsible for verifying all dimensions in field prior to fabrication of work of this Section.

1.4 SUBMITTALS:

- A. Shop Drawings:
 - 1. Show weights, gauges, or thicknesses of sheet metal. Show location, arrangement, dimensions, materials, fastenings, connections, anchorage, and relation to adjacent work. Use only field verified dimensions for shop drawing submittals.
 - 2. Show nailers, blocking, etc. required to be furnished for securing work of this Section.
 - 3. Show terminations, intersections, and splices in isometric details.
 - 4. Shop Drawings shall be job specific, drawn at a minimum 3" : 12" scale. Marking up contract drawings is not acceptable.
 - 5. Do not proceed with fabrication until shop drawings have been reviewed and approved by the Project Designers.
- B. Samples:
 - 1. Submit samples of each type of gutter, downspout, strapping, drain bar, and expansion joint.
 - 2. Samples shall be of same material composition, thickness and dimension as required for construction. Samples shall be a minimum of 12 inches long.

1.5 DELIVERY, STORAGE, AND HANDLING:

- A. Sheet metal items shall be handled carefully to prevent damage to surface, edges, and ends.
- B. Store at Site and above ground in a dry location, free from physical abuse. Store materials in a manner to prevent staining from condensation.
- C. Store and handle metal in a manner that will prevent damage to the membrane roofing system due to exposed ends and edges of metal. Do not allow direct contact with membrane roofing.

PART 2 - PRODUCTS

2.1 MATERIALS:

A. Sheet Metal:

1. Prefinished base sheet material shall be Galvalume Aluminum-Zinc Alloy Coated Steel Grade C meeting ASTM A792.
2. Strippable film shall be applied to the topside of the painted coil to protect the finish during fabrication, shipping and field handling. This strippable film must be removed during installation.
3. Thickness shall be as indicated on Drawings or as specified herein.
4. Color shall be as selected by the Owner from standard colors.

B. Fasteners:

1. Nails, screws, bolts, rivets, and other fastenings for sheet metal (unless otherwise notes) shall be corrosion-resistant and compatible material to secure work of this Section. Recommended fasteners for each sheet metal shape and substrate shall be indicated on Drawings and of size and type suitable for the intended use. Nails shall be minimum 12 gauge, ring-shank, flat-head type, and of sufficient length to penetrate substrate at least 3/4 inch.
2. Fasteners for attaching sheet-metal flashing or continuous mechanical-restraint bars to concrete/masonry shall be 1/4" x 1-1/2" flat-head zamac nailins with stainless steel nails as mfd. by Rawlplug or Olympic. When sheet metal attachment to masonry is designed to be removable, fasteners shall be Tapcons as manufactured by Rawlplug.
 - a. Provide stainless steel sealing washer, 1/8", at all exposed fasteners.
3. Fasteners for attaching flashing to sheet-metal shall be self-drilling, self-tapping stainless steel screws with neoprene washers.

C. Sealant: as specified in Section 079010.

D. Waterproofing Material:

1. Single-component moisture-cured urethane coating, fluid applied in successive stages to form one continuous, seamless, watertight membrane; 40 mil minimum cured total system thickness;
 - a. Basis of Design is Soprema Alsan Flashing as manufactured by Soprema US, Wooster, Ohio or Sika 621 roof coating system as manufactured by Sika Sarnafil
 - b. Color as selected from manufacturer's standard colors
2. Reinforcing Fabric for Detailing: Material shall be non-woven 100% polyester, stitch bonded, heat-set fabric with the following characteristics:

Weight		3 oz / sq yard
Tensile Strength	ASTM D5034	Warp 74 lbs.
		Fill 45 lbs.
Elongation @ Break	ASTM D5034	Warp 21.3%
		Fill 51.3%
Thickness	ASTM D-1777	.018 inches

2.2 FABRICATION:

- A. Work shall be fabricated in a shop equipped with machinery and tools for working sheet metal. Work shall be performed by skilled mechanics. Fabricate all work possible in shop.
- B. Work shall be formed to profiles, sizes, and dimensions as shown on Drawings and on approved shop drawings. Work shall conform to approved samples.

- C. Work shall conform to practices recommended in SMACNA Manual, except as required specifically otherwise in Contract Documents. Work shall conform to recommendations of Manufacturer except where required otherwise in Contract Document.
- D. Work shall be fabricated in maximum lengths to minimize joints; except where required specifically otherwise, and where consideration of control of expansion and contraction require otherwise. Maximum length to be 24'-0" for gutter section.
- E. Work shall be formed to true lines and sharp arrises. Work shall be straight, without bulges or waves.
- F. Exposed edges shall be turned under for stiffness. No exposed sheared or raw edges shall be permitted.
- G. Corners of gutters shall be mitered, seamed, riveted, and sealed. Legs shall be not less than 2 ft. long. Form and fabricate in shop.
- H. Except as noted specifically otherwise in Contract Documents, thickness of metal shall be as follows:
 - 1. Downspouts: 24 gage
 - 2. Gutters: 22 gage
- I. Strapping or other means of securement shall be in accordance with "SMACNA Manual".
- J. Spacers for gutters shall be spaced at a maximum of 36" oc.
- K. Gutters shall be supported by 0.120" aluminum support brackets, formed to fit under the gutters and spaced at 36" oc maximum. Color to match the gutters.
- L. Downspouts shall be formed with concealed, longitudinal joints. All breaks and turns at elbows shall be designed to shed water. Back-water laps are not acceptable.
 - 1. Connection of downspout to gutters shall have a concealed inverted tube inside the downspout with flanges pop-riveted to bottom of gutter.
- M. Finishes
 - 1. Sheet metal shall be primed (in the factory before forming) on side required herein to receive subsequent finish coating. Prime with a primer of flexibilized epoxy-based coating to a minimum thickness (dry film) of 0.2 mil.
 - 2. Where required, metal shall be finish-coated (in the factory before forming) with a finish coating of Kynar 500 (formulated with not less than 70% polyvinylidene fluoride). Thickness of coating (dry film) shall be a minimum of 0.7 mil.
 - 3. Color variance shall not vary more than 0.5 NBS unit from master standard, tested by use of a color-difference meter.
 - 4. Colors will be selected by Owner from manufacturer's standard colors. The intent is to match the existing fascia metal.

PART 3 - EXECUTION

3.1 EXAMINATION OF SUBSTRATE:

- A. Substrate shall be suitable to receive work of this Section. Work shall not commence until unsuitable conditions of substrate have been corrected.

3.2 GENERAL REQUIREMENTS FOR INSTALLATION:

- A. Work shall be installed by skilled mechanics.
- B. Work shall conform to approved shop drawings, approved samples, and requirements herein. Work shall conform to SMACNA Manual except where required otherwise in Contract Documents.

- C. Work shall allow for thermal movement, between sections and in relation to adjacent materials. Maximum distance between expansion joints to be 60'-0". Locate so as not to impede drainage to the downspouts.
- D. Lap joints a minimum of 1". Apply a continuous bead of approved sealant within lap and rivet 1" o.c. Seal joints with waterproofing coating material as specified in Part 2 and applied as specified in Article 3.3.
- E. Insulate dissimilar metals from each other to prevent galvanic action.
- F. All gutter sections shall be sloped to drain at downspout openings. Ponded water between downspouts is unacceptable. Rework as necessary for proper drainage.

3.3 SEALING:

- A. Seal joints between sheet-metal work and adjacent work as necessary to provide resilient, watertight condition. Work of this Section shall be watertight.
- B. Joints in gutters shall be stripped with liquid-flashing coating specified herein for flashing. Joints include end closures, lap splices, and at downspout inlet tubes.
 - 1. Downspout Openings in gutters: Use reinforcing fabric and the 2-courses of coating to seal transition from gutter to downspout a minimum of 6" on to horizontal.
 - 2. Horizontal Laps: Using 12 inch fabric and 2-courses of coating to seal all horizontal laps. Coatings & fabric components must be centered on the gutter laps. Protect from weather until dry.
 - 3. Fluid-applied coating system must be installed to a minimum 40 mil total cured, dry-film thickness over all seams, laps, fasteners, wall transitions, and penetrations.
 - 4. The base-coat of material shall be applied with roller or brush to required wet mil thickness to achieve required dry-film thickness.
 - 5. Reinforcing scrim is to be placed in base coat while wet achieving full saturation and embedment. Allow to dry completely prior to top coat.

3.4 CLEANING:

- A. After completion of installation of work of this Section, exposed work shall be cleaned thoroughly of all scraps, stains, oil, and other materials which would damage work.
- B. Clean metal in accordance with Manufacturer's printed instructions.
- C. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain in a clean condition during construction.
- D. Any damage to the coating system used for gutter joints shall be repaired with new materials before acceptance of this system. Protection and repair is the responsibility of the Roofing Contractor.

3.5 WORKMANSHIP:

- A. Weatherproofing of work of this Section is a part of requirements of the contractor's guaranty/warranty of roofing installation.
- B. Gutters shall be warranted by the contractor not to leak at the seams between metal section or at expansion joints.

END OF SECTION 076310

SECTION 079200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Silicone joint sealants.
2. Urethane joint sealants.
3. Latex joint sealants.
4. Preformed joint sealants.
5. Acoustical joint sealants.

1.2 SUBMITTALS

- A. Product Data: For each joint-sealant product indicated.
- B. Samples: For each kind and color of joint sealant required.
- C. Joint-Sealant Schedule: Include the following information:
1. Joint-sealant application, joint location, and designation.
 2. Joint-sealant manufacturer and product name.
 3. Joint-sealant formulation.
 4. Joint-sealant color.
- D. Product test reports.
- E. Preconstruction compatibility and adhesion test reports.
- F. Preconstruction field-adhesion test reports.
- G. Field-adhesion test reports.
- H. Warranties.

1.3 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM C 1021 to conduct the testing indicated.

1.4 WARRANTY

- A. Special Installer's Warranty: Manufacturer's standard form in which Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
 - 1. Warranty Period: Three years from date of Final Acceptance.
- B. Special Manufacturer's Warranty: Manufacturer's standard form in which joint-sealant manufacturer agrees to furnish joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.
 - 1. Warranty Period: Three years from date of Final Acceptance.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. VOC Content of Interior Sealants: Provide sealants and sealant primers for use inside the weatherproofing system that comply with the following limits for VOC content when calculated according to 40 CFR 59, Part 59, Subpart D (EPA Method 24):
 - 1. Architectural Sealants: 250 g/L.
 - 2. Sealant Primers for Nonporous Substrates: 250 g/L.
 - 3. Sealant Primers for Porous Substrates: 775 g/L.
- B. Liquid-Applied Joint Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied joint sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.
 - 1. Suitability for Immersion in Liquids. Where sealants are indicated for Use I for joints that will be continuously immersed in liquids, provide products that have undergone testing according to ASTM C 1247. Liquid used for testing sealants is deionized water, unless otherwise indicated.
- C. Stain-Test-Response Characteristics: Where sealants are specified to be non-staining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.
- D. Suitability for Contact with Food: Where sealants are indicated for joints that will come in repeated contact with food, provide products that comply with 21 CFR 177.2600.
- E. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. BASF Building Systems.
 - b. DAP
 - c. Dow Corning Corporation.
 - d. GE Advanced Materials - Silicones.
 - e. May National Associates, Inc.

- f. Pecora Corporation.
- g. Polymeric Systems, Inc.
- h. Schnee-Morehead, Inc.
- i. Sika Corporation; Construction Products Division.
- j. Tremco Incorporated.

2.2 SILICONE JOINT SEALANTS

A. Mildew-Resistant Silicone Joint Sealant ASTM C 920.

- 1. Type: Single component (S)
- 2. Grade: nonsag (NS).
- 3. Class: 25.
- 4. Uses Related to Exposure: Nontraffic (NT).

B. Neutral Curing Silicone Joint Sealant ASTM C 920

- 1. Type: Multi-component (M)
- 2. Grade: nonsag (NS)
- 3. Class: 50
- 4. Uses Related to Exposure: Nontraffic (NT)

2.3 URETHANE JOINT SEALANTS

A. Urethane Joint Sealant ASTM C 920.

- 1. Type: Multi-component (M)
- 2. Grade: nonsag (NS)
- 3. Class: 25.
- 4. Uses Related to Exposure: Nontraffic (NT).

2.4 LATEX JOINT SEALANTS

A. Latex Joint Sealant: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.

2.5 ACOUSTICAL JOINT SEALANTS

A. Acoustical Joint Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

2.6 JOINT SEALANT BACKING

A. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin), Type O (open-cell material), Type B (bicellular material with a surface skin), or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application

indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

- B. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer.

2.7 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials.
- C. Masking Tape: Non-staining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions.
 - 1. Remove laitance and form-release agents from concrete.
 - 2. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants.
- B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.2 INSTALLATION

- A. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- B. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of sealant backings.
 2. Do not stretch, twist, puncture, or tear sealant backings.
 3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.
- C. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- D. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
1. Place sealants so they directly contact and fully wet joint substrates.
 2. Completely fill recesses in each joint configuration.
 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- E. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
1. Remove excess sealant from surfaces adjacent to joints.
 2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
 3. Provide concave joint profile per Figure 8A in ASTM C 1193, unless otherwise indicated.
- F. Acoustical Sealant Installation: Comply with ASTM C 919 and with manufacturer's written recommendations.
- G. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.3 JOINT-SEALANT SCHEDULE

- A. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces.
1. Joint Locations:
 - a. Control and expansion joints on exposed interior surfaces of exterior walls.
 - b. Perimeter joints of exterior openings where indicated.
 - c. Tile control and expansion joints.
 - d. Vertical joints on exposed surfaces of interior unit masonry concrete walls and partitions.
 - e. Joints on underside of plant-precast structural concrete beams and planks.
 - f. Perimeter joints between interior wall surfaces and frames of interior doors windows and elevator entrances.
 - g. Other joints as indicated.

2. Joint Sealant: Latex
 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors
- B. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces:
1. Joint Sealant Location:
 - a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
 - b. Tile control and expansion joints where indicated.
 - c. Between construction and adjoining lab casework.
 - d. Surface mounted devices, boxes enclosures and lights, recess and flush mount devices or equipment, and devices or equipment mounted on recessed boxes
 - e. Other joints as indicated.
 2. Joint Sealant: Mildew-Resistant Silicone Joint Sealant
 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- C. Joint-Sealant Application: Interior acoustical joints in vertical surfaces and horizontal nontraffic surfaces
1. Joint Location:
 - a. Acoustical joints where indicated.
 - b. Other joints as indicated.
 2. Joint Sealant: Acoustical.
 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range.
- D. Joint-Sealant Application: Exterior vertical and horizontal nontraffic construction joints.
1. Joint Sealant: Neutral Curing Silicone Joint Sealant (See Section 2.2B)
 2. Joint-Sealant Color: As selected by Architect from manufacturer's full range
- E. Joint-Sealant Application: Conduit standoff clamps, conduit penetrations, surface mounted conduit or raceway,
1. Joint Sealant Location:
 - a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
 - b. Tile control and expansion joints where indicated.
 - c. Between construction and adjoining lab casework.
 - d. Other joints as indicated
 2. Joint Sealant: Siliconized acrylic latex
 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range.

END OF SECTION

SECTION 081113 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Standard hollow metal doors and frames.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Include elevations, door edge details, frame profiles, metal thicknesses, preparations for hardware, fire resistance rating and other details.

1.3 QUALITY ASSURANCE

- A. Quality Standard: Comply with SDI 100.
- B. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at **as close to neutral pressure as possible** according to **NFPA 252**.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ceco Door Products; an Assa Abloy Group company.
 - 2. Curries Company; an Assa Abloy Group company.
 - 3. Kewanee Corporation (The).
 - 4. Mesker Door Inc.
 - 5. Pioneer Industries, Inc.
 - 6. Steelcraft; an Ingersoll-Rand company.

2.2 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, CS, Type B; suitable for exposed applications.
- B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, CS, Type B.

- C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum **G60 (Z180) or A60 (ZF180)**] metallic coating.
- D. Frame Anchors: ASTM A 591/A 591M, Commercial Steel (CS), 40Z (12G) 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. Grout: ASTM C 476, except with a maximum slump of 4 inches (102 mm), as measured according to ASTM C 143/C 143M.
- G. Mineral-Fiber Insulation: ASTM C 665, Type I.
- H. Glazing: Division 08 Section "Glazing."
- I. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil (0.4-mm) dry film thickness per coat.

2.3 STANDARD HOLLOW METAL DOORS

- A. General: Comply with ANSI/SDI A250.8.
 - 1. Design: Flush panel
 - 2. Core Construction: Manufacturer's standard kraft-paper honeycomb, polystyrene, polyurethane, polyisocyanurate, mineral-board, or vertical steel-stiffener core.
 - a. Fire Door Core: As required to provide fire-protection] ratings indicated.
 - b. Thermal-Rated (Insulated) Doors: Where indicated, provide doors fabricated with thermal-resistance value (R-value) of not less than 6.0 deg F x h x sq. ft./Btu when tested according to ASTM C 1363.
 - 1) Locations: Exterior doors
 - 3. Vertical Edges for Single-Acting Doors: Beveled edge, 1/8 inch in 2 inches (3 mm in 50 mm) or Manufacturer's standard.
 - 4. Top and Bottom Edges: Closed with flush 0.042-inch- (1.0-mm-) thick, end closures or channels of same material as face sheets.
 - 5. Tolerances: SDI 117, "Manufacturing Tolerances for Standard Steel Doors and Frames."
- B. Interior & Exterior Doors: Face sheets fabricated from metallic coated steel sheet. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:
 - 1. Level 3 and Physical Performance Level A (Extra Heavy Duty), Model 2 (Seamless)
 - 2. Fabricate Exterior Doors from Galvanized sheet steel.
 - 3. Fabricate Exterior Doors from Galvanized sheet steel as shown in Alternate No.2.
- C. Hardware Reinforcement: ANSI/SDI A250.6.
- D. Vision Lite Systems:

1. Typical Lite frames: Manufacturer's standard kits consisting of glass lite moldings to accommodate glass thickness and size of vision lite indicated.

2.4 STANDARD HOLLOW METAL FRAMES

- A. General: Comply with ANSI/SDI A250.8.
- B. Interior & Exterior Frames: Fabricated from metallic-coated steel sheet.
 1. Fabricate frames with mitered or coped corners.
 2. Fabricate frames as full profile welded unless otherwise indicated.
 3. Frames for Level 3 Steel Doors: 0.053-inch- (1.3-mm-) thick steel sheet.
 4. Fabricate Exterior Frames from galvanized sheet steel.
 5. Fabricate Interior Frames from galvanized sheet steel as indicated in Alternate No.2.
- C. Hardware Reinforcement: ANSI/SDI A250.6.

2.5 FRAME ANCHORS

- A. Jamb Anchors:
 1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than **0.042 inch (1.0 mm)** thick, with corrugated or perforated straps not less than **2 inches (50 mm)** wide by **10 inches (250 mm)** long; or wire anchors not less than **0.177 inch (4.5 mm)** thick.
 2. Postinstalled Expansion Type for In-Place Concrete or Masonry: Minimum **3/8-inch-(9.5-mm-)** diameter bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.
- B. Floor Anchors: Formed from same material as frames, not less than 0.042 inch (1.0 mm) thick, and as follows:
 1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.
 2. Separate Topping Concrete Slabs: Adjustable-type anchors with extension clips, allowing not less than 2-inch (50-mm) height adjustment. Terminate bottom of frames at finish floor surface.

2.6 STOPS AND MOLDINGS

- A. Moldings for Glazed Lites in Doors: Minimum 0.032 inch (0.8 mm) thick, same material as door face sheet.
- B. Fixed Frame Moldings: Formed integral with hollow metal frames, a minimum of 5/8 inch (16 mm) high unless otherwise indicated.
- C. Loose Stops for Glazed Lites in Frames: Minimum 0.032 inch (0.8 mm) thick, same material as frames.

- D. Terminated Stops: Where indicated, terminate stops **6 inches (152 mm)** above finish floor with a **45-degree** angle cut, and close open end of stop with steel sheet closure. Cover opening in extension of frame with welded-steel filler plate, with welds ground smooth and flush with frame.

2.7 ACCESSORIES

- A. Mullions and Transom Bars: Join to adjacent members by welding or rigid mechanical anchors.
- B. Ceiling Struts: Minimum 1/4-inch-thick by 1-inch- (6.4-mm-thick by 25.4-mm-) wide steel.
- C. Grout Guards: Formed from same material as frames, not less than **0.016 inch (0.4 mm)** thick.

2.8 FABRICATION

- A. Tolerances: Fabricate hollow metal work to tolerances indicated in SDI 117.
- B. Hollow Metal Doors:
 - 1. Exterior Doors: Provide weep-hole openings in bottom of exterior doors. Seal joints in top edges of doors against water penetration.
 - 2. Glazed Lites: Factory cut openings in doors.
- C. Hollow Metal Frames: Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
 - 1. Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.
 - 2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
 - 3. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
 - 4. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.
 - 5. Jamb Anchors: Provide number and spacing of anchors as follows:
 - a. Masonry Type: Locate anchors not more than **18 inches (457 mm)** from top and bottom of frame. Space anchors not more than **32 inches (813 mm)** o.c. and as follows:
 - 1) Two anchors per jamb up to **60 inches (1524 mm)** high.
 - 2) Three anchors per jamb from **60 to 90 inches (1524 to 2286 mm)** high.
 - 3) Four anchors per jamb from **90 to 120 inches (2286 to 3048 mm)** high.
 - 4) Four anchors per jamb plus 1 additional anchor per jamb for each **24 inches (610 mm)** or fraction thereof above **120 inches (3048 mm)** high.
 - b. Postinstalled Expansion Type: Locate anchors not more than **6 inches (152 mm)** from top and bottom of frame. Space anchors not more than **26 inches (660 mm)** o.c.

6. Door Silencers: Except on weather-stripped doors, drill stops to receive door silencers.
 - a. Single-Door Frames: Three door silencers.
 - b. Double-Door Frames: Two door silencers.
- D. Hardware Preparation: Factory prepare hollow metal work to receive templated mortised hardware according to the Door Hardware Schedule and templates furnished as specified in Division 08 Section "Door Hardware."
 1. Locate hardware as indicated, or if not indicated, according to ANSI/SDI A250.8.
 2. Reinforce doors and frames to receive nontemplated, mortised and surface-mounted door hardware.
 3. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metal work for hardware.
 4. Coordinate locations of conduit and wiring boxes for electrical connections with Division 26 electrical Sections.
- E. Stops and Moldings: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints.
 1. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of hollow metal work.
 2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
 3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.
 4. Provide loose stops and moldings on inside of hollow metal work.
 5. Coordinate rabbet width between fixed and removable stops with type of glazing and type of installation indicated.

2.9 STEEL FINISHES

- A. Prime Finish: Apply manufacturer's standard primer immediately after cleaning and pretreating.
 1. Shop Primer: ANSI/SDI A250.10.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Hollow Metal Frames: Comply with ANSI/SDI A250.11.
 1. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
 - a. At fire-protection-rated openings, install frames according to NFPA 80.

- b. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
 - c. Install frames with removable glazing stops located on secure side of opening.
 - d. Install door silencers in frames before grouting.
 - e. Remove temporary braces necessary for installation only after frames have been properly set and secured.
 - f. Check plumbness, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
 - g. Field apply bituminous coating to backs of frames that are filled with grout containing antifreezing agents.
 2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with postinstalled expansion anchors.
 - a. Floor anchors may be set with powder-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.
 3. Metal-Stud Partitions: Solidly pack mineral-fiber insulation behind frames.
 4. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.
 5. Concrete Walls: Solidly fill space between frames and concrete with grout. Take precautions, including bracing frames, to ensure that frames are not deformed or damaged by grout forces.
 6. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
 7. In-Place Gypsum Board Partitions: Secure frames in place with postinstalled expansion anchors through floor anchors at each jamb. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
 8. Ceiling Struts: Extend struts vertically from top of frame at each jamb to overhead structural supports or substrates above frame unless frame is anchored to masonry or to other structural support at each jamb. Bend top of struts to provide flush contact for securing to supporting construction. Provide adjustable wedged or bolted anchorage to frame jamb members.
 9. Installation Tolerances: Adjust hollow metal door frames for squareness, alignment, twist, and plumb to the following tolerances:
 - a. Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 - b. Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.
 - c. Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - d. Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs at floor.
- B. Hollow Metal Doors: Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.
1. Non-Fire-Rated Standard Steel Doors:

- a. Jambs and Head: 1/8 inch (3 mm) plus or minus 1/16 inch (1.6 mm).
 - b. Between Edges of Pairs of Doors: 1/8 inch (3 mm) plus or minus 1/16 inch (1.6 mm).
 - c. Between Bottom of Door and Top of Threshold: Maximum 3/8 inch (9.5 mm).
 - d. Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum 3/4 inch (19 mm).
 2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
 3. Smoke-Control Doors: Install doors according to [NFPA 105] [UBC Standard 7-2].
- C. Glazing: Comply with installation requirements in Division 08 Section "Glazing" and with hollow metal manufacturer's written instructions.
1. Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches (230 mm) o.c. and not more than 2 inches (50 mm) o.c. from each corner.

3.2 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.
- B. 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.
- C. Metallic-Coated Surfaces: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

END OF SECTION 081113

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SECTION 083113 - ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Ceiling access doors and frames

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

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated or comparable product by one of the following:
1. Access Panel Solutions.
 2. Acudor Products, Inc.
 3. Alfab, Inc.
 4. Babcock-Davis.
 5. Cendrex Inc.
 6. Elmdor/Stoneman Manufacturing Co.; Div. of Acorn Engineering Co.
 7. Jensen Industries; Div. of Broan-Nutone, LLC.
 8. J. L. Industries, Inc.; Div. of Activar Construction Products Group.
 9. Karp Associates, Inc.
 10. Larsen's Manufacturing Company.
 11. Maxam Metal Products Limited.
 12. Metropolitan Door Industries Corp.
 13. MIFAB, Inc.
 14. Milcor Inc.
 15. Williams Bros. Corporation of America (The).
- B. Source Limitations: Obtain each type of access door and frame from single source from single manufacturer.

- C. For projects with multiple access doors, consider providing a schedule, or distinguish between units by giving each a number designation and creating an additional set of requirements for each variation.
- D. Flush, uninsulated, Non-Rated Fully Gasketed Stainless Steel Access Doors and Frames:
 - 1. Steel stainless sheet with No. 4 finish. 24" x 24" unless otherwise note.
 - 2. Locations: Vivarium gypsum board wall and ceiling surfaces.
 - 3. Door: Stainless steel. Sizes as indicated.
 - 4. Frame: Minimum 0.060-inch- thick sheet metal with 1-inch wide surface-mounted trim.
 - 5. Hinges: Concealed pin type.
 - 6. Gasketing: 1/8-inch x 3/8-inch closed cell neoprene gasket.
 - 7. Automatic Closer: Spring type.
 - 8. Latch: Screwdriver operated cam latch.
 - 9. Basis of Design: Acudor Products AS-9000 Series – "Recessed for Drywall"

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. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063-T6.
- F. Aluminum-Alloy Rolled Tread Plate: ASTM B 632/B 632M, Alloy 6061-T6.
- G. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A 666, Type 304; with minimum sheet thickness indicated representing specified thickness according to ASTM A 480/A 480M.
- H. Aluminum Sheet: ASTM B 209 (ASTM B 209M), alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than strength and durability properties of Alloy 5005-H15; with minimum sheet thickness according to ANSI H35.2 (ANSI H35.2M).
- I. Frame Anchors: Same type as door face.
- J. 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.
- F. Extruded Aluminum: After fabrication, apply manufacturer's standard protective coating on aluminum that will come in contact with concrete.

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.
 - 2. Factory Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat, with a minimum dry-film thickness of 1 mil (0.025 mm) for topcoat.
- E. Aluminum Finishes:

1. Mill finish.
2. Clear Anodic Finish: AAMA 611, [AA-M12C22A41, Class I, 0.018 mm] [AA-M12C22A31, Class II, 0.010 mm] or thicker.

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.

END OF SECTION 083113

SECTION 087100 - DOOR HARDWARE

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Mechanical door hardware for the following:
 - a. Swinging doors.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings:
 - 1. Provide a copy with each hardware schedule submitted.
 - 2. Electrical components shall be listed by opening in hardware submittals.
 - 3. Submit details of interface between electrified door hardware and the following:
 - a. Fire alarm system
 - b. Access control system
 - c. Security system
 - d. Building control system
 - 4. Provide description of each electrified door hardware function, including location, sequence of operation and interface with other building control systems: include description of component functions that occur in the following situations:
 - a. Authorized person wants to enter
 - b. Authorized person wants to exit
 - c. Unauthorized person wants to enter
 - d. Unauthorized person wants to exit
 - 5. Provide elevation drawings of electronic hardware and systems identifying locations of system components with respect to their placement in door opening.
 - 6. Indicate mounting heights and locations of electronic components listed by opening in hardware submittals.
- C. Wiring Diagrams:
 - 1. Submit detail wiring for power, signal and control systems for each opening that requires electrified hardware, except openings where only magnetic hold-opens are specified. Differentiate between manufacturer-installed and field-installed wiring. Include the following:
 - a. System schematic
 - b. Point-to-point wiring diagram
 - c. Riser diagram
 - d. Elevation of each door
- D. Samples: For each exposed product and for each color and texture specified.

E. Other Action Submittals:

1. Door Hardware Schedule: Prepared by or under the supervision of Installer, 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.
 - a. Format: Use same scheduling sequence and format and use same door numbers as in the Contract Documents.
 - b. Content: Include the following information:
 - 1) Identification number, location, hand, fire rating, size, and material of each door and frame.
 - 2) Locations of each door hardware set, cross-referenced to Drawings on floor plans and to door and frame schedule.
 - 3) Complete designations, including name and manufacturer, type, style, function, size, quantity, function, and finish of each door hardware product.
 - 4) Description of electrified door hardware sequences of operation and interfaces with other building control systems.
2. Keying Schedule: All keying shall be done by NC State University Lock Shop, zero bitted cores and uncut key blanks shall be sent to the lock shop.
3. Operating and Maintenance Manuals: Provide manufacturers hardware, software, operating and maintenance manuals for each item compiling the complete door hardware installation as required in Division 01, Closeout Submittals. Include final hardware and keying schedule.
4. Warranties and Maintenance: Special warranties and maintenance agreements specified in this Section.

1.3 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 experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project and who is currently certified by DHI as follows:
 1. For door hardware, an Architectural Hardware Consultant (AHC) who is also an Electrified Hardware Consultant (EHC).
- C. Source Limitations: Provide electrified door hardware from same manufacturer as mechanical door hardware, unless otherwise indicated. Manufacturers that perform electrical modifications and that are listed by a testing and inspecting agency acceptable to authorities having jurisdiction are acceptable.

- D. Means of Egress Doors: Latches do not require more than 15 lbf (67 N) to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.
- E. Accessibility Requirements: For door hardware on doors in an accessible route, comply with the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines, ICC/ANSI A117.1, 2012 NC Building Code .
 - 1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf (22.2 N).
 - 2. Comply with the following maximum opening-force requirements:
 - a. Interior, Non-Fire-Rated Hinged Doors: 5 lbf (22.2 N) applied perpendicular to door.
 - 3. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than 1/2 inch (13 mm) high.
 - 4. Adjust door closer sweep periods so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 3 inches (75 mm) from the latch, measured to the leading edge of the door.
- F. Keying Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver keys and permanent cores to Owner by registered mail or overnight package service.

1.5 COORDINATION

- A. Installation Templates: Distribute for doors, frames, and other work specified to be factory prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.
- B. Security: Coordinate installation of door hardware, keying, and access control with University's security consultant.
- C. Existing Openings: Where hardware components are scheduled for application to existing construction or where modifications to existing door hardware are required, field verify existing conditions and coordinate installation of door hardware to suit opening conditions and to provide proper door operation.

1.6 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. Warranty Period: Three years from date of Final Acceptance, unless otherwise indicated.
 - a. Manual Closers: 10years from date of Final Acceptance.

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.
 - 1. Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and products equivalent in function and comparable in quality to named products.
 - 2. Named Manufacturers' Products: Manufacturer and product designation are listed for each door hardware type required for the purpose of establishing minimum requirements. Manufacturers' names are abbreviated in Part 3 "Door Hardware Schedule" Article.
 - 3. References to BHMA Designations: Provide products complying with these designations and requirements for description, quality, and function.

2.2 HINGES

- A. Hinges: BHMA A156.1. Provide template-produced hinges for hinges installed on hollow-metal doors and hollow-metal frames.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. IVES Hardware; an Ingersoll-Rand company.
 - b. McKinney Products Company; an ASSA ABLOY Group company.
 - c. Stanley Commercial Hardware; Div. of The Stanley Works.

2.3 MECHANICAL LOCKS AND LATCHES

- A. Cylindrical Lock 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.
 - 1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
 - 2. Aluminum-Frame Strike Box: Manufacturer's special strike box fabricated for aluminum framing.
 - 3. Standards: Comply with BHMA A156.13.
- B. Mortise Locks: BHMA A156.13; Operational Grade 1; stamped steel case with steel or brass parts; Series 1000, UL listed.
 - 1. Product by one of the following:
 - a. Best Access Systems; Div. of Stanley Security Solutions, Inc.
 - b. Corbin Russwin Architectural Hardware; an ASSA ABLOY Group company.
 - c. Schlage Commercial Lock Division; an Ingersoll-Rand company.
 - 2. Lever Design: match cylindrical lever set styles.

2.4 LOCK CYLINDERS

- A. Lock Cylinders: Tumbler type, constructed from brass or bronze, stainless steel, or nickel silver.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Schlage AL series with removable core x SAT x 626, or comparable product by one of the following:
 - a. Best Access Systems; Div. of Stanley Security Solutions, Inc.
 - b. Corbin Russwin Architectural Hardware; an ASSA ABLOY Group company.
 - c. Schlage Commercial Lock Division; an Ingersoll-Rand company.
- B. NC State Requirements for Keying System and Cylinders:
 - 1. Keyway for additional cylinders will match the existing keyway. NC State uses the small format interchangeable core system for grandmaster keying. All lock-sets and lock cylinders shall accept 7 pin small format interchangeable cores only.
 - 2. Hardware shall be shipped with temporary construction cores.
 - 3. Permanent cylinder cores will be delivered to the NC State Lock Shop. NC State will remove the construction cores upon final keying of the building prior to acceptance.

2.5 KEYING

- A. Keying System: Factory registered, complying with guidelines in BHMA A156.28, Appendix A. Incorporate decisions made in keying conference.
 - 1. Existing System:
 - a. Master key or grand master key locks to Owner's existing system.
- B. Keys: Nickel silver
 - 1. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:
 - a. Notation: Information to be furnished by Owner.
 - 2. Quantity: In addition to one extra key blank for each lock, provide the following:
 - a. Cylinder Change Keys: Three.
 - b. Master Keys: Five.
 - c. Grand Master Keys: Five.
 - d. Great-Grand Master Keys: Five.

2.6 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 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.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide product LCN 4000 and 4100 series, or comparable product by one of the following:

- a. DORMA Architectural Hardware; Member of The DORMA Group North America.
- b. LCN Closers; an Ingersoll-Rand company.
- c. Norton Door Controls; an ASSA ABLOY Group company.
2. Opening Force: Opening pressure shall be adjustable between 8 pounds and 15 pounds.
3. Cover: Provide removable cover with lacquer finish to allow adjustments.
4. Closers shall be installed on room-side of doors and shall not be visible from corridors, lobbies, or other public spaces.

2.7 MANUAL FLUSH BOLTS

- A. Manual Flush Bolts: BHMA A156.16; minimum 3/4-inch (19-mm) throw; designed for mortising into door edge.
 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on schedule or comparable product by one of the following:
 - a. Glynn-Johnson
 - b. Ives
 - c. Rockwood

2.8 MECHANICAL STOPS AND HOLDERS

- A. Wall- and Floor-Mounted Stops: BHMA A156.16; aluminum base metal.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Glynn-Johnson.
 - b. IVES Hardware; an Ingersoll-Rand company.
 - c. Rockwood Manufacturing Company.
 2. Provide convex rubber bumper with concealed fastener. Coordinate installation with new partition framing for blocking.

2.9 OVERHEAD STOPS AND HOLDERS

- A. Overhead Stops and Holders: BHMA A156.8.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. IVES Hardware; an Ingersoll-Rand company.
 - b. Glynn-Johnson; an Ingersoll-Rand company.
 - c. Rockwood Manufacturing Company.

2.10 OPERATING TRIM

- A. Standard: BHMA A156.6 and as illustrated..
- B. Materials: Fabricate from polished stainless steel.

C. Manufacturers:

1. IVES Hardware; an Ingersoll-Rand Company (IVS).
2. Glynn-Johnson
3. Rockwood Manufacturing Company (RM).

2.11 METAL PROTECTIVE TRIM UNITS

A. Metal Protective Trim Units: BHMA A156.6; fabricated from 0.050-inch- (1.3-mm-) thick stainless steel; with manufacturer's standard machine or self-tapping screw fasteners.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Don-Jo Mfg., Inc.
 - b. IVES Hardware; an Ingersoll-Rand company.
 - c. Rockwood Manufacturing Company.

2.12 FABRICATION

A. Fasteners: Provide door hardware manufactured to comply with published templates prepared for machine, wood, 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.

1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.
2. Fire-Rated Applications:
 - a. Wood or Machine Screws: For the following:
 - 1) Hinges mortised to doors or frames; use threaded-to-the-head wood screws for wood doors and frames.
 - 2) Strike plates to frames.
 - 3) Closers to doors and frames.
 - b. Steel Through Bolts: For the following unless door blocking is provided:
 - 1) Surface hinges to doors.
 - 2) Closers to doors and frames.
 - 3) Surface-mounted exit devices.
3. Spacers or Sex Bolts: For through bolting of hollow-metal doors.
4. Fasteners for Wood Doors: Comply with requirements in DHI WDHS.2, "Recommended Fasteners for Wood Doors."

5. Gasketing Fasteners: Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.

2.13 FINISHES

- A. Provide finishes complying with BHMA A156.18 as indicated in door hardware schedule.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance.
- B. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

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. Wood Doors: Comply with DHI WDHS.5 "Recommended Hardware Reinforcement Locations for Mineral Core Wood Flush Doors."
- C. Provide solid wood blocking for door mounted hardware, through-bolts are not acceptable.
- D. All hinge installation screws shall be predrilled to avoid splitting the wood door stile.
- E. Mounting Heights: Mount door hardware units at heights to comply with the following unless otherwise indicated or required to comply with governing regulations.
 1. Standard Steel Doors and Frames: ANSI/SDI A250.8.
 2. Custom Steel Doors and Frames: HMMA 831.
 3. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
- F. 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 specified in Division 09 Sections. 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.
- G. 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) of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.
- H. Lock Cylinders: Install construction cores to secure building and areas during construction period.
- I. Boxed Power Supplies: Locate power supplies as indicated or, if not indicated, above accessible ceilings. Verify location with Architect.
1. Configuration: Provide least number of power supplies required to adequately serve doors with electrified door hardware.
- J. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they will impede traffic.
- K. 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 CLEANING AND PROTECTION

- A. Clean adjacent surfaces soiled by door hardware installation.
- B. Clean operating items as necessary to restore proper function and finish.
- C. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain door hardware and door hardware finishes. Refer to Division 01 Section "Demonstration and Training."

3.5 DOOR HARDWARE SCHEDULE

Door Hardware Set No. 1

3 Hinges	MC	T4A3386	US32D
1 Closer/Hold Open	LC	4040XP-3049CNS	AL
3 Door Silencer	ROC	608	Grey

1 12" Kick Plate	Pull side	1" LTDW	630
1 36" Armor Plate	Push side	1" LTDW	630
1 Protector Bar	ROC	SD1260	32D
1 Lockset (Classroom)	Best	45H7R15H	626
1 Cylinder	SC	AS REQUIRED x CONST CORE	626
1 Permanent Core	SC	AS REQUIRED x CONST CORE	626
1 Door Lite Cover	Life Science Products	Door Lite Cover	630
1 Door Sweep	NG	200SSS	630
1 Wall Stop (Door 105, 111)	RO	409	US26D

Door Hardware Set No. 2

3 Hinges	MC	T4A3386	US32D
1 Closer	LC	4110 REG	AL
3 Door Silencer	ROC	608	Grey
1 Lockset (Storeroom)	Best	45H7D15H	626
1 Cylinder	SC	AS REQUIRED x CONST CORE	626
1 Permanent Core	SC	AS REQUIRED x CONST CORE	626
1 Set Weatherstrip	PE	303AS	AL
1 Rain Drip	PE	346D	DB AL
1 Door Bottom Sweep	PE	3452DNB	DB AL
1 Threshold	PE2550A	255A	AL

Door Hardware Set No. 3

6 Hinges	MC	T4A3386	US32D
2 Closer	LC	4040XP	AL
2 Door Silencer	GL	GJ64	Grey
2 12" Kick Plate	Pull side	1" LTDW	630
2 36" Armor Plate	Push side	1" LTDW	630
2 Push Plate	IVE	8200 4" x 16"	630
2 Door Pull	IVE	8302-8 6" x 16"	630
2 Door Sweep	NG	200SSS	630
2 Wall Stop	RO	409	US26D

Door Hardware Set No. 4

3 Hinges	MC	T4A3386	US32D
1 Closer	LC	4040XP	AL
3 Door Silencer	ROC	608	Grey
2 12" Kick Plate	Push/pull sides	1" LTDW	630
1 Lockset (Classroom)	Best	45H7R15H	626
1 Cylinder	SC	AS REQUIRED x CONST CORE	626
1 Permanent Core	SC	AS REQUIRED x	626

		CONST CORE	
1 Wall Stop	RO	409	US26D
Door Hardware Set No. 5			
3 Hinges	MC	TA2714 4 1/2 x 4 1/2	US32D
1 Closer	LC	4040XP	AL
1 Door Silencer	GL	GJ64	Grey
2 12" Kick Plate	Pull side	1" LTDW	630
1 Push Plate	IVE	8200 4" x 16"	630
1 Door Sweep	NG	200SSS	630
1 Door Pull	IVE	8302-8 6" x 16"	630
Door Hardware Set No. 6			
6 Hinges – Swing Clear	MC	T4A3395	US32D
2 Door Silencer	GL	GJ64	Grey
2 12" Kick Plate	Pull side	1" LTDW	630
2 36" Armor Plate	Push side	1" LTDW	630
1 Lockset (Classroom)	Best	45H7R15H	626
		AS REQUIRED x	
1 Cylinder	SC	CONST CORE	626
1 Permanent Core	SC	AS REQUIRED x	626
		CONST CORE	
1 Flush Bolt	RO	555 12"	US26D
1 Flush Bolt	RO	555 18"	US26D
1 Dust Proof Strike	RO	570 DPS	US26D
1 Door Stop	RO	474	626
1 Overhead Stop (Inactive leaf)	GJ	90S	US32D
Door Hardware Set No. 6A			
6 Hinges – Swing Clear	MC	T4A3395	US32D
2 Door Silencer	GL	GJ64	Grey
2 12" Kick Plate	Pull side	1" LTDW	630
2 36" Armor Plate	Push side	1" LTDW	630
1 Lockset (Classroom)	Best	45H7R15H	626
		AS REQUIRED x	
1 Cylinder	SC	CONST CORE	626
1 Permanent Core	SC	AS REQUIRED x	626
		CONST CORE	
1 Flush Bolt	RO	555 12"	US26D
1 Flush Bolt	RO	555 18"	US26D
1 Dust Proof Strike	RO	570 DPS	US26D
1 Wall Stop	RO	409	626
Door Hardware Set No. 7			
6 Hinges	MC	T4A3386	US32D

2 Closer	LC	4110 REG	AL
2 Door Silencer	ROC	608	Grey
1 Lockset (Classroom)	Best	45H7R15H	626
1 Cylinder	SC	AS REQUIRED x CONST CORE	626
1 Permanent Core	SC	AS REQUIRED x CONST CORE	626
1 Flush Bolt	RO	555 12"	US26D
1 Flush Bolt	RO	555 18"	US26D
1 Dust Proof Strike	RO	570 DPS	US26D
1 Set Weatherstrip	PE	303AS	AL
1 Threshold	PE	2550A	AL
1 Door Bottom Sweep	PE	293100DVD	DB AL
1 Split Astragal	PE	303DV	DB
2 36" Armor Plate	Push side	1" LTDW	630

Door Hardware Set No. 8

6 Hinges	MC	T4A3386	US32D
2 Closer	LC	4110 REG	AL
2 Door Silencer	ROC	608	Grey
2 12" Kick Plate	Push sides	1" LTDW	630
1 Lockset (Storeroom)	Best	45H7D15H	626
1 Cylinder	SC	AS REQUIRED x CONST CORE	626
1 Permanent Core	SC	AS REQUIRED x CONST CORE	626
2 Overhead Stops	GJ	90S	US32D
1 Flush Bolt	RO	555 12"	US26D
1 Flush Bolt	RO	555 18"	US26D
1 Dust Proof Strike	RO	570 DPS	US26D
1 Set Weatherstrip	PE	303AS	AL
1 Threshold	PE	2550A	AL
1 Door Bottom Sweep	PE	293100DVD	DB AL
1 Split Astragal	PE	303DV	DB
1 Rain Drip	PE	346D	DB AL

Door Hardware Set No. 9

3 Hinges	MC	T4A3386	US32D
1 Closer	LC	4040XP	AL
3 Door Silencer	ROC	608	Grey
2 12" Kick Plate	Push/pull sides	1" LTDW	630
1 Lockset (Privacy)	Best	45H7L15H	626
1 Cylinder	SC	AS REQUIRED x CONST CORE	626
1 Permanent Core	SC	AS REQUIRED x CONST CORE	626

1 Overhead Stop	GJ	90S	US32D
Door Hardware Set No. 10			
3 Hinges	MC	T4A3386	US32D
1 Closer	LC	4040XP	AL
3 Door Silencer	ROC	608	Grey
2 12" Kick Plate	Push/pull sides	1" LTDW	630
1 Lockset (Classroom)	Best	45H7R15H	626
1 Cylinder	SC	AS REQUIRED x CONST CORE	626
1 Permanent Core	SC	AS REQUIRED x CONST CORE	626
1 Door Sweep	NG	200SSS	630
1 Wall Stop	RO	409	US26D
Door Hardware Set No. 11			
4 Hinges	MC	T4A3386	US32D
4 Hinges – Swing Clear	MC	T4A3395	US32D
2 Door Silencer	ROC	608	Grey
2 12" Kick Plate	Pull sides	1" LTDW	630
2 36" Armor Plate	Push side	1" LTDW	630
1 Lockset (Passage)	Best	45H7N15H	626
1 Cylinder	SC	AS REQUIRED x CONST CORE	626
1 Permanent Core	SC	AS REQUIRED x CONST CORE	626
2 Door Stop	RO	474	626
1 Surface Bolt, Heavy Duty, 18"	IV	253	626
1 Surface Bolt, Heavy Duty, Custom – 60" or spring load- ed with chain	IV	253	626
1 Split Astragal	PE	305CN	US26D
2 Door Edge Guard	306B	US32D	RO
1 Protector Bar	ROC	SD1260	32D
1 Dust Proof Strike	RO	570 DPS	US26D

END OF SECTION 087100

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SECTION 088000 - GLAZING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:
 - 1. Doors.
 - 2. Interior borrowed lites.

1.2 PRECONSTRUCTION TESTING

- A. Preconstruction Adhesion and Compatibility Testing: Test each glazing material type, tape sealant, gasket, glazing accessory, and glass-framing member for adhesion to and compatibility with elastomeric glazing sealants.
 - 1. Testing will not be required if data are submitted based on previous testing of current sealant products and glazing materials matching those submitted.

1.3 SUBMITTALS

- A. Product Data: For each glass product and glazing material indicated.
- B. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.
- C. Delegated-Design Submittal: For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- D. Preconstruction adhesion and compatibility test report.

1.4 QUALITY ASSURANCE

- A. Safety Glazing Labeling: Provide Category II products which comply with test requirements of 16 CFR 1201 and ANSI Z97.1. Permanently mark glazing with certification label of the SGCC. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

PART 2 - PRODUCTS

2.1 GLASS PRODUCTS, GENERAL

- A. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass lites in thicknesses as needed to comply with requirements indicated.
- B. Strength: Where fully tempered glass is indicated, provide Kind FT heat-treated float glass.

2.2 GLASS PRODUCTS

- A. Heat-Treated Float Glass: ASTM C 1048; Type I; Quality-Q3; Class I (clear) unless otherwise indicated; of kind and condition indicated.
 - 1. Products: Subject to compliance with requirements, provide products made by one of the following:
 - a. AFG Industries, Inc.
 - b. Guardian Industries Corporation
 - c. HGP Industries, Inc.
 - d. Viracon, Inc.
 - e. PPG Performance Glazings

2.3 GLAZING GASKETS

- A. Dense Compression Gaskets: Molded or extruded gaskets of profile and hardness required to maintain watertight seal, made from one of the following:
 - 1. Neoprene complying with ASTM C 864.
 - 2. EPDM complying with ASTM C 864.
 - 3. Silicone complying with ASTM C 1115.
 - 4. Thermoplastic polyolefin rubber complying with ASTM C 1115.
- B. Soft Compression Gaskets: Extruded or molded, closed-cell, integral-skinned neoprene, EPDM, silicone, or thermoplastic polyolefin rubber gaskets complying with ASTM C 509, Type II, black; of profile and hardness required to maintain watertight seal.
 - 1. Application: Use where soft compression gaskets will be compressed by inserting dense compression gaskets on opposite side of glazing or pressure applied by means of pressure-glazing stops on opposite side of glazing.

2.4 GLAZING TAPES

- A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C 1281 and AAMA 800 for products indicated below:

1. AAMA 804.3 tape, where indicated.
 2. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
 3. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.
- B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:
1. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.
 2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.5 MISCELLANEOUS GLAZING MATERIALS

- A. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
- B. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
- C. Spacers: Elastomeric blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
- D. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).
- E. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.
- F. Perimeter Insulation for Fire-Resistive Glazing: Product that is approved by testing agency that listed and labeled fire-resistant glazing product with which it is used for application and fire-protection rating indicated.
- G. For windows scheduled to receive “red glazing” provide laminated dyed color polyester film designed for the control of specific spectral light and transmission levels and heat treated with UV inhibitors laminated with an acrylic adhesive for applications to glass and coated with a scratch resistant coating (AMMTM D1044).
1. Basis of Design: RC-3 Rose-Chocolate by Light Gard

2.6 MONOLITHIC-GLASS TYPES

- A. Glass Type S-1: fully tempered clear float glass.
1. Thickness: 6.0 mm
 2. Provide safety glazing labeling.

PART 3 - EXECUTION

3.1 GLAZING, GENERAL

- A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.
- B. Adjust glazing channel dimensions as required by Project conditions during installation to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.
- C. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.
- D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.
- E. 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.
- F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
- G. Provide spacers for glass lites where length plus width is larger than 50 inches (1270 mm).
- H. 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 TAPE GLAZING

- A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.
- B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.
- C. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.
- D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.
- E. Apply heel bead of elastomeric sealant.

- F. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.
- G. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.3 GASKET GLAZING (DRY)

- A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
- B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.
- C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
- D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
- E. Install gaskets so they protrude past face of glazing stops.

3.4 SEALANT GLAZING (WET)

- A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.
- B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.
- C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.5 CLEANING AND PROTECTION

- A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels and clean surfaces.

- B. Protect glass from contact with contaminating substances resulting from construction operations. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer.
- C. 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; remove as recommended in writing by glass manufacturer.
- D. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.

END OF SECTION 088000

SECTION 08 9000 - LOUVERS AND VENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Stationary wall louvers.

1.2 REFERENCES

- A. AAMA 2604 – High Performance Organic Coatings on Architectural Extrusions and Panels.
- B. AAMA 2605 - High Performance Organic Coatings on Architectural Extrusions and Panels.
- C. AMCA 500 - Test Methods for Louvers, Dampers and Shutters.
- D. AMCA 511 - Certified Ratings Program for Air Control Devices.
- E. ASCE 7 - Minimum Design Loads for Buildings and Other Structures.
- F. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- G. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
- H. ASTM D822 - Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings
- I. ASTM D4214 - Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films.
- J. ASTM D2244 - Standard Test Method for Calculation of Color Differences From Instrumentally Measured Color Coordinates.

1.3 SUBMITTALS

- A. Submit under provisions of Section 013300.
- B. Product Data: For each product to be used, including:
 - 1. Manufacturer's product data including performance data.
 - 2. Preparation instructions and recommendations.
 - 3. Storage and handling requirements and recommendations.
 - 4. Installation methods.
- C. Shop Drawings:
 - 1. Submit shop drawings indicating materials, construction, dimensions, accessories, and installation details.

- D. Samples: Submit sample of louver to show frame, blades, bird screen, gutters, downspouts, vertical supports, sill, accessories, finish, and color.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
 - 1. The manufacturer shall have implemented the management of quality objectives, continual improvement, and monitoring of customer satisfaction to assure that customer needs and expectations are met.
 - 2. Manufacturer shall be International Organization for Standardization (ISO) 9000 accredited.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Store materials in a dry area indoors, protected from damage and in accordance with manufacturer's instructions.
- C. Handling: Protect materials and finishes during handling and installation to prevent damage.
- D. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.6 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.

1.7 WARRANTY

- A. Manufacturer shall provide standard limited warranty for louver systems for a period of one year (12 months) from date of installation, no more than 18 months after shipment from manufacturing plant. When notified in writing from the Owner of a manufacturing defect, manufacturer shall promptly correct deficiencies without cost to the Owner.
- B. Manufacturer shall provide 20 year limited warranty for fluoropolymer-based finish on extruded aluminum substrates.
 - 1. Finish coating shall not peel, blister, chip, crack or check.
 - 2. Chalking, fading or erosion of finish when measured by the following tests:
 - a. Finish coating shall not chalk in excess of 8 numerical ratings when measured in accordance with ASTM D4214.
 - b. Finish coating shall not change color or fade in excess of 5 NBS units as determined by ASTM D2244 and ASTM D822.
 - c. Finish coating shall not erode at a rate in excess of .01 mils/year as determined by Florida test sample.

PART 2 PRODUCTS

LOUVERS AND VENTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following.
- B. Basis of Design Product: ELF6375X, Ruskin Company; 3900 Dr. Greaves Road, Kansas City, Missouri 64030. Tel: (816) 761-7476.
 - 1. Air Balance Inc.; a Mestek company.
 - 2. Air Flow Company, Inc.
 - 3. Airolite Company, LLC (The).
 - 4. All-Lite Architectural Products.
 - 5. American Warming and Ventilating, Inc.; a Mestek company.
 - 6. Arrow United Industries; a division of Mestek, Inc.
 - 7. Construction Specialties, Inc.
 - 8. Greenheck Fan Corporation.
 - 9. Industrial Louvers, Inc.
 - 10. NCA Manufacturing, Inc.
 - 11. Nystrom Building Products.
 - 12. Reliable Products, Inc.
 - 13. Ruskin Company; Tomkins PLC.
 - 14. United Enertech Corp.

2.2 STATIONARY LOUVER

- A. Fabrication: Hidden support style.
 - 1. Frame:
 - a. Frame Depth: 6 inches (152 mm), nominal.
 - b. Wall Thickness: 0.081 inch (2.1 mm), nominal.
 - c. Material: Extruded aluminum, Alloy 6063-T5
 - 2. Blades:
 - a. Style: Horizontal “J”.
 - b. Material: Formed aluminum, Alloy 6063-T5.
 - c. Wall Thickness: 0.081 inch (2.1 mm), nominal.
 - d. Angle: 37-1/2 degrees.
 - e. Centers: 5-29/32 inches (150 mm), nominal.
 - 3. Gutters: Drain gutter in head frame.
 - 4. Downspouts: Downspouts in jambs to drain head.
 - 5. Sill: Steeply angled integral sill eliminating areas of standing or trapped moisture where mold or mildew may thrive and effect indoor air quality.
 - 6. Fabrication:
 - a. Mullion/Hidden Intermediate Support Style – Design incorporates visible mullions or frames at the perimeter of the louver and at section joints only. Rear-mounted hidden blade supports are utilized where required and do not interrupt the louver blade sightlines. The rear-mounted blade support depth varies depending on louver height and the design windload.
 - 7. Assembly:
 - a. Factory assembled louver components. Welded construction.
- B. Performance Data:
 - 1. Performance Ratings: AMCA licensed.

- a. Based on testing 48 inch by 48 inch (1219 mm by 1219 mm) size unit in accordance with AMCA 500.
 2. Free Area: 55 percent, nominal.
 3. Maximum Recommended Air Flow through Free Area: 1000 feet per minute (306 m/min).
 4. Maximum Recommended Air Flow: 8800 cubic feet per minute (251 cu. m/min).
 5. Maximum Pressure Drop (Intake): .175 inches w.g. (43.58 Pa).
 6. Water Penetration: Maximum of 0.01 ounces per square foot (3.1 g/sm) of free area at an air flow of 1010 feet per minute (306 m/min) free area velocity when tested for 15 minutes.
- C. Design Load: Incorporate structural supports required to withstand wind load of:
1. 20 lb/sf (0.96 kPa).
 2. Per Code.
 3. Louvers shall be factory engineered to withstand the specified seismic loads.
 - a. Minimum design loads shall be calculated to comply with ASCE – 7, or local requirements of Authority Having Jurisdiction.

2.3 ACCESSORIES

- A. Bird Screen:
1. Aluminum: Aluminum, 1/2 inch mesh by 0.063 inch (13 mm mesh by 1.6 mm), intercrimp.
 2. Frame: Removable, rewirable.
- B. Extended Sills:
1. Extruded aluminum, Alloy 6063-T6. Minimum nominal thickness 0.060 inch.

2.4 FINISHES

- A. 70 percent Fluoropolymer-Based Painted Finishes:
1. Coating shall conform to AAMA 2605. Apply coating following cleaning and pretreatment. Cleaning: AA-C12C42R1X.
 2. Standard 2-coat.
- B. Color: Custom to match existing louvers and doors on adjacent Finger Barn buildings.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Inspect areas to receive louvers. Notify the Architect of conditions that would adversely affect the installation or subsequent utilization of the louvers. Do not proceed with installation until unsatisfactory conditions are corrected.
- B. If opening preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

- A. Clean opening thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

- A. Install louvers at locations indicated on the drawings and in accordance with manufacturer's instructions.
- B. Install louvers plumb, level, in plane of wall, and in alignment with adjacent work. See drawings for setback dimension from face of building wall.
- C. The supporting structure shall be designed to accommodate the point loads transferred by the louvers when subject to the design wind loads.
- D. Install joint sealants as specified in Section 07 9200.
- E. Apply field topcoat within 6 months of application of shop prime coat. Apply field topcoat as specified in Section 09 9110.

3.4 CLEANING

- A. Clean louver surfaces in accordance with manufacturer's instructions.
- B. Touch-up, repair or replace damaged products before Final Completion.

END OF SECTION 089000

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SECTION 092216 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Non-load-bearing steel framing systems for interior gypsum board assemblies.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: Provide materials and construction identical to those tested according to ASTM E 119.
- B. STC-Rated Assemblies: Provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413.
- C. Recycled Content of Steel Products: Provide products with average recycled content of steel products such that postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.

2.2 FRAMING SYSTEMS

- A. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
1. Minimum Base-Metal Thickness: 0.033 inch (0.84 mm)
 2. Depth: As indicated on Drawings

2.3 AUXILIARY MATERIALS

- A. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.
- B. Isolation Strip at Exterior Walls: Provide asphalt saturated organic felt or foam gasket.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Installation Standard: ASTM C 754.
 - 1. Gypsum Plaster Assemblies: Also comply with requirements in ASTM C 841 that apply to framing installation.
 - 2. Portland Cement Plaster Assemblies: Also comply with requirements in ASTM C 1063 that apply to framing installation.
 - 3. Gypsum Veneer Plaster Assemblies: Also comply with requirements in ASTM C 844 that apply to framing installation.
 - 4. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.
- B. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
- C. Install bracing at terminations in assemblies.
- D. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.2 INSTALLING FRAMED ASSEMBLIES

- A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
- B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.
- C. Install studs so flanges within framing system point in same direction.
- D. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.
 - 1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
 - 2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
 - a. Install two studs at each jamb unless otherwise indicated.
 - b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch (13-mm) clearance from jamb stud to allow for installation of control joint in finished assembly.

- c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.
- 3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
- 4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.
 - a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
- 5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
- 6. Curved Partitions:
 - a. Bend track to uniform curve and locate straight lengths so they are tangent to arcs.
 - b. Begin and end each arc with a stud, and space intermediate studs equally along arcs. On straight lengths of no fewer than two studs at ends of arcs, place studs 6 inches (150 mm) o.c.
- E. Direct Furring:
 - 1. Screw to wood framing.
 - 2. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches (610 mm) o.c.
- F. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch (3 mm) from the plane formed by faces of adjacent framing.

END OF SECTION 092216

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SECTION 092900 - GYPSUM BOARD

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interior gypsum board.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.
1. STC ratings: As indicated on drawings or minimum 50.

2.2 INTERIOR GYPSUM BOARD

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. American Gypsum.
2. CertainTeed Corp.
3. Georgia-Pacific Gypsum LLC.
4. Lafarge North America Inc.
5. National Gypsum Company.
6. PABCO Gypsum.
7. Temple-Inland.
8. USG Corporation.

- B. Abuse-Resistant Gypsum Wallboard: ASTM C 36, manufactured to produce greater resistance to surface indentation and through-penetration than standard gypsum panels.

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. National Gypsum Company; Gold Bond Hi-Abuse Wallboard.
 - b. United States Gypsum Co.; SHEETROCK Brand Abuse-Resistant Gypsum Panels.

2. Core: 5/8 inch, unless otherwise indicated.
3. Long Edges: Tapered.

2.3 TRIM ACCESSORIES

- A. Interior Trim: ASTM C 1047.
 1. Material: Galvanized steel or zinc alloy and configured for concealment in joint compound.
- B. Control Joints: provide manufacturer's standard one-piece control joints of extruded vinyl, zinc alloy, or other non-corrosive metal.

2.4 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C 475/C 475M.
- B. Joint Tape:
 1. Interior Gypsum Board: Paper.
 2. Tile Backing Panels: As recommended by panel manufacturer.
- C. Joint Compound for Interior Gypsum Board: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.

2.5 AUXILIARY MATERIALS

- A. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
 1. Laminating adhesive shall have a VOC content of 50g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 2. Laminating adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- B. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.
- C. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing).
- D. Acoustical Joint Sealant: ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings as demonstrated by testing according to ASTM E 90.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Accumetric LLC; BOSS 824 Acoustical Sound Sealant.
 - b. Grabber Construction Products; Acoustical Sealant GSC.
 - c. Pecora Corporation; AC-20 FTR, AIS-919.

- d. Specified Technologies, Inc.; Smoke N Sound Acoustical Sealant.
 - e. USG Corporation; SHEETROCK Acoustical Sealant.
2. Acoustical joint sealant shall have a VOC content of 250g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Acoustical joint sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

PART 3 - EXECUTION

3.1 APPLYING AND FINISHING PANELS

- A. Comply with ASTM C 840.
- B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
- C. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch- (6.4- to 12.7-mm-) wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
- D. 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. Control Joints: Install control according to ASTM C 840 and in specific locations approved by Architect for visual effect.
- E. Prefill open joints, rounded or beveled edges, and damaged surface areas.
- F. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.
- G. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:
 1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
 2. Level 2: Panels that are substrate for tile
 3. Level 3: Where indicated on Drawings
 4. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.
 - a. Primer and its application to surfaces are specified in other Division 09 Sections.
 5. Level 5: Where indicated on Drawings
 - a. Primer and its application to surfaces are specified in other Division 09 Sections.
- H. Protect adjacent surfaces from drywall compound and texture finishes and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.

- I. Remove and replace panels that are wet, moisture damaged, and mold damaged.

END OF SECTION 092900

SECTION 09 6723 - RESINOUS FLOORING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Resinous flooring Systems
 - 2. Waterproofing of the system

1.2 SYSTEM DESCRIPTION

- A. Provide a complete resinous flooring system complete with all layers and waterproofing membrane free of defects in materials and workmanship. System shall match the approved mock-ups and provide physical performance specified.

1.3 SUBMITTALS

- A. Product Data: For each type of product specified. Include manufacturer's technical data, installation instructions, and recommendations for each resinous flooring component required.
 - 1. Data shall include manufacturers recommended procedures for surface and crack preparation for final resinous floor installation.
 - 2. Provide listing of chemical resistance to specific chemicals tested by the manufacturer. Listing shall include the industry standard chemicals and substances and verifiable values.
- B. Samples for initial selection: For each resinous flooring system required, 6 inches square, applied to a rigid backing by Installer for this Project. Provide step down panels indicated variety of slip resistance finishes obtainable.
- C. Samples for Verification: Of each resinous flooring system required, 12 inches square, applied by Installer for this Project to a rigid backing, in color, texture, and finish indicated. Where finishes involve normal color and texture variations, include Sample sets showing the full range of variations expected.
- D. Product Schedule: Use designations indicated in the Finish Schedules and the room designations indicated on Drawings to delineate locations of specific resinous flooring and colors.
- E. Certifications: Signed by manufacturer certifying that the manufacturer will perform the installation and that installation professionals have been trained and are approved by the manufacturer of application of the project specific resinous flooring system. Include listing of references of comparable projects and reference contacts of reference projects.
- F. Material Certifications: Signed by manufacturers certifying that materials furnished comply with requirements. Include differences in the proposed system components and the specified components and define the differences.
- G. Surface Preparation Report: Submit manufacturers report indicating acceptance of the surface for installation of resinous flooring systems. Report shall indicate defects and remedies required by the manufacturer prior to installation and acceptance of the final prepared surface.

Any testing and cost thereof required by manufacturer to certify acceptance shall be borne by manufacturer

- H. Concrete Slab Moisture Test results: Submit written results to the Architect and Owner.
- I. Warranties: Submit warranties specified in this Section.
- J. Operations and Maintenance Data: Resinous flooring data shall include recommended daily and periodic cleaning and maintenance data, step by step cleaning procedures, and chemical resistance charts indicating anticipated results to exposure of the Owner anticipated use chemicals and exposure products.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced installer (applicator) who has specialized in installing resinous flooring similar in material, design, and extent to that indicated for this Project and who is certified by the resinous flooring manufacturer. Installer shall have a successful record of 10 projects of similar size over the last five years.
 - 1. Engage an installer who employs only installer trained and approved by resinous flooring manufacturer for installing resinous flooring systems specified.
 - 2. The installer shall utilize the same installation individual for the final product as is used for the installation of the mock-up.
- B. Manufacturer Field Technical Service Representatives: Resinous Flooring System Manufacturer shall retain the services of Field Technical Service Representatives who are trained specifically on installing the system to be used on the project.
 - 1. Field Technical Service Representatives shall be employed by the system manufacturer to assist in the quality assurance and quality control process of the installation and shall be available to perform field problem solving issues.
- C. Source Limitations: Obtain primary resinous flooring materials, including primers, resins, hardening agents, flakes, and sealing or finish coats, through one source from a single manufacturer. Provide secondary materials including patching and fill material, joint sealant, and repair materials of type and from source recommended by manufacturer of primary materials.
- D. In Place bench-mark mock-ups:
 - 1. Provide in place mockup.
 - 2. Final mock-ups shall be installed by the actual installation contractor's mechanics or as a minimum the installer's supervisor for the final in-place product.
 - 3. Provide mockup areas to demonstrate typical for each color and location required. Mock-up shall indicate anticipated surface finish, texture, tolerances, and standard of workmanship. Provide mock-up assemblies for horizontal and vertical conditions.
 - 4. Mock-ups shall include conditions adjacent to frames, floor drains, inside corners and outside corners, and integral base.
 - a. Build mockups approximately of whole room size with a minimum of 100 sq. ft. in the location indicated or, if not indicated, as directed by Architect.
 - b. Notify Architect fifteen days in advance of dates and times when mockups will be constructed.

- c. Obtain Owner's and Architect's approval of mockups before starting construction of the remainder if the specified Work of this Section.
 - d. If Architect determines that mockups do not meet requirements, demolish and remove them from the site and cast another. Continue until the mockup is approved.
 - e. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 - f. Approved mockups may become part of the completed Work if undisturbed at time of Final Completion.
 - g. Where mock-ups are indicated to not become part of the work or where mock-ups have been rejected, demolish and remove mockups when directed.
- E. Preinstallation Conference:
- 1. Pre-installation participants shall include the Architect, the Owner's Representative, the Contractor, the manufacturers representative, installer and installer's project supervisor of the actual work.
 - 2. Review requirements for resinous flooring, including surface preparation specified under other Sections, schedule of installation, sequence of related work, substrate condition and pretreatment, minimum curing period, special details, installation procedures, testing and inspection procedures, and protection and repairs.
 - 3. Floor substrate and preparation shall be acceptable to the manufacturer and the installer prior to installation of the work.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage and mixing with other components.
- B. Store materials to comply with manufacturer's written instructions to prevent deterioration from moisture, heat, cold, direct sunlight, age of products, or other detrimental effects.
- C. Materials shall be used in accordance with the manufacturers required time constraints, inclusive of shelf life.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Comply with resinous flooring manufacturer's written instructions for substrate temperature, ambient temperature, substrate moisture content, humidity levels, ventilation, and other conditions affecting resinous flooring installation. Beginning of installation implies acceptance of all existing condition.
- B. Lighting: Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during resinous flooring installation.
- C. Close spaces to traffic during resinous flooring application and for not less than 24 hours after application, unless manufacturer recommends a longer period.
- D. Do not install floor over concrete slabs until slabs have cured and are sufficiently dry to bond as determined by flooring manufacturer's recommended bond and moisture test.

- E. This Section shall determine the extent of moisture seal requirements as it relates to the system to be provided and to what extent the moisture seal system is required.
- F. Ventilation: Provide ventilation during coating evaporation stage in confined or enclosed areas in accordance with manufacturer's and owner's instructions. Submit an odor control plan to NC State CVM prior to installation.
- G. Dust and contaminants: Schedule coating work to avoid excessive dust and airborne contaminants. Protect work areas from excessive dust and airborne contaminants during coating application and curing.

1.7 WARRANTY

- A. Provide a joint warranty with the manufacturer and the installer for a period of two years from the date of Final Acceptance stating that the resinous flooring system shall be free of defects in material and workmanship and that it will not crack, blister, delaminate from the substrate, leak water or any liquid, stain, discolor, or otherwise fail to perform as required.
- B. Locate and repair the defective workmanship, replace the defective material, and remove and replace other work, which has been superimposed on that portion of the resinous floor requiring repair or replacement. In the event of a complete failure of the resinous flooring, remove and replace the flooring system in its entirety.
 - 1. Repair or replace any portion of the building damaged by the defect or repair of it.
- C. Work required by the warranty shall be performed at no cost to the Owner.
- D. The warranty shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and will be in addition to and run concurrent with other warranties made by the Contractor under requirements of the Contract Documents.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers/Products Broadcast Applied System
 - 1. Dudick, Inc.
 - 2. General Polymers Inc/Sherwin Williams
 - 3. Life Science Products / Seamless Technologies, Inc.
 - 4. Stonhard
 - 5. Plexi-Chemie Inc d/b/a Industrial Flooring Specialists

2.2 MATERIALS

- A. Resinous Flooring: Resinous floor surfacing system consisting of manufacturer's recommended leveling agent (as required by design), primer; body coat(s) including resin, hardener, crack isolation membrane (as required by design), aggregates, flakes, and colorants, if any; and sealing or finish coat(s). Systems shall be pin-hole free.

2.3 RESINOUS FLOORING SYSTEMS

- A. Broadcast Applied (**RF-1**)

1. Basis of Design: SeamTek Type 4 Epoxy Quartz Flooring System
2. Color and Pattern: As selected by Architect from manufacturer's full range of colors and patterns produced for resinous flooring complying with requirements indicated.
3. System Thickness: minimum 1/8 inch (125 mm) dry film thickness (DFT).
4. Wearing Surface: Antislip, orange peel, to match approved mock-up.
5. Base: straight base at height indicated on drawings
6. Components: Provide manufacturer's standard components complying with requirements, unless otherwise indicated. Provide the following components:
 - a. Penetrating Primer: Manufacturer's recommended penetrating primer for existing floor slabs that additionally acts as a waterproofing membrane.
 - b. Body Coats: 100% resins and aggregates.
 - c. Thickness: Minimum 1/16" in one lift 1/8" with a minimum of 2 lifts.
 - d. Top coat: clear coating with UV resistance. Polyester or Aliphatic Urethane
7. System Physical Properties: Provide resinous flooring system with the following minimum physical property requirements when tested according to standard test methods indicated:
 - a. Compressive Strength: minimum 11,000 psi per ASTM C 579.
 - b. Tensile Strength: minimum 2400 psi per ASTM C 307.
 - c. Surface Tensile Strength: minimum 400 psi per ASTM D-4541 or cohesion failure of concrete.
 - d. Flexural Strength: 4000 psi per ASTM C-580
 - e. Water Absorption: 0.1% per ASTM C 413.
 - f. Abrasion Resistance: maximum .06 gm . maximum weight loss per ASTM C 501.
 - g. Flammability: Self-extinguishing per ASTM D 635. Extent of burning 0.25 inches maximum.
 - h. Hardness: 85 - 90, Shore D per ASTM D 2240.
 - i. Temperature Service: provide system to service continuous 140F water without failure.
 - j. Solids content: 100%
 - k. VOC content: 0 for all components
 - l. Accessories and Additives:

Antimicrobial: Provide antimicrobial additive as approved for use with the system by the manufacturer to protect against bacterial and fungal attack and growth. Additive shall be non-staining and be integral to the resin matrix.

 - 1) Broadcast elements: Broadcast colored flakes (chips), colors as selected by the Architect.
 - m. Chemical Resistance: As indicated by system designation and components indicated above.
- C. Joint Sealant: Type recommended or produced by resinous flooring manufacturer for type of service and joint condition indicated. Refer to Section 07 9200 "Joint Sealants".
- D. Termination Bar: unless otherwise required by the manufacturer or as detailed in the drawings, provide aluminum angle mounted to wall surface for terminating integral cover base.

- E. Crack Isolation membrane: Flexible resin formulation that is recommended by manufacturer for substrate and primer and body coat(s) indicated and that prevents substrate cracks from reflecting through resinous flooring.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. General: Do not apply resinous flooring for at least 28 days following installation of the concrete slab to permit complete curing.
- B. Moisture Testing: Flooring installer shall provide the moisture tests for all areas to be tested. Desiccant Test kits as required by the manufacturer:
 - 1. For Calcium Chloride testing perform the test as follows:
 - a. For areas of 2000 sf or less, a minimum of 3 tests; for each additional 1000 sf, make one additional test.
 - b. Conduct the tests simultaneously, one at the center of the room, and the others at the perimeter, within five feet of the walls.
 - c. Perform calcium chloride moisture no more than 7 days prior to installation of the resinous flooring system.
 - 2. Moisture content: The moisture content of the concrete slab shall be within the tolerances levels of the resinous flooring system manufacturer.
- C. Surface Preparation Report:
 - 1. Prepare a written report indicating surface preparation of the slabs. Report shall indicate locations of moisture testing and recommendations by the manufacturer for installation of the system and acceptability of the cleanliness (lack of laitance) of the surface.
 - 2. Report shall include the manufacturers and installers acceptance of the substrate for moisture content and surface conditions for surface physical properties.

3.2 PREPARATION

- A. General: Prepare and clean substrate according to resinous flooring manufacturer's written instructions for substrate indicated. Provide clean, dry, and ph-neutral substrate for resinous flooring application.
 - 1. Concrete Substrates: Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminates incompatible with resinous flooring. Shot-blast surfaces with an apparatus that abrades the concrete surface, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup.
 - 2. Repair damaged and deteriorated concrete according to resinous flooring manufacturers written Instructions.
 - 3. Remove all laitance from the surface of the concrete to clean condition satisfactory to the manufacturer.
 - 4. Prior to application of primers, the surface shall be tested for surface tensile strength of no less than 250 psi.
 - 5. Prepare and correct cracks in the concrete substrate in accordance with the resinous flooring manufacturers recommended procedures. Route out cracks to a width and depth

- as required receiving sealants. Use urethane sealants and/or fiberglass matting to bridge cracks.
- 6. Manufacturers representative shall inspect existing floor slabs and prepare a procedure report indicating their required surface preparation.
 - a. As a minimum the slab shall be degreased, shot-blasted and degreased again. Apply manufacturers penetrating primer prior to application of system primer.
- 7. Where documents indicate renovation of existing slabs and flooring due to high spots, low spots, lack of flatness or sloping, preparation will include removing high spots or infilling low spots with manufacturers recommended leveling agent to achieve flatness and levelness as specified for new slabs in this area
- B. Manufacturer and installer shall approve the floor preparation and the mock-up prior to installation of the floor system.
- C. Resinous Materials: Mix components and prepare materials according to resinous flooring manufacturer's written instructions.
- D. Use patching and fill material to fill holes and depressions in substrates according to manufacturer's written instructions.
- E. Treat other nonmoving substrate cracks to prevent cracks from reflecting through resinous flooring in accordance with manufacturer's written instructions.
- F. Crack Isolation Membrane installation: Upon inspection of the substrate, provide membrane designed to isolate cracking of concrete and deter telegraphing of cracks through the system as recommended by the system manufacturer.

3.3 APPLICATION

- A. General: Apply components of resinous flooring system according to manufacturer's written instructions to produce a uniform, monolithic wearing surface of thickness indicated.
 - 1. Coordinate application of components to provide optimum adhesion of resinous flooring system to substrate and optimum intercoat adhesion.
 - 2. Cure resinous flooring components according to manufacturer's written instructions, including UV technology if required. Prevent contamination during application and curing processes.
 - 3. If substrate expansion or isolation joints occur within the resinous flooring, provide joint in resinous flooring to comply with resinous flooring manufacturer's written recommendations.
 - a. Apply joint sealant to comply with manufacturer's written installation.
- B. Primer application: Apply primer over prepared substrate at manufacturer's installation spreading rate and thickness. Allow primer to dry to manufacturer's installation dryness level.
- C. Integral Cove Base: Apply troweled cove base mix to wall surfaces at locations indicated. Radius tool internal and external corners. Install cove base according to manufacturer's written instructions and details including taping, mixing, priming, troweling, sanding, and topcoating of cove base.
 - 1. Cove bases shall be terminated in a straight and even manner as required by the details. Terminate coves on substrates other than concrete masonry units with metal termination bars unless otherwise detailed.

2. Spoon cove base at door frame interface.
- D. Apply sealing or finish coat of type recommended by resinous flooring manufacturer to produce finish required. Apply in number of coats and at spreading rates required in writing by manufacturer.

3.4 FIELD QUALITY CONTROL

- A. Core Sampling: At the direction of Owner and at locations designated by Owner, take 1 core sample per 1000 sq. ft. of resinous flooring, or portion of, to verify thickness. For each sample that fails to comply with requirements, take two additional samples. Repair damage caused by coring and correct deficiencies.
- B. Material Sampling: Owner may at any time and any numbers of times during resinous flooring application require material samples for testing for compliance with requirements.
 1. Owner will engage an independent testing agency to take samples of materials being used. Material samples will be taken, identified, sealed, and certified in presence of Contractor.
 2. Testing agency will test samples for compliance with requirements, using applicable referenced testing procedures or, if not referenced, using testing procedures listed in manufacturer's product data.
 3. If test results show materials do not comply with requirements, the Contractor may be directed by the Owner or the Independent Testing Agency to stop work, remove noncomplying materials, pay for additional testing, remove rejected materials, and reapply flooring materials to comply with requirements.

3.5 CLEANING AND PROTECTING

- A. Protect resinous flooring from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by resinous flooring manufacturer.
- B. Clean resinous flooring not more than 4 days before dates scheduled for inspections intended to establish date of Final Completion in each Project area. Use cleaning materials and procedures recommended in writing by resinous flooring manufacturer.

END OF SECTION 096723

SECTION 099110 - EXTERIOR PAINTING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes surface preparation and the application of paint systems on the following exterior substrates:
 - 1. Steel – Exterior hollow metal doors and frames, steel lintels at exterior doors and louvers, and all steel supporting concrete walkway, and bent plate along sides of, equipment platform.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For each finish and for each color and texture required.
- C. Product List: Printout of current "MPI Approved Products List" for each product category specified in Part 2, with the proposed product highlighted.

1.3 QUALITY ASSURANCE

- A. MPI Standards:
 - 1. Products: Complying with MPI standards indicated and listed in "MPI Approved Products List."
 - 2. Preparation and Workmanship: Comply with requirements in "MPI Architectural Painting Specification Manual" for products and paint systems indicated.
- B. Mockups: Apply benchmark samples of each paint system indicated and each color and finish selected to verify preliminary selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Architect will select one surface to represent surfaces and conditions for application of each paint system specified in Part 3.
 - a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft. (9 sq. m).
 - b. Other Items: Architect will designate items or areas required.
 - 2. Final approval of color selections will be based on benchmark samples.
 - a. If preliminary color selections are not approved, apply additional benchmark samples of additional colors selected by Architect at no added cost to Owner.

1.4 EXTRA MATERIALS

- A. Furnish extra materials described below that are from same production run (batch mix) as materials applied and that are packaged for storage and identified with labels describing contents.
 - 1. Quantity: Furnish an additional 5 percent, but not less than 2 gallons of each material and color applied.

PART 2 - PRODUCTS

2.1 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. Colors: Match Architect's samples.

2.2 METAL PRIMERS

- A. Alkyd Anticorrosive Metal Primer: MPI #79.

2.3 EXTERIOR ALKYD PAINTS

- A. Exterior Alkyd Enamel (Flat): MPI #8 (Gloss Level 1).
- B. Exterior Alkyd Enamel (Semigloss): MPI #94 (Gloss Level 5).

2.4 EXTERIOR LATEX

- C. Exterior Latex Paint, Low Sheen: Water-based, pigmented coating; formulated for alkali, mold, microbial, and water resistance and for use on exterior surfaces, such as portland cement plaster, concrete, and primed wood.
 - 1. Gloss and Sheen Level: Manufacturer's standard low-sheen finish

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 work.
- B. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- C. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.
 - 1. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION AND APPLICATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.
- B. Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, and incompatible paints and encapsulants.
 - 1. Remove incompatible primers and reprime substrate with compatible primers as required to produce paint systems indicated.
- C. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
- D. 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.
- E. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.3 EXTERIOR PAINTING SCHEDULE

- A. Steel Substrates:
 - 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 (semigloss).

B. Fiber-Cement Panels

1. Latex System

- a. Prime Coat: Manufacturer's pre-primed surface
- b. Intermediate Coat: Matching topcoat
- c. Topcoat: Exterior Latex paint; low sheen

END OF SECTION 09911

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SECTION 09 9330 – CONCRETE SEALER

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Surface preparation
 - 2. Application of water repellent to unstained and exposed to view surfaces

1.2 SUBMITTALS

- A. Product Data: Manufacturer's technical product data and recommendations for use of each type of product required
- B. Manufacturer's Instructions: Detailed application instructions, including weather limitations, condition of substrates, surface preparation or cleaning, protection of adjacent surfaces, application of product, and cleaning of accidental over-spray and spills.

1.3 QUALITY ASSURANCE

- A. Installer: A company skilled in the application of concrete sealer whose installations have performed in a satisfactory manner under comparable conditions for a period of 5 years.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials in manufacturer's original unopened containers bearing stain name and color, material composition data, date of manufacture, and mixing, thinning, and application instructions.
- B. Storage:
 - 1. Store materials in an orderly fashion and in clean, well-closed containers with labels intact.
 - 2. Maintain above 40 degrees F. Do not allow materials to freeze.

1.4 PROJECT CONDITIONS

- A. Schedule sealing, to the extent possible, to precede construction that could be damaged by sealant whether by spray, drift, drip or spillage.
- B. Apply sealant only under the following environmental conditions:
 - 1. Air and surface temperatures are between 50 and 120 degrees F.
 - 2. Surface temperature is at least 5 degrees F above dew point.
 - 3. Relative humidity is less than 85 percent.
- C. Do not apply sealant during inclement weather.
- D. Provide continuous ventilation and heating, and maintain surface and ambient temperatures above 45 degrees F for 24 hours before, during and for 48 hours after application of stain, or longer if required to obtain full cure as indicated by manufacturer's instructions.

PART 2 - PRODUCTS

2.1 WATER REPELLENT SEALER

A. Sealed Concrete - Clear

1. Tnemec:

- a. Primer: series 201 Epoxoprime, thinned. DFT 6.0 – 8.0 mils (68 g/l)
- b. Clear epoxy finish coat: Series 201 Epoxoprime, DFT 6.0 – 8.0 mils (28 g/l)

2. Carboline:

- a. Primer: Carboguard 1340, thinned. DFT 4.0 mils
- b. Clear epoxy finish coat: Carboguard 1340 DFT 4.0 mils

3. PPG:

- a. Primer: Aquapon WB Epoxy 98-57 Series thinned 10% DFT 2.0 to 3.0 mils
- b. Clear epoxy finish coat: Aquapon WB Epoxy 98-57 Series, DFT 2.0 to 3.0 mils

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that surfaces and conditions are ready for work in accordance with the contract documents and manufacturer's recommendations.
- B. Prior to commencement of work, examine surfaces schedule to be finished.
 1. Report any unsatisfactory
 2. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the applicator.
 3. Beginning work on an area will be deemed acceptance of surfaces in that area.

3.2 PREPARATION

- A. Blast cleaning: Prepare the entire concrete surface to be sealed:
 1. Perform blasting operation on fully cured surfaces that are at least 28 days old so as to open any surface voids, bugholes, etc., and to remove curing compounds, surface glaze, laitance, salts, loosely adhering material, and foreign material of any kind that would be deleterious to penetration or performance of sealer.
 2. Use only dry, oil-free air and clean media, unless other blast cleaning methods are approved.
 3. After blast cleaning, completely remove dust and loose particles by vacuuming. Merely brushing or blowing will not be accepted.
 4. Do not patch surface voids, bugholes, etc., without Architect's approval.
 5. Allow substrate to dry thoroughly. Test for moisture in accordance with stain manufacturer's recommendations before applying stain.
 6. Degree of exposure: Expose underlying aggregate to match approved samples and mock-ups.
- B. Protection:

1. Mask off and cover adjacent surfaces to prevent contamination by sealant whether by spray, drift, drip, or spillage.
2. Take special care to protect aluminum, glass, and live plant or turf surfaces.
3. Should contamination occur, clean surfaces immediately, following manufacturer's instructions.

3.3 CLEANING

- A. Remove protective coverings from adjacent surfaces at completion of work.
- B. Remove all trace of sealer inadvertently applied to adjacent surfaces not scheduled to be coated. Remove by appropriate methods that do not damage surfaces.

3.4 PROTECTION

- A. Protect work against damage until fully cured. Provide signs identifying wet surfaces until surfaces are adequately cured.
- B. Shortly before final completion of the project, examine surfaces for damage to sealer and report status to the Architect. Touch-up of minor damage will be acceptable only where, in the opinion of the Architect, result is not visibly different from surrounding surfaces.

END OF SECTION 099330

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SECTION 099610 - HIGH-PERFORMANCE COATINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes surface preparation and field application of high-performance coating systems to items and surfaces scheduled.

1.2 DEFINITIONS

- A. Standard coating terms defined in ASTM D 16 apply to this Section.
- B. Gloss ranges used in this Section include the following:
- C. High gloss refers to high-sheen finish with a gloss range more than 65 when measured at a 60-degree meter.

1.3 SUBMITTALS

- A. Product Data: For each coating system indicated. Include block fillers and primers.
- B. Material List: An inclusive list of required coating materials. Indicate each material and cross-reference the specific coating, finish system, and application. Identify each material by manufacturer's catalog number and general classification.
- C. Manufacturer's Information: Manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each material specified.
- D. Certification by manufacturer that products supplied comply with requirements indicated that limit the amount of VOCs in coating products.
- E. Samples for Initial Selection: Manufacturer's color charts showing the full range of colors available for each type of finish-coat material indicated.
 - 1. After color selection, furnish Architect will color chips for surfaces to be coated.
- F. Samples for Verification: For each color and material to be applied, with texture to simulate actual conditions, on representative samples of the actual substrate.
 - 1. Provide stepped Samples defining each separate coat, including block fillers and primers. Use representative colors when preparing Samples for review. Resubmit until required sheen, color, and texture are achieved.
 - 2. List of material and application for each coat of each sample. Label each sample for location and application.
- G. Submit samples on the following substrates for Architect's review of color and texture:
 - 1. Concrete: Provide two 4-inch- square samples for each color and finish.
 - 2. Concrete Masonry: Provide two 8-inch- square samples of masonry, with mortar joint in the center, for each finish and color.
 - 3. Ferrous and Nonferrous Metal: Provide two 4-inch- square samples of flat metal and two 8-inch- long samples of solid metal for each color and finish.

- H. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

1.4 QUALITY ASSURANCE

- A. Applicator Qualifications: Engage an experienced applicator who has completed high-performance coating system applications similar in material and extent to those indicated for Project and whose work has a record of successful in-service performance.
 - 1. Applicator approved in writing by the manufacturer with over five year's experience.
- B. Source Limitations: Obtain primers and undercoat materials for each coating system from the same manufacturer as the finish coats.
- C. Benchmark Samples (Mockups): Provide a full-coat benchmark finish sample of each type of coating and substrate required. Comply with procedures specified in PDCA P5. Duplicate finish of approved sample Submittals.
 - 1. Architect will select one room, area, or surface to represent surfaces and conditions for application of each type of coating and substrate.
 - 2. Wall Surfaces: Provide samples on at least 100 sq. ft. of wall surface.
 - 3. Small Areas and Items: Architect will designate items or areas required.
 - 4. After permanent lighting and other environmental services have been activated, apply coatings in this room or to each surface as specified. Provide the required sheen, color, and texture of each surface.
 - 5. After finishes are accepted, Architect will use the room or surface to evaluate coating systems of a similar nature.
 - 6. Final approval of colors will be from benchmark samples.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Project site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label with the following information:
 - 1. Name or title of material.
 - 2. Product description (generic classification or binder type).
 - 3. Manufacturer's stock number and date of manufacture.
 - 4. Contents by volume, for pigment and vehicle constituents.
 - 5. Thinning instructions.
 - 6. Application instructions.
 - 7. Color name and number.
 - 8. Handling instructions and precautions.
- B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45 deg F. Maintain containers used in storage in a clean condition, free of foreign materials and residue.
- C. Protect materials from freezing. Keep storage area neat and orderly. Remove oily rags and waste daily. Take necessary measures to ensure that workers and work areas are protected from fire and health hazards resulting from handling, mixing, and applying coatings.

1.6 PROJECT CONDITIONS

- A. Apply coatings only when temperature of surfaces to be coated and surrounding air temperatures are between 60 and 90 deg F.
- B. Do not apply coatings when relative humidity exceeds 85 percent; or to damp or wet surfaces.
- C. Allow wet surfaces to dry thoroughly and attain temperature and conditions specified before proceeding with or continuing coating operation.
- D. Work may continue during inclement weather only if areas and surfaces to be coated are enclosed and temperature within the area can be maintained within limits specified by manufacturer during application and drying periods.

1.7 WARRANTY

- A. Special Warranty: Submit a written warranty executed by the manufacturer agreeing to repair or replace high performance coating systems that fail in materials or workmanship within the specified warranty period. Failures include, but are not limited to, the following:
 - 1. Cracks.
 - 2. Blisters.
 - 3. Delamination from substrate.
 - 4. Warranty Period: 5 years from date of Final Acceptance.

1.8 EXTRA MATERIALS

- A. Furnish extra high-performance coating materials from the same production run as materials applied and in quantities described below. Package coating materials in unopened, factory-sealed containers for storage and identify with labels describing contents.
- B. Quantity: Furnish extra coating materials in quantities indicated below:
 - 1. One case of each color applied with required components.
 - 2. 1 gallon each product for each color for steel substrates.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the products indicated in the coating system descriptions.
- B. Manufacturers' Names: The following manufacturers are referred to in the coating system descriptions by shortened versions of their names shown in parenthesis:
 - 1. General Polymers Corp (General Polymers).
 - 2. Tnemec Company, Inc. (Tnemec).
 - 3. Valspar, Federal Flooring Division (Valspar).

2.2 COATINGS MATERIALS, GENERAL

- A. Material Compatibility: Provide primers, undercoats, and finish-coat materials 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.

- B. Material Quality: Provide manufacturer's highest grade of the various high-performance coatings specified. Materials not displaying manufacturer's product identification are not acceptable.
- C. VOC Classification: Provide high-performance coating materials, including primers, undercoats, and finish-coat materials, that have a VOC classification of 450 g/L or less.

2.3 COLORS

- A. Colors: As selected by Architect from manufacturers full range pallet.

2.4 INTERIOR HIGH-PERFORMANCE COATING SYSTEMS – WATER BORNE

- A. Concrete and Concrete Masonry Units Used as Wall Finish: Basis of Design:
 - 1. Sherwin Williams Saniglaze High Build Wall and Ceiling System/Resuwall Aqua High Build Wall and Ceiling System consisting of:
 - a. Loxon Acrylic Block Surfacer LX01W0200 at 80 to 120 square feet per gallon based on porosity.
 - b. Concrete Surface: Resuflor Aqua 3462G wall primer, two base coats at 6-8 mils DFT
 - c. 4685W Polycoat at 4 mils D.F.T.
- B. Gypsum Board Based Units Used as Wall Finish: Provide one of the following finish systems over interior Gypsum base board products:
 - 1. Sherwin Williams Saniglaze High Build Wall and Ceiling System/Resuwall Aqua High Build Wall and Ceiling System consisting of:
 - a. Primer: Resuflor Aqua 3462G
 - b. Base coats: 2 coats of Resuflor Aqua 3462G at 6-8 mils DFT
 - c. 4865W Polycoat at 6-8 mils D.F.T.
- C. Ferrous and non-ferrous metals: Provide one of the following finish systems over interior ferrous and non-ferrous metals:
 - 1. Sherwin Williams Saniglaze High Build Wall and Ceiling System/Resuwall Aqua High Build Wall and Ceiling System consisting of:
 - a. Primer: As required by the manufacturer for ferrous and non-ferrous metal, or Macropoxy 646 Fast Cure
 - b. Base coats: 2 coats of 3746G epoxy
 - c. 4685W Polycoat at 4 mils D.F.T.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. With Applicator present, examine substrates and conditions under which high-performance coatings will be applied, for compliance with coating application requirements.
- B. Apply coatings only after unsatisfactory conditions have been corrected and surfaces to receive coatings are thoroughly dry.

- C. Start of application is construed as Applicator's acceptance of surfaces within that particular area.
- D. Coordination of Work: Review other Sections in which primers or other coatings are provided to ensure compatibility of total systems for various substrates. On request, furnish information on characteristics of specified finish materials to ensure compatible primers.
- E. If a potential incompatibility of primers applied by others exists, obtain the following from the primer Applicator before proceeding:
 - 1. Confirmation of primer's suitability for expected service conditions.
 - 2. Confirmation of primer's ability to be top coated with materials specified.
- F. Notify Architect about anticipated problems before using the coatings specified over substrates primed by others.

3.2 PREPARATION

- A. General: Remove plates, machined surfaces, and similar items already in place that are not to be coated. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and coating.
- B. After completing coating operations, reinstall items that were removed; use workers skilled in the trades involved.
- C. Cleaning: Before applying high-performance coatings, clean substrates of substances that could impair bond of coatings. Remove oil and grease before cleaning.
- D. Schedule cleaning and coating application so dust and other contaminants from cleaning process will not fall on wet, newly coated surfaces.
- E. Surface Preparation: Clean and prepare surfaces to be coated according to manufacturer's written instructions for each substrate condition and as specified.
- F. Provide barrier coats over incompatible primers or remove primers and reprime substrate.
- G. Cementitious Substrates: Prepare concrete, precast concrete planks, concrete masonry block, and cement plaster surfaces to be coated. Remove efflorescence, chalk, dust, dirt, grease, oils, and release agents. Roughen as required to remove glaze. If hardeners or sealers have been used to improve curing, use mechanical methods to prepare surfaces.
 - 1. Use abrasive blast-cleaning methods if recommended by coating manufacturer.
 - 2. Determine alkalinity and moisture content of surfaces by performing appropriate tests. If surfaces are sufficiently alkaline to cause the finish coating to blister and burn, correct this condition before application. Do not coat surfaces if moisture content exceeds that permitted in manufacturer's written instructions.
- H. Ferrous-Metal Substrates: Clean ungalvanized ferrous-metal surfaces that have not been shop coated; remove oil, grease, dirt, loose mill scale, and other foreign substances. Use solvent or mechanical cleaning methods that comply with SSPC recommendations.
 - 1. Blast-clean steel surfaces as recommended by coating manufacturer and according to SSPC-SP 10/NACE No. 2.

2. Treat bare and sandblasted or pickled clean metal with a metal treatment wash coat before priming.
 3. Touch up bare areas and shop-applied prime coats that have been damaged. Wire brush, solvent clean, and touch up with same primer as the shop coat.
- I. Nonferrous-Metal Substrates: Clean nonferrous and galvanized surfaces according to manufacturer's written instructions for the type of service, metal substrate, and application required.
 1. Remove pretreatment from galvanized sheet metal fabricated from coil stock.
 - J. Material Preparation: Carefully mix and prepare coating materials according to manufacturer's written instructions.
 - K. Maintain containers used in mixing and applying coatings in a clean condition, free of foreign materials and residue.
 - L. Stir materials before applying to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into the material. Remove film and, if necessary, strain coating material before using.
 - M. Use only the type of thinners approved by manufacturer and only within recommended limits.
 - N. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of the same material are to be applied. Tint undercoats to match color of finish coat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

3.3 APPLICATION

- A. General: Apply high-performance coatings according to manufacturer's written instructions.
- B. Use applicators and techniques best suited for the material being applied.
- C. Do not apply high-performance coatings over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to forming a durable coating film.
- D. Coating colors, surface treatments, and finishes are indicated in the coating system descriptions.
- E. Provide finish coats compatible with primers used.
- F. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, convactor covers, grilles, and similar components are in place. Extend coatings in these areas, as required, to maintain system integrity and provide desired protection.
- G. Coat surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before final installation, coat surfaces behind permanently fixed equipment or furniture with prime coat only.
- H. Coat back sides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
- I. Scheduling Coating: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for coating as soon as practicable after preparation and before subsequent surface deterioration.

1. The number of coats and film thickness required is the same regardless of application method.
 2. Omit primer on metal surfaces that have been shop primed and touchup painted.
 3. Do not apply succeeding coats until previous coat has cured as recommended by manufacturer.
- J. Where manufacturer's written instructions require sanding, sand between applications to produce a smooth, even surface.
- K. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until coating has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and application of another coat does not cause undercoat to lift or lose adhesion.
- L. If undercoats or other conditions show through final coat, apply additional coats until cured film has a uniform coating finish, color, and appearance. Give special attention to edges, corners, crevices, welds, exposed fasteners, and similar surfaces to ensure that they receive a dry film thickness equivalent to that of flat surfaces.
- M. Application Procedures: Apply coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions.
1. Brush application for small and narrow surfaces only: Use brushes best suited for material applied and of appropriate size for the surface or item being coated.
 2. Apply primers and first coats by brush unless manufacturer's written instructions permit using roller or mechanical applicators.
 3. Brush out and work brush coats into surfaces in an even film.
- N. Eliminate cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Neatly draw glass lines and color breaks. Provide a pin-hole free surface.
- O. Rollers where protection of adjacent areas is prohibited by locations and surrounding space: Use rollers of carpet, velvet back, or high-pile sheep's wool as recommended by manufacturer for the material and texture required.
- P. Spray Equipment for larger fields of substrate: Use mechanical methods to apply coating if permitted by manufacturer's written instructions and governing regulations.
1. Use spray equipment with orifice size recommended by manufacturer for material and texture required.
 2. Apply each coat to provide the equivalent hiding of brush-applied coats.
 3. Do not double back with spray equipment building-up film thickness of two coats in one pass, unless recommended by manufacturer.
- Q. The final coat for all systems shall be brush or roller applied as an aid in matching future touch-up.
- R. Minimum Coating Thickness: Apply each material no thinner than manufacturer's recommended spreading rate. Provide total dry film thickness of the entire system as recommended by manufacturer.
- S. Block Fillers:

1. Apply block fillers to concrete masonry block at a rate to ensure complete coverage with pores filled.
 2. Apply two or more applications of block filler as required to completely conceal flush joints in unit masonry walls as indicated in Section 04 2000 – Unit Masonry.
- T. Prime Coats:
1. Before applying finish coats, apply a prime coat of material, as recommended by manufacturer, to material required to be coated or finished that has not been prime coated by others.
 2. Recoat primed and sealed substrates if there is evidence of suction spots or unsealed areas in first coat, to ensure a finish coat with no burn-through or other defects caused by insufficient sealing.
- U. Completed Work: Match approved Samples for color, texture, and coverage. Remove, refinish, or recoat work that does not comply with specified requirements and pin hole free.

3.4 FIELD QUALITY CONTROL

- A. Owner reserves the right to invoke the following procedure at any time and as often as Owner deems necessary during the period when coatings are being applied:
- B. Owner will engage the services of a qualified testing agency to sample coating material being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
- C. Testing agency will perform appropriate tests for the following characteristics as required by Owner:
1. Quantitative materials analysis.
 2. Absorption.
 3. Accelerated weathering.
 4. Accelerated yellowness.
 5. Color retention.
 6. Alkali and mildew resistance.
 7. Abrasion resistance.
 8. Apparent reflectivity.
 9. Washability.
 10. Dry opacity.
 11. Recoating.
 12. Skinning.
- D. Testing agency will inspect the Work during application for conformance to specified requirements:
- E. Owner may direct Contractor to stop applying coatings if test results show materials being used do not comply with specified requirements or if application procedures are not in accordance with specified requirements or manufacturer's instructions. Contractor shall remove noncomplying coating materials from Project site, pay for testing, and recoat surfaces coated with rejected materials. If necessary, Contractor may be required to remove rejected materials from previously coated surfaces if, on recoating with specified materials, the two coatings are not compatible.

3.5 CLEANING

- A. Cleanup: At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

3.6 PROTECTION

- A. Protect work of other trades, whether being coated or not, against damage from coating operation. Correct damage by cleaning, repairing, replacing, and recoating, as approved by Architect, and leave in an undamaged condition.
- B. Provide "Wet Paint" signs to protect newly coated finishes. After completing coating operations, remove temporary protective wrappings provided by others to protect their work.
- C. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces. Comply with procedures specified in PDCA P1.

3.7 WASTE MANAGEMENT

- A. Set aside extra paint for future color matches, or reuse by Owner. If paint recycling is available, collect all waste paint by type and provide for delivery to recycling or collection facility.
- B. Close and tightly seal partly used paint and finish containers. Store in protected and well ventilated fire-safe area at moderate temperature.
- C. Place empty containers of solvent based paints in containers designated for hazardous materials.
- D. Do not dispose of paints or solvents by pouring on the ground. Place in designated containers for proper disposal.
- E. Contractor shall be responsible for the legal removal and disposal of all special or hazardous waste materials produced or other hazardous by products.

END OF SECTION 099610

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SECTION 102600 - WALL AND DOOR PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Corner guards

1.2 SUBMITTALS

- A. Product Data: Include physical characteristics, such as durability, resistance to fading, and flame resistance, for each impact-resistant wall protection system component indicated.
- B. Shop Drawings: Show locations, extent, and installation details of each impact-resistant wall protection system component. Show methods of attachment to adjoining construction. Field verify dimensions prior to submitting shop drawings. Coordinate recessed protection systems with partition construction.
- C. Samples for Initial Selection: Manufacturer's color charts consisting of sections of vinyl plastic material showing the full range of colors and textures available for each impact-resistant wall protection system component indicated.
- D. Samples for Verification: For the following products, showing the full range of color and texture variations expected in each impact-resistant wall protection system component. Prepare Samples from the same material to be used for the Work.
 - 1. Wall and Corner Guards: 12-inch long Samples of each type of impact-resistant wall protection system component required. Include examples of joinery, corners, and field splices.
- E. Material Test Reports: From a qualified testing agency indicating compliance of each impact-resistant wall protection system component with requirements indicated, based on tests performed by testing agency within the past five years.

1.3 QUALITY ASSURANCE

- A. Environmental Quality Assurance
 - 1. VOC limits for Adhesives: VOC content shall not be greater than the limits stated in the South Coast Air Quality Management District Rule #1168.
- B. Installer Qualifications: An experienced installer who has completed installation of impact-resistant wall protection system components similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- C. Source Limitations: Obtain each color, grade, finish, and type of impact-resistant wall protection system component from a single source with resources to provide components of consistent quality in appearance and physical properties.
- D. Fire-Test-Response Characteristics: Provide impact-resistant wall protection system components with the following surface-burning characteristics, as determined by testing

materials identical to those required in this Section per ASTM E 84 by a testing and inspecting agency acceptable to authorities having jurisdiction. Identify impact-resistant wall protection system components with appropriate markings of applicable testing and inspecting agency.

1. Flame Spread: 25 or less.
2. Smoke Developed: 450 or less.

- E. Impact Strength: Provide impact-resistant wall protection system components with a minimum impact resistance of **25.4 ft-lbf/in** of width when tested according to ASTM D 256, Test Method A.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store wall surface-protection materials in original undamaged packages and containers inside a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.
 1. Maintain room temperature within the storage area at not less than **70 deg F** during the period plastic materials are stored. Keep sheet material out of direct sunlight to avoid surface distortion.

1.5 PROJECT CONDITIONS

- A. Environmental Limitations:
 1. Do not install wall surface-protection system components until the space is enclosed and weatherproof and ambient temperature within the building is maintained at not less than **70 deg F** for not less than 72 hours before beginning installation.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Aluminum Extrusions: Provide alloy and temper recommended by the manufacturer for the type of use and finish indicated, but with not less than the strength and durability properties specified in **ASTM B 221** for alloy 6063-T5.
- B. Fasteners: Provide aluminum, nonmagnetic stainless-steel, or other noncorrosive metal screws, bolts, and other fasteners compatible with aluminum components, hardware, anchors, and other items being fastened. Use theftproof fasteners where exposed to view.
- C. Adhesive: Type recommended by the manufacturer for use with material on the substrate indicated.
 1. VOC Limit: 70 g/l

2.2 STAINLESS STEEL CORNER GUARDS

- A. Stainless-Steel Corner Guards: satin-finish, 0.0625-inch minimum, stainless-steel sheet corner guards; height as indicated. Provide 90-degree turn, unless otherwise indicated; and formed edges.
 1. Wing Size: 3in. x 3in. as detailed.
 2. Mounting Method: adhesive as recommended by the manufacturer.
 3. Corner Radius: 1/8 inch

4. Height: Full height from the top of the base to the underside of the ceiling or soffitted plane, unless otherwise noted

B. Manufacturers:

1. Construction Specialties, Inc.
2. Pawling Corporation.
3. Life Science Products

2.3 FABRICATION

- A. General: Fabricate impact-resistant wall and door protection systems to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including thicknesses of components.
- B. Preassemble components in the shop to greatest extent possible to minimize field assembly. Disassemble only as necessary for shipping and handling.
- C. Fabricate components with tight seams and joints with exposed edges rolled. Provide surfaces free of wrinkles, chips, dents, uneven coloration, and other imperfections. Fabricate members and fittings to produce flush, smooth, and rigid hairline joints.
- D. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors for interconnecting members to other construction.
- E. Provide inserts and other anchoring devices for connecting components to concrete or masonry. Fabricate anchoring devices to withstand imposed loads. Coordinate anchoring devices with the supporting structure.

2.4 FINISHES, GENERAL

- 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 covering before shipping.
- C. Appearance of Finished Work: Variations in appearance of abutting or 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. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.5 ALUMINUM FINISHES

- A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
- B. Class II, Clear Anodic Finish: AA-M12C22A31 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, clear coating 0.010 mm or thicker) complying with AAMA 607.1.

2.6 STAINLESS-STEEL FINISHES

- A. General: Remove or blend tool and die marks and stretch lines into finish. Grind and polish surfaces to produce uniform, directionally textured polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.
- B. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions in which impact-resistant wall protection system components and impact-resistant wall covering materials will be installed.
 - 1. Complete finishing operations, including painting, before installing impact-resistant wall protection system components.
- B. Impact-Resistant Wall Covering Materials: Wall surfaces to receive impact-resistant wall covering materials shall be dry and free from dirt, grease, loose paint, and scale.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. General: Before installation, clean substrate to remove dust, debris, and loose particles.

3.3 INSTALLATION

- A. Install impact-resistant wall protection system components level, plumb, and true to line without distortions.
- B. Do not use materials with chips, cracks, voids, stains, or other defects that might be visible in the finished Work.
- C. Install aluminum retainers, mounting brackets, and other accessories according to the manufacturer's written instructions.
- D. Minimize splices in the panel assembly.
- E. Adhesive applied panels: spread adhesive using a notched trowel as recommended by the manufacturer. Complete coverage of the back side of the panels with random spreading.
- F. Install stainless steel corner guards with epoxy adhesive to the clean substrate. Remove finish material that will be concealed after installation of corner guard for location of adhesive.

3.4 CLEANING

- A. General: Immediately on completion of installation, clean plastic covers and accessories using a standard ammonia-based household cleaning agent. Clean metal components according to the manufacturer's written instructions.
- B. Remove excess adhesive using methods and materials recommended by the manufacturer.

- C. Remove surplus materials, rubbish, and debris, resulting from installation, on completion of work and leave installation areas in neat, clean condition.

END OF SECTION 102600

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SECTION 102800 - TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Public-use washroom accessories.

1.2 SUBMITTALS

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

B. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.

1. Identify locations using room designations indicated.
2. Identify products using designations indicated.

C. Maintenance data.

D. Warranty: Sample of special warranty.

PART 2 - PRODUCTS

2.1 PUBLIC-USE WASHROOM ACCESSORIES

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. A & J Washroom Accessories, Inc.
2. American Specialties, Inc.
3. Bobrick Washroom Equipment, Inc.
4. Bradley Corporation.
5. GAMCO Specialty Accessories; a division of Bobrick Washroom Equipment, Inc.
6. Tubular Specialties Manufacturing, Inc.

B. Grab Bar

1. Basis-of-Design Product: Bobrick B-68137 & B5806 series.
2. Mounting: Flanges with concealed fasteners.
3. Material: Stainless steel, 0.05 inch (1.3 mm) thick.
 - a. Finish: Smooth, No. 4 finish (satin).

4. Outside Diameter: 1-1/2 inches (38 mm)
 5. Configuration and Length: As indicated on Drawings
- C. Mirror Unit:
1. Frame: Stainless-steel channel
 - a. Corners: Manufacturer's standard
 2. Hangers: Produce rigid, tamper- and theft-resistant installation, using method indicated below.
 - a. One-piece, galvanized-steel, wall-hanger device with spring-action locking mechanism to hold mirror unit in position with no exposed screws or bolts.
 - b. Wall bracket of galvanized steel, equipped with concealed locking devices requiring a special tool to remove.
 3. Size: As indicated on Drawings
- D. Sanitary Napkin Disposal
1. Basis-of-Design Product: Bobrick Contura Series Surface-mounted sanitary napkin disposal Model B-270
- E. Sanitary Napkin Dispenser
1. Basis-of-Design Product: Bobrick Trim line series surface mounted sanitary napkin/tampon vendor Model B2800 with 25 cents operation.
 - a. Satin Finish Stainless Steel
- F. Mop and Broom Holder
1. Basis-of-Design Product: Bobrick Mop and Broom Holder B-223x24
- G. Paper Towel Dispenser: Owner Furnished and Contractor Installed
- H. Soap Dispenser: Owner Furnished and Contractor Installed
- I. Toilet Paper Dispensers: Owner Furnished and Contractor Installed
- J. Trash and Compost Bins: Owner Furnished and Contractor Installed

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.
- B. Grab Bars: Install to withstand a downward load of at least 250 lbf (1112 N), when tested according to ASTM F 446.

END OF SECTION 102800

SECTION 104413 - FIRE EXTINGUISHER CABINETS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes fire protection cabinets for fire extinguishers.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Maintenance data.

1.3 QUALITY ASSURANCE

- A. Fire-Rated, Fire Protection Cabinets: Listed and labeled to comply with requirements in ASTM E 814 for fire-resistance rating of walls where they are installed.
- B. Coordinate size of fire protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.
- C. Coordinate sizes and locations of fire protection cabinets with wall depths.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Fire extinguisher cabinets
 1. JL Industries, Inc.
 2. Larsen's Manufacturing
 3. Potter-Roemer

2.2 FIRE PROTECTION CABINET

- A. Cabinet Type: Suitable for fire extinguisher.
- B. Cabinet Material: stainless steel sheet.
- C. Recessed Cabinet: Cabinet box recessed in walls of sufficient depth to suit style of trim indicated.
 1. Basis of Design: Larsen SS2409-R1
 2. Cabinet Trim Style: Recessed
 3. Cabinet Projection: 0.3125 inches
 4. Interior nominal box dimension of 24 inches high x 9.5 inches wide x 5 inches deep.
- D. Door Glazing: Tempered glass, clear, 1/8 inch thick. Set in resilient channel gasket glazing.

- E. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.
- F. Accessories:
 - 1. Identification:
 - a. Identify fire extinguisher in fire protection cabinet with the words "FIRE EXTINGUISHER"
 - 1) Location: Applied to cabinet glazing
 - 2) Lettering Color: Black
 - 3) Orientation: Vertical

2.3 FABRICATION

- A. Fire Protection Cabinets: Provide manufacturer's standard box (tub), with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated. Miter and weld joints and grind smooth.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Examine walls and partitions for suitable framing depth and blocking where recessed and semirecessed cabinets will be installed and prepare recesses as required by type and size of cabinet and trim style.
- B. Install fire protection cabinets plumb and level, 34 inches from the finished floor to inside bottom of cabinet, or maximum of 48" to operational hardware.
- C. Adjust fire protection cabinet doors to operate easily without binding.
- D. Replace fire protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 104413

SECTION 105113 – METAL LOCKERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Standard metal lockers.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of metal locker.
- B. Shop Drawings: For metal lockers. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Show locker trim and accessories.
 - 2. Include locker identification system and numbering sequence.
- C. Samples for Initial Selection: For units with factory-applied color finishes.
- D. Samples for Verification: For metal lockers, in manufacturer's standard sizes.
- E. Qualification Data: For qualified Installer.
- F. Maintenance Data: For adjusting, repairing, and replacing locker doors and latching mechanisms to include in maintenance manuals.
- G. Warranty: Sample of special warranty.

1.3 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- B. Source Limitations: Obtain metal lockers and accessories from single source from single manufacturer.
- C. Regulatory Requirements: Where metal lockers are indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver metal lockers until spaces to receive them are clean, dry, and ready for their installation.

1.5 PROJECT CONDITIONS

- A. Field Measurements: Verify actual dimensions by field measurements before fabrication.

1.6 COORDINATION

- A. Coordinate sizes and locations of bases for metal lockers.
- B. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of work specified in other Sections to ensure that metal lockers can be supported and installed as indicated.

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal lockers that fail in materials or workmanship, excluding finish, within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures.
 - b. Faulty operation of latches and other door hardware.
 - 2. Damage from deliberate destruction and vandalism is excluded.
 - 3. Warranty Period for Knocked-Down Metal Lockers: Two years from date of Final Acceptance.

1.8 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Full-size units of the following metal locker hardware items equal to 10 percent of amount installed for each type and finish installed, but no fewer than one unit:
 - a. Identification plates.
 - b. Locks.
 - c. Hooks.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B, suitable for exposed applications.
- B. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with A60 zinc-iron, alloy (galvannealed) coating designation.
- C. Expanded Metal: ASTM F 1267, Type II (flattened), Class I, 3/4-inch steel mesh, with at least 70 percent open area.
- D. Stainless-Steel Sheet: ASTM A 666, Type 304.

- E. Plastic Laminate: NEMA LD 3, Grade HGP.
- F. Extruded Aluminum: ASTM B 221 alloy and temper recommended by aluminum producer and manufacturer for type of use and finish indicated.
- G. Steel Tube: ASTM A 500, cold rolled.
- H. Particleboard: ANSI A208.1, Grade M-2.
- I. Fasteners: Zinc- or nickel-plated steel, slotless-type, exposed bolt heads; with self-locking nuts or lock washers for nuts on moving parts.
- J. Anchors: Material, type, and size required for secure anchorage to each substrate.
 - 1. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls for corrosion resistance.
 - 2. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.

2.2 STANDARD METAL LOCKERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Standard Lockers by Lyon Workspace Products, LLC or comparable product by one of the following:
 - 1. Art Metal Products.
 - 2. ASI Storage Solutions Inc.
 - 3. DeBourgh Mfg. Co.; Worley Lockers.
 - 4. General Storage Systems Ltd.; Decor Tri-Lok
 - 5. Hadrian Manufacturing Inc.; Emperor Lockers.
 - 6. List Industries Inc.;
 - 7. Penco Products, Inc.
 - 8. WEC Manufacturing; Durable Plus
- B. Locker Arrangement: Double tier.
- C. Material: Cold-rolled steel sheet.
- D. Body: Assembled by riveting or bolting body components together. Fabricate from unperforated steel sheet as follows:
 - 1. Tops, Bottoms, and Intermediate Dividers: 0.024-inch nominal thickness, with single bend at sides.
 - 2. Backs and Sides: 0.024-inch nominal thickness, with full-height, double-flanged connections.
 - 3. Shelves: 0.024-inch nominal thickness, with double bend at front and single bend at sides & back.
- E. Frames: Channel formed; fabricated from 0.060-inch nominal-thickness steel sheet; lapped and factory welded at corners; with top and bottom main frames factory welded into vertical main frames. Form continuous, integral door strike full height on vertical main frames.
 - 1. Cross Frames between Tiers: Channel formed and fabricated from same material as main frames; welded to vertical main frames.
 - 2. Frame Vents: Fabricate face frames with vents.
- F. Doors: One piece; fabricated from 0.060-inch nominal-thickness steel sheet; formed into channel shape with double bend at vertical edges and with right-angle single bend at horizontal edges.

1. Doors less than 12 inches wide may be fabricated from 0.048-inch nominal-thickness steel sheet.
 2. Doors for box lockers less than 15 inches wide may be fabricated from 0.048-inch nominal-thickness steel sheet.
 3. Reinforcement: Manufacturer's standard reinforcing angles, channels, or stiffeners for doors more than 15 inches wide; welded to inner face of doors.
 4. Stiffeners: Manufacturer's standard full-height stiffener fabricated from 0.048-inch nominal-thickness steel sheet; welded to inner face of doors.
 5. Sound-Dampening Panels: Manufacturer's standard, designed to stiffen doors and reduce sound levels when doors are closed, of die-formed metal with full perimeter flange and sound-dampening material; welded to inner face of doors.
 6. Door Style: Unperforated panel.
- G. Hinges: Welded to door and attached to door frame with no fewer than two factory-installed rivets per hinge that are completely concealed and tamper resistant when door is closed; fabricated to swing 180 degrees; self-closing.
1. Knuckle Hinges: Steel, full loop, five or seven knuckles, tight pin; minimum 2 inches high. Provide no fewer than three hinges for each door more than 42 inches high.
- H. Projecting Door Handle and Latch: Finger-lift latch control designed for use with either built-in combination locks or padlocks; positive automatic latching, chromium plated; pry and vandal resistant.
1. Latch Hooks: Equip doors less than 48 inches high with two latch hooks; fabricated from 0.105-inch nominal-thickness steel sheet; welded or riveted to full-height door strikes; with resilient silencer on each latch hook.
 2. Latching Mechanism: Manufacturer's standard, rattle-free latching mechanism and moving components isolated to prevent metal-to-metal contact, and incorporating a prelocking device that allows locker door to be locked while door is open and then closed without unlocking or damaging lock or latching mechanism.
- I. Combination Padlocks: Provided by Owner.
- J. Equipment: Equip each metal locker with identification plate and the following unless otherwise indicated:
1. Double-Tier Units: One double-prong ceiling hook and two single-prong wall hooks.
- K. Accessories:
1. Filler Panels: Fabricated from [manufacturer's standard thickness, but not less than 0.036-inch nominal-thickness steel sheet.
 2. Boxed End Panels: Fabricated from 0.060-inch nominal-thickness steel sheet.
 3. Center Dividers: Fabricated from 0.024-inch nominal-thickness steel sheet.
 4. Continuous Zee Base: Fabricated from 0.060-inch nominal-thickness steel sheet. Height – 4 inches.
- L. Finish: powder coat.
1. Color(s): As selected by Architect from manufacturer's full range.

2.3 FABRICATION

- A. Fabricate metal lockers square, rigid, and without warp and with metal faces flat and free of dents or distortion. Make exposed metal edges safe to touch and free of sharp edges and burrs.

1. Form body panels, doors, shelves, and accessories from one-piece steel sheet unless otherwise indicated.
 2. Provide fasteners, filler plates, supports, clips, and closures as required for complete installation.
- B. Knocked-Down Construction: Fabricate metal lockers using nuts, bolts, screws, or rivets for preassembly at plant prior to shipping.
- C. Accessible Lockers: Fabricate as follows:
1. Locate bottom shelf no lower than 15 inches above the floor.
 2. Where hooks, coat rods, or additional shelves are provided, locate no higher than 48 inches above the floor.
- D. Hooks: Manufacturer's standard ball-pointed type, aluminum or steel; zinc plated.
- E. Identification Plates: Manufacturer's standard, etched, embossed, or stamped aluminum plates, with numbers and letters at least 3/8 inch high.
- F. Filler Panels: Fabricated in an unequal leg angle shape; finished to match lockers. Provide slip-joint filler angle formed to receive filler panel.
- G. Boxed End Panels: Fabricated with 1-inch- wide edge dimension, and designed for concealing fasteners and holes at exposed ends of nonrecessed metal lockers; finished to match lockers.
- H. Center Dividers: Full-depth, vertical partitions between bottom and shelf; finished to match lockers.

2.4 STEEL SHEET FINISHES

- A. Factory finish steel surfaces and accessories except stainless-steel and chrome-plated surfaces.
- B. Powder-Coat Finish: Immediately after cleaning and pretreating, electrostatically apply manufacturer's standard, baked-polymer, thermosetting powder finish. Comply with resin manufacturer's written instructions for application, baking, and minimum dry film thickness.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine walls, floors, and support bases, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Install level, plumb, and true; shim as required, using concealed shims.

1. Anchor locker runs at ends and at intervals recommended by manufacturer, but not more than 36 inches o.c. Using concealed fasteners, install anchors through backup reinforcing plates, channels, or blocking as required to prevent metal distortion.
 2. Anchor single rows of metal lockers to walls near top and bottom of lockers.
- B. Knocked-Down Metal Lockers: Assemble with standard fasteners, with no exposed fasteners on door faces or face frames.
- C. Equipment and Accessories: Fit exposed connections of trim, fillers, and closures accurately together to form tight, hairline joints, with concealed fasteners and splice plates.
1. Attach hooks with at least two fasteners.
 2. Attach door locks on doors using security-type fasteners.
 3. Identification Plates:
 - a. Attach plates to each locker door, near top, centered, with at least two aluminum rivets.
 4. Attach filler panels with concealed fasteners. Locate filler panels where indicated on Drawings.
 5. Attach boxed end panels with concealed fasteners to conceal exposed ends of nonrecessed metal lockers.

3.3 ADJUSTING, CLEANING, AND PROTECTION

- A. Clean, lubricate, and adjust hardware. Adjust doors and latches to operate easily without binding.
- B. Protect metal lockers from damage, abuse, dust, dirt, stain, or paint. Do not permit use during construction.
- C. Touch up marred finishes, or replace metal lockers that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by locker manufacturer.

END OF SECTION 10 5113

SECTION 12 3553 – LABORATORY CASEWORK

PART 1 – GENERAL

1.1 SUMMARY

- A. Furnish and install work under this section including but not limited to the following:
 - 1. Laboratory casework, metal
 - 2. Shelves
 - 3. Stainless steel pass through

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Related sections:
 - 1. Section 12 3653 – Laboratory Countertops.
 - 2. Division 22: Furnishing and installation of piping, drainline, traps, final connections and setting of sinks and fixtures.
 - 3. Division 26: Furnishing and installation of electrical wiring, conduit and/or electrical items and final connections.

1.3 SUBMITTALS

- A. Submit complete materials list for all raw and manufactured items.
 - 1. Provide complete data on finish material. Include chemical resistance chart and application method to assure compliance with specified qualities.
- B. Provide complete manufacturer's full product line catalog for casework. Provide individual catalog cut sheets for hardware items, including manufacturer's name, address and phone number.
- C. Submit the following samples:
 - 1. Two - 6 inch x 6 inch samples of exposed and semi-exposed materials indicated in the drawings and specified herein. Include casework, finish, work-surfaces, service units and shelving.
 - 2. Two - each of locks, door pulls, hinges, and other casework hardware.
 - 3. Samples and Mock-ups will be retained by the Owner or Architect to ensure that material delivered to job site conforms in every respect to the accepted submittals.
- D. Include product test reports from and based on tests performed by a qualified independent testing laboratory evidencing compliance of laboratory casework finishes with requirements specified for chemical and physical resistance.
- E. Shop drawings for laboratory casework and fittings showing plan layout, elevations, ends, cross-sections, service run spaces, location and type of service fittings, together with associated service supply connection required.
 - 1. Submit shop drawings as one complete submittal that includes all items specified in this section. Submittals that include only part of the specified items of this section are not acceptable and will be rejected.
 - 2. Include details and location of anchorages and fitting to floors, walls, and base, including required blocking or back blocking.

3. Include layout of units with relation to surrounding walls, doors, windows, and other building components.
 4. Coordinate shop drawings with other work involved.
 5. Include manufacturer's recommendations for blocking and securing of laboratory casework units and fittings.
- F. Submit written certification stating that work is installed per specifications, applicable codes, and standards.
1. Structural calculations, as required showing conformance to applicable Codes, including shelf loading.
 2. Independent testing laboratory report on chemical resistance and physical requirements.
 3. Submit location, facility, owner, city and state where casework finish is being applied.
- G. Submit casework Installer's qualifications and location.
- H. Submit for Owner's review and use, three complete operations and maintenance manuals that describe proper maintenance and replacement schedules, components and parts list. Provide point of contact for factory representative.

1.4 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide laboratory casework capable of withstanding the following loads without permanent deformation, excessive deflection, or binding of drawers and doors:
1. Fixed Casework:
 - a. Shelves of Base, Wall, and Storage Cabinets: 100 lb.
 - b. Drawers: 150 lb
 - c. Wall Cabinets: 300 lb/ft.
 - d. Doors less than 48 inch: 150 lbs.

1.5 QUALITY ASSURANCE

- A. Single Source Responsibility:
1. Provide laboratory casework with tops, sinks, and service fittings, manufactured or furnished by same laboratory furniture company for single responsibility within the laboratory areas and rooms.
 2. Provide casework by company with minimum of 10 years experience in the manufacture of laboratory casework of the type specified for this project.
- B. Installer: Installer of laboratory casework shall be trained and certified by the manufacturer of the casework. Installer shall have a minimum of 5 years experience with the installer in successful completion of comparable work.
- C. Testing Laboratory Qualifications: To qualify for acceptance, an independent testing laboratory must demonstrate to Architect's satisfaction, based on evaluation of laboratory-submitted criteria conforming to ASTM E 699, that it has the experience and capability to conduct satisfactorily the testing indicated.
- D. Product Standard: Comply with SEFA 8, "Laboratory Furniture--Casework, Shelving and Tables--Recommended Practices."

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver laboratory casework only after building is enclosed, weathertight, and wet operations in building are completed, and proper facilities are available for handling, storage and protection
- B. Protect finished surfaces from soiling and damage during handling and installation. Cover with polyethylene film or other protective covering.
- C. Store laboratory casework in a ventilated area, protected from the weather, with relative humidity of 50 percent or less, at 70 degrees F (22 degrees C).
- D. Replacements: In the event of damage, immediately make repairs and replacement necessary for acceptance by the Owner at no change in contract amount.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install casework until HVAC system is operating and will maintain temperature and relative humidity at occupancy levels during the remainder of the construction period.
- B. Coordinate installation of casework with General Contractor to determine whether adjacent construction, especially floor, wall, and ceiling finishes, is at a stage of completion permitting the installation of casework.
- C. Coordinate layout and installation of framing and reinforcements for support of wood laboratory casework.

1.8 EXTRA MATERIALS

- A. Furnish four complete touch-up kits for each type and color of laboratory casework provided. Kit to include touch-up paint, touch-up transparent finish, and other materials necessary to perform permanent spot repairs to damaged casework finish.

1.9 WARRANTY

- A. Special Project Warranty: Submit a written warranty for 2 years after the date of Final Acceptance, executed by the manufacturer, agreeing to repair or replace laboratory casework that fails in materials or workmanship within the specified warranty period. This warranty shall be in addition to and not a limitation of other rights the Owner may have against the Contractor under the Contract Documents.
- B. Defects include, but are not limited to:
 - 1. Ruptured, cracked, or stained coating.
 - 2. Weld or structural failure.
 - 3. Slippage, shifts, or failures of connected components, including attachments to wall, floor, ceiling, or building structure.
 - 4. Warping or unloaded deflection of components.
 - 5. Discoloration or lack of finish integrity.
 - 6. Cracking or peeling of finish.
 - 7. De-lamination of plastic laminate or edge banding.
 - 8. Visible weld marks.
 - 9. Sealant deterioration, shrinkage, or failure.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with requirements, provide products of one of the following:
 - 1. Jamestown Metal Products
 - 2. Kewaunee Scientific Corporation.
 - 3. Mott Manufacturing.
- B. Subject to compliance with requirements, provide the named product or a comparable product by one of the other manufacturers specified.

2.2 RECYCLED CONTENT OF STEEL MATERIALS

- A. Recycled Content of Steel Materials: Provide steel materials manufactured domestically using the electric arc furnace method and containing the maximum possible amount of postconsumer and preconsumer recycled steel content

2.3 MATERIALS

A. METAL LABORATORY CASEWORK

- 1. Steel Sheet: Prime furniture steel, stretcher, or roller leveled, free of scales, buckles, or other defects impairing strength, durability, or appearance; ASTM A 366, Class 1 (matte) finish.
- 2. Stainless-Steel Sheet: ASTM A 167, Type 302 or 304, stretcher leveled, free of scales, buckles, or other defects impairing strength, durability, or appearance; polished after fabrication to produce an AISI No. 4 finish.
- 3. Minimum Metal Thickness: Provide steel laboratory casework components of following minimum thickness, expressed in inches. Manufacturers proposing substitutions for the material thickness listed below shall submit warranty of equivalent performance for the Architect's review.
 - a. 0.0396 inch thick:
 - 1) Back panels.
 - 2) Inner door panels.
 - 3) One-piece drawer body and drawer front.
 - 4) Shelves; add hat channel reinforcement or use 0.0516 inch thick material for shelves over 36 inch long.
 - b. 0.0516 inch thick:
 - 1) Sides, ends, and fixed backs.
 - 2) Bottoms, tops, and soffits.
 - 3) Door fronts.
 - 4) Base.
 - 5) Filler panels.
 - 6) Items not otherwise noted.
 - c. 0.0635 inch thick:
 - 1) Top front rails and intermediate horizontal rails.

- 2) Center posts.
- 3) Top gussets.
- d. 0.0785 inch thick:
 - 1) Front corner reinforcement (4 corners).
 - 2) Top back rail.
 - 3) Drawer suspension.
 - 4) Sink supports
 - 5) Hinge reinforcements.
- e. 0.1084 inch thick: Leveling and corner gussets.
- f. Glass for Glazed Doors: 3/16 inch (5mm) clear float tempered.

2.4 SURGICAL PASS THROUGH CABINETS

1. Finish: constructed of 18 gauge, type 304 stainless steel with No.4 finish. All welds to be Heliarc process and ground and polished to match No.4 finish.
2. Flange: self trimming or applied matching perimeter flange to maintain seal at surrounding construction.
3. Mounting: mounted on contractor built base
4. Door glazing: Double wall construction; outer head shall be one piece construction; inner head shall consist of top, bottom and side framing members which are removable for installation and replacement of glass. Provide continuous neoprene glazing retainer to receive glass. Provide gasketing and astragal for double doors.
5. Shelving - combination of one fixed (as required by height) and multiple adjustable. Pilaster strips for adjustable shelving support should be easily removed to allow for sterilization of cabinet and strips.
6. Mechanical interlocks prevent both doors from opening simultaneously.
7. Manufacturers in addition to 2.1.A:
 - a. Continental Metal Products
 - b. G2 Advanced Technologies
 - c. Stanley Innerspace
 - d. Steris
 - e. TBJ
 - f. Terra Universal

2.5 HARDWARE

- A. Standard drawer suspension:
 1. Drawers less than 6 inch deep: Full extension, ball-bearing roller, 100 lb. dynamic load, zinc-plated Accuride 3832 series or equal on all drawers except file drawers.
 2. Drawers 6 inch and deeper: Full extension with overtravel, ball-bearing roller, 150 lb. dynamic load, zinc-plated Accuride 4034 series or equal.
- B. Drawer and hinged door pulls:
 1. Metal Casework: Wire with Satin Chrome finish.

2. All pulls are mounted horizontally on drawers and vertical on doors, inset nominally 1 inch from edge.
- C. Hinges:
 1. Metal Casework: Institutional construction, 5 knuckles, 2-1/2 inch long; type 304 stainless steel, brush finish with hinge barrel only projected beyond face of cabinet. Furnish two per door 36 inch high and less, three per door over 36 inch high.
- D. Door Catch:
 1. Metal Casework: Adjustable type, spring actuated nylon roller catches.
- E. Shelf Supports
 1. Metal: Die formed steel, zinc plated, designed to engage in shelf adjustment holes.
- F. Locks:
 1. 5-pin tumbler for MASTER / GRANDMASTER key system. 4488 key changes.

2.6 FABRICATION

A. METAL LABORATORY CASEWORK

1. General: Complete assembly and finishing at point of manufacture. Perform unit assembly on precision jigs to provide units which are square; fully reinforced with angles, gussets, and channels; integrally framed and welded to form a dirt and vermin- retardant enclosure. Grind exposed welds smooth. Where applicable, reinforce base cabinets for sink support. Maintain uniform clearance around door and drawer fronts of between 1/16 inch minimum to 3/32 inch maximum.
2. Fabricate units to permit interchangeability of drawers, hinged doors, and similar pieces of like sizes.
3. Case Construction: Fabricate case with removable back panel and end panels internally reinforced at front and rear with channels that have shelf clip adjustment holes spaced at 1/2 inch o.c.; front of end panel formed into post for attachment of hinges and shelf clips.
 - a. Removable Back Panel: One-piece panel, formed on four sides for rigidity and screwed in place; full height between top back rail and case bottom and full width between end panels or between end panel and intermediate back vertical post.
 - b. Case Bottom: One-piece case bottom and horizontal front rail with case bottom turned up and radiused at sides and rear for ease of cleaning. Horizontal front rail formed with rabbeted offset. Lower corner reinforcing gusset with 2-1/2 inch high leveling bolt at all four corners for base cabinets.
 - 1) Leveling Access: Provide bolt access hole with sealed removable plug button in case bottom or access hole in toe base.
 - c. Top Rail: Interlock and overlap end panels. Form with rabbeted offset.
 - d. Intermediate Horizontal Rails (Base Cabinets): Required for recessed and concealed locks.
 - e. Fabricate cabinets without center posts to permit complete access to interior.
4. Acoustical Lining: Acceptable manufacturer's nonabsorbent lining.
5. Wall Cases: Form ends and back as one-piece, wrap-around design with rear internal reinforcing channels that incorporate shelf clip adjustment holes; fabricate with recess at back to accommodate mounting brackets; form case to conceal mounting brackets or

- furnish filler strips for the purpose; fabricate with double bottom assembly using finished soffit piece to conceal bottom of case.
6. Flush Doors: Double wall construction; outer and inner pans formed and telescoped into box formation, with welded hat channel reinforcements full height on center of each pan. Fill doors solid with fire-resistant, sound-deadening material. Paint interior surfaces before assembly.
 7. Hinges: Attach hinges with screws to 0.0785 inch thick tapped reinforcement strips, welded to inside of inner pan and to case.
 8. Framed Glazed Doors: Double wall construction; outer head shall be one piece construction; inner head shall consist of top, bottom and side framing members which are removable for installation and replacement of glass. Provide continuous neoprene glazing retainer to receive glass
 9. For doors riding on bottom track, provide two adjustable ball bearing traction devices at top of each door to prevent door from riding off track.
 10. Drawers: Assemble fronts from telescoping inner and outer pans, designed to eliminate raw edge of steel at top. Fabricate sides, back, and bottom of one piece with fully coved 1/4 inch minimum radius inside corners (front, back, and both sides vertically and horizontally), with rolled or formed top of sides for stiffening and comfortable grasp for drawer removal. Weld drawer front to sides, and bottom to form a single, integral unit. Provide drawers with rubber bumpers, runners, and positive stops to prevent metal-to-metal contact or accidental removal. Provide fire-resistant, sound-deadening material between inner and outer pans. Paint interior surfaces before assembly.
 11. Adjustable Shelves: Front, back, and ends formed down, with returns at front and back edges. Form front and back edges down and back 3/4". Form ends down 3/4". Reinforce shelves over 36" long with hat channel reinforcement the full width of shelf.
 12. Pull-Out Shelves: Turn front, sides, and back edges up to form lip.
 13. Filler Panels: Provide at exposed-to-view areas, between back of cabinets and walls, knee opening spaces, and scribed where required to enclose gaps; easily removed for access to utility chase; fabricate with 1/2 inch return at four sides.
 14. Utility Space: Provide space, cutouts, and holes for pipes, conduits, and fittings in cabinet bodies to accommodate services and their support-strut assemblies.
 15. Cabinet Base: Flanged metal strip welded to case bottom forming a fully enclosed toe space --approximately 4 inch high by 3 inch deep without gaps or pockets; inside corners mitered and outside corners wrapped.
 16. Rubber Bumpers: Provide 3/8 inch diameter soft rubber buttons attached to case for doors and drawers to close against.

2.7 CASEWORK FINISH

A. METAL LABORATORY CASEWORK

1. Provide laboratory casework with a factory-applied finish that is capable of withstanding the tests specified in this article with no permanent change in gloss, color, film hardness, adhesion, or film protection.
 - a. Acids:
 - 1) Not less than 10 drops (0.50 cc) of the following reagents applied to finish surface, covered with watch glass, convex side down, for 60 minutes, then washed and dried.

- 2) Hydrochloric acid (37 percent), sulfuric acid (85 percent), nitric acid (25 percent), phosphoric acid (75 percent), acetic acid (98 percent).
- b. Solvents:
 - 1) Not less than 10 drops (0.5 cc) of the following reagents applied to finish surface, covered with watch glass, convex side up, for 60 minutes, then washed and dried.
 - 2) Ethyl alcohol, butyl alcohol, methyl alcohol, toluene, acetone, benzene, carbon tetrachloride, formaldehyde (37 percent), gasoline, ethyl acetate, ethyl ether, methyl ethyl ketone, naphtha, kerosene, xylene, glycerin, furfural.
- c. Bases and Salts:
 - 1) Not less than 5 drops (0.25 cc) of the following reagents applied to finish surface, covered with watch glass, convex side up, for 60 minutes, then washed and dried.
 - 2) Sodium hydroxide (25 percent), ammonium hydroxide (28 percent), potassium hydroxide (40 percent), saturated zinc chloride, saturated sodium chloride, saturated sodium sulphide, saturated sodium carbonate, poultice of "Tide" laundry detergent and water.
- d. Salt Spray: Withstand 200 hours salt spray exposure conforming to ASTM-B117-59T procedure.
- e. Moisture Resistance: No visible effect when finish surface exposed to the following:
 - 1) Hot water at a temperature of 190 degrees F (91 degrees C) to 205 degrees F (96 degrees C), trickled down surface at 45-degree angle for 5 minutes.
 - 2) Constant moisture using a 2 inch by 3 inch by 1 inch cellulose sponge, soaked with water, in contact with surface for 100 hours.
- f. Cold Crack: No effect when subjected to 10 cycles of temperature change from 20 degrees F (14 degrees C) for 60 minutes to 125 degrees F (52 degrees C) for 60 minutes.
- g. Adhesion and Flexibility: No peeling or cracking or exposure of metal when metal is bent 180 degrees over a 1/2 inch diameter mandrel.
- h. Abrasion: Maximum weight loss of 5.5 mg. per 100 cycles as tested on a Taber abrasion tester #E4010 with 1000 GM wheel pressure and calibrate #CS10 wheels.
- i. Hardness: Hard surface equivalent to 6H pencil lead.
- j. Impact: Withstand forward impact of 64 pounds without chipping or crazing using a Gardner #167 Impact Tester with a 5/8 inch diameter spherical punch.
- k. Humidity Resistance: Withstand 1000 hours exposure in saturated humidity at 100 degrees Fahrenheit.
2. Provide steel laboratory casework with a factory-applied enamel finish that complies with chemical and physical resistance requirements specified.
 - a. Pretreatment: After assembly, thoroughly clean surfaces of grease, dirt, oil, flux, and other foreign matter by physical and chemical means. Treat entire unit with metallic phosphate process leaving surfaces with uniform, fine-grained, crystalline phosphate coating providing excellent bond for subsequent finish.
 - b. Finish Coats: One or more coats of high-bake chemical-resistant enamel to provide a hard and smooth, satin luster finish applied to treated surfaces. Apply finish in powder

form, electrostatically charged, (or use dip-tank method) to interior and exterior surfaces, and average thickness of 1.5 mils and minimum thickness of 1.2 mils.

- 1) Backs of cabinets and other surfaces not exposed to view: 1.0 mil average.
- 2) Color: As selected by the Architect from full range.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Rough-In Work: Examine roughed-in mechanical and electrical services, floors, walls, columns, and ceilings, and other conditions affecting installation of casework. Verify dimensions and locations of services and substrates before fabricating work.
- B. Notify Contractor of unsatisfactory conditions preventing proper installation of casework. Do not proceed with fabrication and installation until unsatisfactory conditions have been corrected in manner satisfactory to Architect and Owner.
- C. Determine that related work in place is not detrimental to the timely completion of the work of this section. Start of this work shall indicate acceptability of related work.

3.2 CASEWORK INSTALLATION

- A. Install plumb, level, true and aligned with no distortions. Shim as required, using concealed shims. Where laboratory casework abuts other finished work, scribe and apply filler strips for accurate fit with fasteners concealed where practicable.
- B. Prior to Substantial Completion verify that all casework hardware has been properly installed. Adjust and align hardware so that moving parts operate freely and contact points meet accurately. Allow for final field adjustment after installation. Adjust casework and hardware so that doors and drawers operate smoothly without warp or bind.
- B. Provide cutouts for related work coordinate with other trades.
- C. Install hardware uniformly and precisely. Set hinges snug and flat in mortises.
- D. Accessory Installation: Install accessories and fittings in accordance with manufacturer's recommendations. Turn screws to seat flat; do not drive.

3.2 CLEANING AND PROTECTION

- A. Repair or remove and replace defective work as directed upon completion of installation.
- B. Clean factory- and shop-finished surfaces, touch up as required, and remove or refinish damaged or soiled areas to match original factory finish, as acceptable to the Architect. Final clean surfaces in accordance with Closeout Procedures.
- C. Protection: Provide a suitable covering over countertop surfaces to prevent marring of surface due to impact, or staining due to corrosive materials; tape to underside of countertop. Protect installed laboratory casework and fittings from damage by work of other trades until date of Substantial Completion.

END OF SECTION 123553

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SECTION 12 3653 – LABORATORY COUNTERTOPS

PART 1 – GENERAL

1.1 SUMMARY

- A. Furnish and install work of this section including but not limited to the following laboratory accessories:
 - 1. Laboratory Countertops.
- B. Related sections:
 - 1. Section 12 3553 – Laboratory Casework
 - 2. Division 22: Furnishing and installation of piping, drainline, traps, final connections and setting of sinks and fixtures.
 - 3. Division 26: Furnishing and installation of electrical wiring, conduit and/or electrical items and final connections.

1.2 SUBMITTALS

- A. Submit product data including specifications, technical data, standard details, and installation recommendations for each type of product required.
- B. Submit shop drawings showing in large scale, methods of construction, joining, dimensions, materials, thickness, finishes of materials, installation details including location of anchorage, fitting to adjoining work, required blocking, and other details required to fully illustrate the work.
 - 1. Refer to Section 12 3553 – Laboratory Casework for laboratory casework and fittings showing plan layout, elevations, ends, cross-sections, service run spaces, location and type of service fittings, together with associated service supply connection required.
 - a. Submit shop drawings as one complete submittal that includes all items specified in this section. Submittals that include only part of the specified items of this section are not acceptable and will be rejected.
 - b. Include details and location of anchorage and fitting to floors, walls, and base, including required blocking or back blocking.
 - c. Include layout of units with relation to surrounding walls, doors, windows, and other building components.
 - d. Coordinate shop drawings with other work involved.
 - e. Include manufacturer's recommendations for blocking and securing of laboratory casework units and fittings.

1.3 QUALITY ASSURANCE

- A. Comply with requirements of the following codes and standards except as shown or specified otherwise:
 - 1. American Society for Testing and Materials (ASTM).
 - 2. Federal Occupational Safety and Health Act (OSHA) Lab Standard Requirements including safe handling of flammable/volatile solvents.
 - 3. National Fire Protection Association (NFPA) Codes and Standards.
 - 4. Underwriters Laboratories, Inc. (UL) Standards for Safety.

5. National Electric Manufacturers Association (NEMA), Standards Publication No. LD3-1975 including Revisions 1 through 4.
- B. Installer: Installer of laboratory countertops shall be trained and certified by the manufacturer of the countertops.
- C. Catalog Standards:
 1. Manufacturer's catalog numbers may be indicated for convenience in identifying certain laboratory countertops and sinks. Unless modified by notation on drawings or otherwise specified, catalog description for indicated number constitutes requirements for each such unit.
 2. The use of catalog numbers and specific requirements set forth in drawings and specifications are not intended to preclude the use of any other acceptable manufacturer's product or procedures which may be equivalent, but are given for purpose of establishing standard of design and quality for materials, construction, and workmanship.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver units in manufacturer's unopened containers. Comply with manufacturer's instructions for storage and handling. Protect from moisture and damage.
- B. Deliver laboratory countertops and sinks only after building is enclosed, weathertight, and wet operations in building are completed.
- C. Protect finished surfaces from soiling and damage during handling and installation. Cover with polyethylene film or other protective covering.

1.5 PROJECT CONDITIONS

- A. Do not begin installation of countertops or sinks until the following adjacent construction is at a stage of completion permitting the installation of laboratory accessories:
 1. Ceilings, overhead ductwork, and lighting.
 2. Painting and flooring.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

2.2 TOPS AND ACCESSORIES

- A. Stainless Steel Tops:
 1. Provide 0.0635 inch thick stainless steel sheet, AISI Type 302/304 with No. 4 satin finish, unless otherwise indicated. Weld shop joints, grind smooth and polish. Provide hairline, butt jointed field joints, mechanically bolted through continuous channels welded to underside at edges. Keep field jointing to a minimum. Apply reinforcing channels to underside of top where necessary to insure rigidity without deflection. Coordinate with architect/owner for reinforcement necessary at heavy owner furnished owner installed equipment.
 2. Extend top down to provide a 1 inch thickness, 3 inch return flange under frame, and 1 inch overhang. Sound-deaden entire undersurface with heavy-build mastic coating.

3. Form backsplash coved and integral with top surface & provide 45 degree slope on back splash where indicated on drawings.
4. Provide a raised marine edge around perimeter of tops containing sinks. Pitch top surface two ways to bowl to provide drainage without channeling or grooving.
5. Where stainless steel sinks occur in stainless steel tops, factory assemble sinks and tops into integral unit with welds ground smooth and polished.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Notify Architect of unsatisfactory conditions preventing proper installation of laboratory countertops.
- B. Do not proceed with installation until unsatisfactory conditions have been corrected in manner satisfactory to Architect.

3.2 INSTALLATION

- A. Work surface installation:
 1. Where required due to field conditions, scribe or caulk to abutting surfaces.
 2. Secure joints in the field, where practicable, in the same manner as in factory, with dowels, adhesive or fasteners recommended by manufacturer.
 3. Secure work surfaces to casework and equipment components with material and procedures recommended by the manufacturer.
 4. Provide cutouts for related work coordinate with other trades.
- B. Field Jointing of Epoxy Tops: Locate field joints as shown on approved shop drawings; factory prepare mating surfaces so there is no jobsite processing of top and edge surfaces. Join using adhesives recommended by manufacturer and that match the color of the top.
- C. Fastening Tops to Base Cabinets:
 1. Epoxy Tops: Secure tops to cabinets with silicone adhesive, applied at each corner and continuously along perimeter edges.
- D. Tolerance: Install countertops with no more than 1/8 inch in 96 inch sag, bow, or other variation from a straight line.
- E. Abut top and edge surfaces in one true plane, with internal supports placed to prevent deflection.
 1. Join tops using clamping devices to create flush hairline joints. At joints in epoxy tops, use manufacturer's recommended adhesives and clamping devices to create joint widths of not more than 1/16 inch, completely filled and flush with abutting surfaces.
 2. Where necessary to penetrate epoxy tops with fasteners, countersink heads approximately 1/8 inch and plug hole flush with material equal in chemical resistance, color, hardness, and texture to top surface.
- F. Provide holes and cutouts as required for mechanical and electrical service fittings.
- G. Carefully dress joints smooth, remove surface scratches, and clean and polish entire surface.

- H. Provide scribe moldings for closures at junctures of top, curb, and splash with walls as recommended by manufacturer for materials involved.
- I. Use chemical resistant, silicone sealant where top abuts wall surfaces. Refer to Section 07 9200 – Joint Sealants.
- J. If required, install electrical service fittings in accordance with applicable provisions of Division 26 – Electrical.

3.3 CLEANING AND PROTECTION

- A. Repair or remove and replace defective work as directed upon completion of installation.
- B. Clean factory and shop finished surfaces, touch up as required, and remove or refinish damaged or soiled areas to match original factory finish, as acceptable to the Architect. Clean materials as recommended by manufacturer.
- C. Protection: Provide a suitable covering over countertop surfaces to prevent marring of surface due to impact, or staining due to corrosive materials; tape to underside of countertop. Protect installed laboratory casework and fittings from damage by work of other trades until date of Substantial Completion.
- D. Sink installation: Sinks shall be set in chemical-resistant sealing compound, secured and supported per manufacturer's recommendations.
- E. Accessory installation: Install accessories and fittings in accordance with manufacturer's recommendations. Turn screws to seat flat; do not drive.

END OF SECTION 123653

SECTION 146200 – Electric Trolley Hoists

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Electric chain hoist and motor mounted trolley.

1.2 SUBMITTALS

- A. Shop Drawings:
 - 1. Make, model, weight and horsepower
 - 2. Complete catalog information, descriptive literature, materials of construction and specifications on hoist, wheels, controls, remote control systems and accessories.
 - 3. Power and control wiring diagrams including terminals and numbers.
 - 4. Motor nameplate in accordance with NEMA MG1 and include any motor modifications.
 - 5. Spare parts and special tools to maintain the equipment in service for 5 years.
- B. Operations and maintenance data.

1.3 QUALITY ASSURANCE

- A. A single manufacturer shall fabricate and supply the hoist and trolley assembly, electrical equipment, controls and accessories.
- B. Factory inspections: inspect control panels and equipment for required construction, electrical connection, and intended function.
- C. Factory tests and adjustments: no-load run test all equipment furnished.
- D. Provide factor test report.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store materials in original undamaged packages and containers inside a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.

1.5 PROJECT CONDITIONS

- A. Environmental Limitations:
 - 1. Do not install system components until the space is enclosed and weatherproof.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide basis of design product as listed below, or equal:

1. Coffing 1-Ton JLC Single Phase Electric Chain Hoist, 10' of Lift, Motor Trolley Mounted, JLCMT-2016-7-10 (3ph/208V, 10' lift, 35fpm MT trolley); trolley & rollers compatible with W16x50 hoist beam.4Coffing JLC927-1 chain container. Coffing DN-4-45 (08004W) Cord Reel, wire to be compatible with hoist and info shown in electrical drawings for power supply, and supply cable stop and Kellems cord grip.

2.2 DESIGN REQUIREMENTS

- A. Hoist Beam: W16x50 steel beam.
- B. Hoist: ANSI 830.1 1 and Hoist Manufactures' Institute.
- C. Trolley: ANSI MH27.1
- D. Chain hoist service class: ASME HST-1
- E. Stress and safety factors: ANSI MH27.1 and ANSI 830.1 1. Properly select materials of construction for stresses to which subjected.
- F. Safety of Operation, accessibility, interchangeability, and durability of parts: ANSI 830.1 1 and OSHA requirements.
- G. Service Classification: Class A (standby or infrequent service) per CMAA No. 74.
- H. Load Capacity: 1 Ton
- I. Lift: 10 feet
- J. Temperature (interior): maximum 100-degrees F: minimum 50-degrees F

2.3 TROLLEY

- A. Frame: welded steel, cast steel, or ductile iron construction, or combination thereof. Construct to control deflection of trolley assembly while transmitting the carrying load to running surface.
- B. Drive: electric
- C. Bearings: Combination radial and thrust type, double row, angular contact ball bearings, or single-row tapered roller bearings. Bearings prelubricated and sealed, or fitted for pressure lubrication. Locate pressure lubrication fittings for accessibility during maintenance.
- D. Brakes: suitable for service class and rated torque capacities as specified in ANSI 830.1 1.

2.4 HOIST

- A. Hoisting machinery: electric load chain wheel driven through gear reductions, hand chain wheel, load blocks, sheaves, chain, hook, and hoist braking.
- B. Chain: non jamming alloy type Hand chain wheel deep pocket for reception of chain. Hand wheel shall have a guard that prevents chain slipping or jumping. Chain hoists shall have a chain storage adequate for storing the full lift length of chain and shall be designed and located to avoid interference while hoisting.

- C. Hook: construct with sufficient ductility to open noticeably before hood failure, equipped with safety latch, free to rotate 360-degrees with rated load, and positively held in place with locknuts, collars, and other devices.
- D. Brakes: in accordance with ASME HST-1, adjustable to compensate for wear, positive action, Weston Type mechanical load brake, with uniform composition lining and forged steel alloy latch pawl.

2.5 ELECTRICAL

- A. Furnish electrical equipment including motors, motor starters, pendant control, control systems, wire, and conduit.
- B. Electrical: in accordance with NFPA 70, NEC article 610.
- C. Monorail conductor voltage drops from monorail track supply taps shall permit the hoist and trolley motors to operate within voltage tolerances of plus or minus 10 percent, when building supply voltage is at plus or minus 5 percent of design voltage.
- D. Cable Reel Conductors: flexible cable, housed on a circular wheel, countertorque spring to dispense and retrieve cable, with sag not more than 3 feet below connection points on hoist or trolley at maximum travel.
- E. Grounding: external in accordance with NFPA 70, NEC article 250.

2.6 CONTROLS

- A. Hoist: pendant control having momentary contact pushbuttons with a device that will disconnect motors from line on failure of power. Device shall not permit any motor to be restarted until controller handle is brought to the off position, or a reset switch or button is operated. Furnish with undervoltage protection as a function of each motor controller, or by magnetic main line contactor.
- B. Pushbuttons: fully magnetic, plain reversing type, housed in NEMA 250 Type 12 enclosure, with contactors of sufficient size and quantity for starting, accelerating, reversing, and stopping duty for specified hoist service class.

2.7 FACTORY FINISHING

- A. Manufacturer's primer and protective coatings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions
- B. Lubricate all bearings, gears, and fittings in accordance with the manufacturer's recommendations.

3.2 FIELD QUALITY CONTROL

- A. Functional tests: test complete assemblies for proper alignment and connection, and quiet operation.

- B. Performance test: load tests in compliance with OSHA, ANSI 830.11 and ANSI MH27.1 to 125% of capacity by a certified crane vendor.

END OF SECTION 146200

SECTION 22 00 10 – PLUMBING GENERAL REQUIREMENTS

PART 1 - GENERAL

A. DESCRIPTION

1. These general provisions specified herein apply to all Sections of Division 22.
2. Refer to the General and Supplementary Conditions and Division 00 and Division 01 for special requirements and conditions which apply to all Sections of Division 22.
3. Related Sections that pertain to certain Division 22 scope includes the following:
 - a) Section 03 30 00, Cast-in-Place Concrete
 - b) Section 31 50 00, Excavation Support and Protection
 - c) Division 26 Specifications for wiring, raceway and devices for power wiring above 24 V.

B. QUALITY ASSURANCE

1. Conform to the North Carolina State Building Code: Plumbing Code 2018.
2. Conform to the National Institutes of Health (NIH) Design Requirements Manual, Rev 1.5: 3/5/2020 henceforth referred to as the DRM.
3. Codes, standards and regulations specified herein refer to the edition date. Revisions and addenda to these codes, standards and regulations shall be part of these specifications. Provisions of referenced codes, standards, and regulations do not create duty or responsibility by the Architect or the Owner, unless otherwise specified herein.
4. Codes, standards and regulations referred to are minimum standards. Where the requirements of these specifications or drawings exceed those of the codes, standards and regulations, the drawings or specifications shall govern.

C. SPACE CONDITIONS

1. Drawings indicate locations of fixtures, apparatus, equipment, and piping. Changes in the location, and offsets, of same to accommodate building conditions, and coordination with the work of other trades, shall be made prior to initial installation, without additional cost to the Owner.
2. Provide access to equipment and apparatus requiring operation, service or maintenance throughout the life of the system.
3. Piping or equipment shall not be installed directly above or below electrical equipment (switchboards, switchgear, panelboards, motor control centers, variable speed drives, transformers, and starters) from the floor to the structure above. Where such routing cannot be avoided contact the Engineer for direction and assume that installation of a drain pan above the equipment will be required.

D. DEFINITIONS

1. Exposed: Piping, conduit, or ductwork is that which can be seen when the base building is complete without opening or removing access doors or panels or accessible ceiling components.
2. Concealed: Piping, conduit, and ductwork that is not exposed is considered to be concealed.
3. Vivarium: A facility that houses and maintains animals for the purpose of conducting research.

E. TEMPORARY SERVICES

1. Temporary utilities shall be in accordance with requirements specified under Division 1.

F. COORDINATION OF ELECTRICAL REQUIREMENTS

1. The power ratings of motors and other plumbing equipment and the electrical characteristics of electrical systems serving them, as specified herein and indicated on the Drawings, have been established as minimums which will allow that equipment to satisfactorily function while producing the required capacities. These power ratings include a safety factor deemed appropriate to accommodate common differences between design parameters and field construction practices. Under no circumstances shall equipment with power ratings less than those indicated on the Drawings or specified herein be provided.
2. Reasonable efforts have been made to coordinate the electrical requirements of the plumbing equipment with the electrical systems serving that equipment. Differences among manufacturers of plumbing equipment make it impossible to produce a single electrical design which will satisfy the varying electrical requirements of those manufacturers. Consequently, the Contractor shall coordinate the electrical requirements of the plumbing equipment actually furnished on this Project and provide the electrical systems required by that equipment. This coordination effort shall be completed prior to the installation of either the plumbing equipment or the electrical systems serving that equipment. Electrical system revisions required to coordinate with the plumbing equipment actually furnished shall be provided at no additional cost to the Owner.

G. RELATED WORK DESCRIBED IN OTHER DIVISIONS

1. Installation of access panels in wall and ceiling construction.
2. Painting, except as specified herein.
3. Casework.
4. Site water and sewer.

H. SUBMITTALS

1. Submittals shall be prepared in a line-by-line format corresponding to these Specifications and shall indicate compliance with each requirement specified herein and indicated on the Drawings.
 - a) Indicate manufacturer's installation instructions.
 - b) Indicate deviations, if any, including any from the manufacturer's installation instructions.

- c) Reproduction of design drawings shall not satisfy requirement for preparation of shop drawings.
 - d) Coordination drawings of plumbing systems, showing equipment, piping, elevations, dimensions, valves, sleeves, and accessories, coordinated with building conditions and other trades, shall be prepared where multi-trade work is required in a confined area
2. Plumbing submittals shall include the following:
- a) Backflow preventers and check valves.
 - b) Trap primers.
 - c) Hot water circulating flow control and balancing valves.
 - d) Flow meters.
 - e) Hot water circulating pumps and controllers.
 - f) Medical gas equipment, including, regulators, accessories, controls, and alarms.
 - g) Medical gas piping, valves, and fittings.
 - h) Plumbing fixtures and trim.
 - i) Sanitary waste and vent piping.
 - j) Sanitary pipe couplings.
 - k) Medical vacuum system, including liquids/solids interceptor.
 - l) Valves.
 - m) Wall hydrants and hose bibs.
 - n) Water heaters and thermal expansion tanks.
 - o) Water meters.
 - p) Motors

I. EQUIPMENT AND INSTALLATION REQUIREMENTS

- 1. Equipment and materials shall, unless otherwise specified herein, be new and shall be of the customary standard and quality furnished by the designated manufacturer for that catalogue number.
- 2. Materials and equipment shall be UL listed, and shall bear the UL listing mark on products for which standards have been established and for which listing is regularly furnished by UL.
 - a) In lieu of the UL listing, or where standards have not been established by UL and UL listing is not regularly furnished, materials and equipment shall be listed by a laboratory recognized under the OSHA Nationally Recognized Testing Laboratory Program, including:
 - a. ETL Testing Laboratories, Inc.
 - b. MET Electrical Testing Company, Inc.

PART 2 - PRODUCTS

A. General:

- 1. Make all hanger assemblies and channel strut systems complete with hanger rods, nuts, bolts, screw attachments, and upper supports attached to the structure as applicable to project requirements.

2. Select hanger assemblies for single piping, using the weight of piping, insulation, and valves being supported.
3. Select channel strut systems for gang piping, using the combined weight of the piping, insulation, and valves being supported.
4. Select supports for equipment with an additional live load of 300 lbs for workers and supplies.

B. HANGERS AND SUPPORTS

1. Pipe Hangers:

- a) Steel Piping and insulated water piping 0.5" to 3": adjustable band hanger, steel with galvanized finish, and threaded swivel knurl nut.
 - i. Manufacturer: Anvil 69, B-Line B3170NF, or PHD 141.
- b) Copper tubing 0.5" to 3": non-insulated: adjustable band hanger, steel with copper finish and threaded swivel knurl nut.
 - i. Manufacturer: Anvil CT-69, B-Line B3170 CT, or PHD 152.
- c) Cast iron piping: AWWA adjustable clevis hanger, steel with galvanized finish.
 - i. Manufacturer: Anvil 590, B-Line B3102, or PHD 420.
- d) For polypropylene, PVDF, polyvinyl chloride (PVC), and borosilicate glass piping: PVC-coated; B-Line B3100C, Anvil 69C, or PHD 453.
- e) Channel strut systems for gang piping: minimum 14 gauge galvanized steel strut with factory-punched attachment holes, and galvanized straps, nuts, bolts, washers, and accessories.
 - i. Straps shall be designed so that the attachment nut is captive on the shoulder of the strap when tightened, and designed to provide a surface on the turned down edge against the pipe while making positive contact with the side walls of the channel.
 - ii. Trapeze channel strut systems shall be designed for an additional live load of 200 lbs.
 - iii. Manufacturer: Anvil, B-Line, PHD, or Unistrut.
- f) General: complete with rods and supports proportioned to the size of piping or equipment to be supported.

2. Hanger Rods:

- a) One-piece steel type, threaded as required.
- b) Sizes, unless specified otherwise herein, shall be as follows:

<u>Pipe Size</u>	<u>Rod Diameter</u>
2" and smaller	0.375"
2.5" and 3"	0.5"
4"	0.625"
6"	0.75"

- c) Sizes for gang or multiple hangers: calculated for the combined weight of the piping and accessories.
- d) Sizes for equipment hangers: calculated for the weight of the equipment supported.

3. Concrete Inserts:

- a) Single hanger type for piping and equipment up to 1000 lbs load limit per hanger and 10" diameter pipe: steel with galvanized finish, channel nuts, anchor tabs, and nut cavity protection.
 - i. Manufacturer: Anvil 281, B-Line 2505-2508, and PHD 951.
- 4. Expansion Anchors, Concrete/Masonry:
 - a) In concrete walls and slabs: wedge, self-drilling, or drilled flush type. Anchors shall have minimum 1000 psig pull-out strength and shall have zinc finish.
 - i. Steel overhead sleeve type: to concrete slabs for threaded hanger rods. Complete with threaded stud body, expansion sleeve, female threaded rod coupling nut, washer, and zinc finish.
 - b) In masonry walls: Steel sleeve type complete with split expansion sleeve over a threaded stud bolt body with integral expander, nut, washer, and zinc finish. Anchors shall have a minimum 300 psig pull out strengthsleeve type.
 - c) Manufacturer: Hilti, ITW Ramset/Red Head, ITW, Powers, or Rawl.
- 5. Channel strut systems: 14 gauge minimum galvanized steel, with factory-punched attachment holes. Straps shall be designed so that the attachment nut is captivated on the shoulder of the strap when tightened. Attachment nuts shall be designed to provide a surface on the turned down edge while making positive contact with the side walls of the channel. Nuts, bolts, straps, and accessories shall be protected with same finish as channels.
 - a) Manufacturer: B-Line, Kindorf, Midland-Ross, or Unistrut.
- 6. Split Ring Clamps:
 - a) Steel piping 0.5" to 3": hinged split ring pipe clamp, malleable iron with galvanized finish, threaded rod, and base plate with mounting holes.
 - i. Manufacturer: Anvil 138R, B-Line B3198H, PHD 508R.
 - b) Copper piping 0.5" to 2": hinged split ring pipe clamp, malleable iron with copper finish, threaded rod, and base plate with mounting holes.
 - i. Manufacturer: Anvil CT138R, B-Line B3198HCT, PHD 512H.
 - c) Pipe Clamps, rods, and wall flanges supported piping exposed below finished ceilings or on walls within the vivarium shall be stainless steel. Pipe shall be offset from wall ½" to permit cleaning behind the pipe.
- 7. Pipe Stand Supports:
 - a) Piping 4" and larger: steel floor stanchion type with galvanized finish, adjustable pipe saddles with U-bolt yoke, locknut nipple, threaded riser, and threaded baseplate with mounting holes.
 - i. Manufacturer: Anvil 265, B-Line B3092, or PHD 876.
- 8. Riser Clamps:
 - a) Steel piping: standard type, steel with galvanized finish, nuts, and bolts.
 - i. Manufacturer: Anvil 40, B-Line B3373, or PHD 551.
 - b) Cast iron piping: AWWA type, steel with galvanized finish, nuts, and bolts.
 - i. Manufacturer: Anvil 261, B-Line B3373DI, or PHD 522.
 - c) Copper tubing to 6" in size: steel with copper finish, nuts, and bolts.
 - i. Manufacturer: Anvil CT-121, B-Line B3373CT, or PHD 552.
 - d) Plastic piping: standard type, steel with plain finish, PVC lining, nuts, and bolts.
 - i. Manufacturer: B-Line B3373C, or PHD 553.
- 9. Accessories:

- a) Insulation protectors: minimum 18 gauge galvanized rolled steel with radius to fit the outside diameter (OD) of the insulation. Provide protectors 12" long for 6" and smaller OD's, 18" long for 8" to 10" OD's, and 24" long for 12" and larger OD's.
- i. Manufacturer: Anvil 167, B-Line B3151, or PHD 170.

10. Pipe Supports in Vivaria:

- a) Piping supports in finished areas within the secure boundary of the vivarium shall be stainless steel and stand off from the finished surface not less than 1".

C. VALVE TAGS

1. Minimum 19 gauge polished brass, 1.5" minimum size. Tags shall be round for plumbing, square for HVAC, and octagonal for fire protection. Stamped numbers and letters shall be not less than 0.75" high, and filled with black paint.

D. IDENTIFICATION MATERIALS

1. Nameplates and signs: laminated plastic, engraved with white letters. Background color shall be black. Equipment served from standby power shall have black letters and red background.
2. Pipe identification shall be 5 mil thick, self-adhering vinyl plastic tape. Tape and legend shall be as follows:

<u>Diameter (Including Insulation)</u>	<u>Width</u>	<u>Size of Legend Letters</u>
0.75 - 1.25"	8"	0.5"
1.5 - 2"	8"	0.75"
2.5 - 6"	12"	1.25"
8 - 10"	24"	2.5"
Over 10"	32"	3.5"

- a) Legends shall be in full or abbreviated form, in contrasting color to background color.

E. SLEEVES

1. Sleeves shall be standard weight steel pipe except sleeves for concealed piping through floors not in structural members, and through interior drywall construction may be formed from 26 gauge galvanized sheet metal lapped and riveted.

F. PENETRATION SEALS

1. Fire Stops:
 - a) Refer to Section 07 8413 specifications
2. General penetration sealant shall be siliconized acrylic latex ASTM C834.
3. Expansion Seals:
 - a) Waterproof, modular, mechanical expansion type consisting of synthetic rubber grommets or interlocking links shaped to continuously fill the annular space between the penetrating item and the opening. Sizing of links and sleeve shall be determined by the manufacturer.

- b) Manufacturer: Calpico Pipe Linx, Metraflex MetraSeal, or Thunderline Link Seal.

G. ESCUTCHEONS

1. Split hinged type or flat, constructed of chromium-plated steel or cast brass, sized to fit over insulation and to cover sleeve.
2. Escutcheons installed within the secure area of vivaria shall be stainless steel.

H. MOTORS

1. General:
 - a) Motors shall be dripproof, unless otherwise specified herein or indicated on the Drawings, and in compliance with NEMA MG 1-2014. Refer to Electrical Drawings for exact characteristics of motors. Dripproof and totally enclosed fan-cooled motors shall be rated on a 50°C and 55°C temperature rise basis, respectively, unless otherwise specified herein.
 - b) Motors 3/4 hp and above:
 - i. NEMA premium efficiency type, in accordance with NEMA MG 1-2014, for plumbing motors 3/4 hp and larger. Motors shall be three-phase, squirrel cage, open-type induction motors.
 - ii. Motors equipped with variable frequency drives shall be provided with shaft grounding rings (AEGIS SCR or equal). Soft carbon brushes and split grounding rings are not acceptable.
 - iii. Motors used with variable frequency drives shall, at a minimum, meet the requirements of NEMA MG-1, part 31 (definite Purpose Inverter – Fed Motors). Motors shall have a composite power factor rating of 90% or higher when the equipment is operating at design.
 - iv. Motor frames and end-bells shall be cast iron for motors 1 hp and larger.
 - v. Motors shall be equipped with Class F insulation with Class B temperature rise and 1.15 service factor in an ambient temperature of 40°C maximum. Bearings shall have an ANSI/ABFMA L-10 rating of 200,000 hours for direct connected service and shall be capable of being re-lubricated.
 - c) Motors ½ hp and smaller shall be single phase or three phase, open capacitor type in accordance with NEMA standards for 115V, 60Hz motors.
 - i. Motors 1/6 hp and smaller may be split-phase type.

PART 3 - EXECUTION

A. PROTECTION OF EQUIPMENT AND MATERIALS DURING CONSTRUCTION

1. Provide protective covers, skids, plugs or caps to protect equipment and materials from damage or deterioration during construction.
2. Store equipment and material under cover, and off the ground.
3. Plug ends of pipes when work is stopped to prevent debris from entering the pipes.

4. Provide protective covers on floor drains during construction to prevent debris from entering the waste piping system.

B. EQUIPMENT AND INSTALLATION REQUIREMENTS

1. Equipment shall be installed and connected as specified herein or indicated on the Drawings in accordance with the manufacturers' instructions and recommendations for this Project. Furnish and install auxiliary piping, water seals, valves, and electrical connections recommended by the manufacturer for operation.
2. Provide roughing, traps, tail pieces, fittings, and connecting piping, and make final water supply and drain connections to equipment.
3. Where water connection sizes at equipment vary from the pipe size indicated on the Drawings, provide appropriate reducers/increasers directly adjacent to the pipe-equipment unions. Unless otherwise specified herein or indicated on the Drawings, the size of the valves and accessories dedicated to the equipment shall not be less than the pipe size to which they are connected.

C. HANGERS AND SUPPORTS

1. Where several pipes run parallel and in the same plane:
 - a) 2.5" and smaller: may be supported on gang or multiple hangers. Separate copper tubing from ferrous supports with copper-plated steel or 4 psf sheet lead.
 - b) 3" and larger: support independently, parallel, and equally spaced.
2. Supports for steel pipe and for copper tubing, except standpipe piping, 1.25" or larger, shall not be more than 8' apart. Supports for copper tubing 1" and smaller shall be not more than 5' apart. Pipes shall be supported within 1' of each elbow and tee, and for piping 2.5" and larger at each valve, trap and strainer or each close-coupled group of valves, traps, and strainers.
3. Support each horizontal length of cast iron pipe, excluding fittings, at 5' on center, maximum.
4. Support each horizontal length of PVC, polypropylene, or PVDF waste piping as follows:

Schedule 40 Pipe – Pipe Size	Room Temperature – Maximum Span, feet	High Temperature (up to 150°F) - Max Span, ft
1.5" to 2"	5	2
3"	6	2.5
4" to 6"	6	3
Schedule 80 Pipe – Pipe Size		
1.5" to 2"	5.5	2.5
3"	7	3
4" to 6"	7.5	3.5

Continuous support of pipe using 18 ga, half-round, sheet metal may be used to support high temperature waste in lieu of close hanger spacing. Where continuous support is provided, maximum hanger spacing shall be as for room temperature waste.

5. Support domestic hot and cold water piping in chases behind plumbing fixtures with plastic coated brackets and u-bolts secured to cast iron stacks. Size u-bolts to bear on the piping.

6. Support bottom of P-traps 3" and larger.
7. Size hangers for insulated piping to bear on outside of insulation.
8. For hangers bearing on outside of insulation, provide insulation protectors on pipes 2" and larger.
9. Vertical Support Spacing:
 - a) Anchor vertical piping 10' and longer not located in chase at the pipe's midpoint with offset pipe clamps or split ring clamps, as applicable, attached to the building.
 - b) Anchor vertical piping 6' and longer located in chases or walls at the pipe's midpoint with split ring clamps attached to the metal studs.
 - c) Support soil, waste, vent, and rainwater stacks with riser clamps at each floor.
 - d) Support soil, waste, vent, and rainwater piping vertical to horizontal offsets above grade, with a hanger on the first elbow of the offset.
 - e) Support soil and vent stacks and inside downspouts at the base by means of concrete piers or hangers close to the bottom of the stack.
 - f) Support pressure piping risers with riser clamps at each floor.
 - g) Support vertical PVC, Polypropylene, and PVDF piping at each floor and at mid-span.
 - h) Support vertical piping in open shafts on channel struts at every floor line, and as specified above.
10. Support piping independently of equipment.
11. Adjust hangers and supports so that loading is uniform.
12. Hanger rods shall be suspended from the structure. Do not suspend from other piping, equipment, or ductwork.
13. Expansion Anchors:
 - a) Use for piping in existing concrete and masonry construction.
14. Where indicated on the Drawings, support piping on pipe stand supports. At the base of each support, weld a slip-on flange to the vertical stanchion. Place stanchion and flange on top of a baseplate, welding the flange to the baseplate. Anchor baseplates to vibration isolators or foundations. Provide schedule 40 pipe to increase stanchion height as required by field conditions.

D. SLEEVES

1. Provide where pipes pass through walls, floors and roofs, except in the following circumstances:
 - a) Concealed wall openings of the required diameter in non fire- or smoke-rated construction, unless specified herein to have voids packed with fiberglass and caulking.
 - b) Core drilled concealed openings. Openings in roofs shall not be core drilled. Obtain written permission prior to core drilling.
2. Sleeves shall be placed into position prior to wall, floor, or roof construction. Sleeves shall be tight-fitting and cut smooth.
3. Wall sleeves shall extend 1" on each side of walls.

4. Sleeves shall be placed into position prior to wall, floor, or roof construction. Sleeves shall be tight-fitting and cut smooth.
5. Floor sleeves shall be cast in place, shall be watertight, and shall extend from the bottom of the slab to 2" above the finished floor.
6. Size sleeves for insulated pipes penetrating nonrated construction to allow full thickness insulation.
7. Sleeves in nonrated construction shall be sized to provide clearance on all sides of piping, including insulation, to accommodate thermal movement. Clearance shall be minimum 0.75".

E. PENETRATION SEALS

1. General:
 - a) Install in accordance with the manufacturer's published instructions to achieve ratings and classifications specified herein. A copy of these instructions shall be maintained and available on site.
2. Fire Stops:
 - a) Close and fire stop penetrations through fire- and smoke-rated construction. Materials used to seal these penetrations shall continue the construction's fire and smoke resistance ratings uninterrupted and shall maintain an effective barrier against the spread of flame, smoke, water and hot gases. Install after installation of ductwork, piping, control tubing and conduits.
 - b) Refer also to fire stopping details on construction drawings and specification section 078413
3. General pipe penetrations:
 - a) Seal all pipe penetrations through walls and ceilings, before sealing perimeter of escutcheons.
 - b) Seal perimeter of escutcheons and wall plates to finished wall or ceiling surfaces.
4. Exterior Wall Seals:
 - a) Piping without insulation: use expansion seals between pipes and sleeves. Where walls exceed the width of expansion seals, use two seals, one being flush with the inside sleeve face and the second with the outside sleeve face. Fill the annular void space between the two seals.
 - b) Piping with insulation: pack center annular space between the insulation and the sleeve with fiberglass, then caulk 1" deep from each face to the fiberglass with nonhardening sealant. Smooth sealant with face of sleeve.

F. EXCAVATION AND BACKFILL

1. Provide excavation for the work of this Division. Excavate all material encountered, to the depths indicated on the drawings or required. Remove excavated materials not required or suitable for backfill from the site. Excavations shall be no longer or deeper than necessary. Backfill material shall be free from rocks and debris.
2. Provide grading as may be necessary to prevent surface water from flowing into trenches or other excavations. Remove any water that accumulates. Provide sheeting and shoring as may be necessary for the protection of the work and for the safety of personnel.

3. Provide trenches of widths necessary for the proper execution of the work. Grade bottom of the trenches accurately to provide uniform bearing and support the work on undisturbed soil at every point along its entire length. Backfill overdepths in the rock excavation and unauthorized overdepths with loose, granular, moist earth; sand, or gravel thoroughly machine tamped. Whenever unstable soil that is incapable of properly supporting the work is encountered in the bottom of the trench, remove soil to a depth required and backfill the trench to the proper grade with coarse sand, fine gravel or other suitable material.
4. Excavate trenches for utilities that will provide the required minimum depths of cover from existing grade or from indicated finished grade, whichever is lower, unless otherwise specifically shown.
5. Trenches shall not be placed near foundation or soil surfaces that must resist horizontal forces.
6. Do not backfill trenches until all required tests have been performed and the installation observed by the Engineer. Comply with the requirements of other sections of the specifications. Deposit backfill in 6-inch thick layers and tamp carefully until the plumbing work is covered by not less than 6 inches of material. Backfill and tamp remainder of trench at 1 foot intervals until complete. Uniformly grade the finished surface.
7. Refer to architectural and structural details for vapor barriers and concrete reinforcing and repair.
8. Refer also to Specification Section 31 50 00 Excavation Support and Protection.

G. IDENTIFICATION OF PIPING

1. Identify piping specified under this Division in accordance with ANSI/ASME A13.1.
2. Legends shall be on the lower quarters of the pipe except where such location would be obscured.
3. Arrow tape shall be wrapped completely around the pipe at each end of the legend with arrows pointing in the direction of flow.
4. Locate pipe identification as follows:
 - a) Mechanical equipment rooms:
 - a. Within 18" of each valve or valve assembly.
 - b. Within 3' of each 90° elbow, connection to equipment or vessel, point where pipe enters shafts and pierces outside walls.
 - c. On not over 20' intervals along exposed piping.
 - d. At wall and ceiling penetrations, both sides.
 - b) Above suspended ceilings:
 - a. Within 18" of each valve or valve assembly.
 - b. At tees within 3' of both main and branch.
 - c. Within 3' of each 90° elbow.
 - d. On not over 20' intervals.
 - e. At wall and ceiling penetrations, both sides.
 - c) Piping concealed in chases or shafts:
 - a. Each pipe visible through an access door or panel.
 - d) Piping exposed in rooms other than mechanical equipment areas:
 - a. Omit identification of piping 0.5" and smaller exposed at connections to equipment or plumbing fixtures.
 - b. With the above exception, identify at not less than 1 point each piping run visible in each room with identification on not over 20' intervals.
 - c. At wall and ceiling penetrations, both sides.

5. Schedule of Piping Identification. Below shall be superceded where University identification colors and labels are in use. All colors and labels shall match University standards.

<u>Piping System and Contents</u>	<u>Tape Color</u>	<u>Legend</u>	<u>Abbreviated Legend</u>
<u>Plumbing</u>			
Cold Water	Green	Dom. Cold Water	DCW
Hot Water	Yellow	Dom. Hot Water	DHW
Hot Water Circulating	Yellow	Dom. Hot Water Circulating	DHWR
Lab Cold Water*	Green	Lab. Cold Water	LCW
Lab Hot Water*	Yellow	Lab. Hot Water	L HW
Lab Hot Water Circulating*	Yellow	Lab Hot Water Circulating	LHWR
Animal Area Cold Water*	Green	Animal. Cold Water	ACW
Animal Area Hot Water*	Yellow	Animal Hot Water	AHW
Animal Area HW Circulating*	Yellow	Animal Hot Water Circulating	AHWR
Animal Drinking Water	Yellow	Animal Drinking Water	ADW
High Pressure Cold Water	Yellow	High Pressure Water	HPCW
Tepid Water for emergency fixtures	Green	Tepid Water	TW
Tepid Circulating Water	Green	Tepid Circ Water	TWC
Storm Drain	Green	Storm	S
Waste	Green	Waste	W
Vent	Green	Vent	V
Compressed Air	Black	Air	A
Non-potable Make-up Water	Green	Non-Potable	NP CW
Deionized Water	Green	DI Water	DI

* Identify separately where lab and/or animal water distribution systems have RPZ backflow prevention separate from other building water supply system and distribution

- a) Refer to specification section 22 60 00, Medical Gas Systems for labeling of medical gas piping, valves, and equipment.

6. NON-POTABLE WATER

- a) All non-potable water outlets hose connections, open end pipes and faucets shall be identified at the point of use per requirements of NCPC 608.8. This shall include outlets downstream of back flow preventers serving cagewash equipment, RO water treatment and HVAC makeup water, and vacuum seal water. Piping shall be labeled 'NON-POTABLE'.

H. VALVE TAGS AND SCHEDULES

1. Provide numbered brass tags on valves except at plumbing fixtures. Attach tags to valve stems with brass S-hooks or brass chain.
2. Provide for each system a typewritten schedule of valves giving number, location (room number), and function of each with a small scale diagram outlining general piping layout and location of each numbered valves.

I. IDENTIFICATION OF EQUIPMENT

1. General:
 - a) Identification shall consist of upper case letters.
 - b) Each starter, pump, water heater, starter, contactor, push button station, control panel, control switch, and disconnect shall be appropriately identified by nameplates with 0.25" high letters.
 - a. Identification shall include the equipment designation and device function, e.g., WPB-1 Water Pressure Booster Pump.

J. CEILING IDENTIFICATION SYSTEMS

1. Ceiling identification labels are not expected to be required because all isolation valves, mixing valves, trap primers, etc. are expected to be located in exposed locations, primarily at the service platform, above the vivarium spaces

K. ESCUTCHEONS

1. Provide escutcheons where exposed piping passes through walls, floors and ceilings in finished areas.
2. Escutcheons within the secure area of the vivarium shall be stainless steel.
3. Caulking shall be applied between pipe and surrounding wall or ceiling penetrations within the finished vivarium area (e.g. at sinks, hose bibs, etc). This requirement applies whether the pipe penetration is concealed by an escutcheon or not. Seal the perimeter of the escutcheon to the adjacent finished wall and finish smooth. Install caulk in accordance with ASTM C919-2012.

L. MOTORS

1. Provide motors for equipment covered in Division 22 unless otherwise specified herein. Select motors for operation not exceeding a 1.0 service factor and within the nameplate amperage and nominal power rating.

M. STARTERS

1. Provide starters, push buttons, thermal overload switches, and contactors for equipment covered in Division 22 unless otherwise specified herein. Installation of starters, push buttons, and thermal overload switches, not factory installed, is specified under Division 26.
2. Provide 120 V secondary control power transformers for control circuits where equipment is served at 208 V or higher.

N. FUSES

1. Provide fuses in equipment furnished under this Division of the specifications.
2. Provide 3 spare fuses of each size, UL class, and voltage rating furnished under this Division of the specifications and turn over to the Owner. Obtain a receipt for same.

O. COORDINATION

1. Provide offsets, transitions, and fittings to coordinate the work of each trade with that of other trades, including HVAC, plumbing, fire protection, electrical, structural, and architectural.
2. Where valves, pumps, strainers, or other equipment requiring regular service is concealed by walls or ceilings, coordinate with general contractor to provide ceiling access doors.

P. EQUIPMENT PADS

1. Provide concrete foundations for the following floor-mounted equipment:

<u>Equipment</u>	<u>Foundation</u>
Water heaters	4" high pad
Vacuum pumps	4" high pad

- a) Foundation height shall accommodate seismic anchors (where required), but shall be not less than the minimum specified above.
2. Foundations shall extend a minimum of 6" beyond the equipment footprint in all directions, including appurtenances, vibration isolators, base elbow supports, and motors.
3. Equipment attached directly to foundations or inertia bases; bases provided with grout holes; and bases consisting of a structural frame shall have voids filled with grout after attachment to foundation.
4. Refer also to Specification Section 03 30 00, Cast-in-Place Concrete

Q. CLEANUP

1. Comply with cleaning requirements as described in other specifications and in the General and Supplementary Conditions.
2. Prior to final inspection:
 - a) Remove dust, dirt, rust, stains, and temporary covers.
 - b) Foreign matter shall be blown, vacuumed, flushed, or cleaned out of and from new equipment, fixtures, floor drains, piping, pumps, motors, bearings, devices, switches, controls, and panels.
 - c) Clean and polish identification plates.
 - d) In equipment rooms, clean equipment, insulation, piping, conduit, and room surfaces from dust and dirt and maintain in a clean condition from date of substantial completion until final completion of work and corrective work.
 - e) Remove excess material from the Project site.

R. START UP AND TESTING

1. Start up the following systems, and witness the following tests:
 - a) Section 22 4200, Plumbing Fixtures:
 - a. Fixture tests.
 - b. Plumbing fixtures.
 - b) Section 22 4300, Drainage Systems:
 - a. Piping and joint tests.
 - b. Sanitary, waste and vent system.
 - c) Section 22 4400, Water Systems:

- a. Hot water circulating flow balancing assemblies.
- b. Backflow preventers.
- c. Emergency fixture water tempering valves.
- d. Freezeproof hydrants.
- e. Hot water circulating pumps and systems.
- f. Thermostatic mixing valves.
- g. Piping and joint tests.
- h. Pressure reducing valves.
- i. Thermal expansion tanks.
- j. Trap primers.
- k. Vacuum breakers.
- l. Water heaters.
- m. Water meters.
- d) Section 22 6000, Medical Gas Systems:
 - a. Gas cylinder manifolds.
 - b. Medical vacuum system.
 - c. Cross connection testing
 - d. Medical piping purge test
 - e. Alarm and valve testing
 - f. Purification tests
 - g. Piping and joint leakage and pressure tests.

R. OPERATION AND MAINTENANCE MANUALS

1. These operation and maintenance manual requirements supplement operation and maintenance manual documentation requirements of other Sections of these specifications.
2. Operation and maintenance documentation, in hardback 3-ring loose-leaf binders except full size drawings and CDs, shall cover the plumbing and medical gas systems. Documentation shall include an operations and maintenance documentation directory, emergency information, operating manual, maintenance manual, test reports, and construction documents.
3. The operation and maintenance documentation package shall be submitted as one comprehensive package to the Owner 1 month before systems start-up, and shall be updated, revised and completed at completion of, construction.
4. Compile and coordinate the documentation for equipment and systems installed. Documentation shall be typewritten and shall contain, at a minimum, the following information.
 - a) Introduction:
 - a. Project name, contractors' and subcontractors' names, addresses, and telephone and facsimile numbers.
 - b. Index.
 - b) Operations and Maintenance Documentation Directory:
 - a. Explanation of the identification system used, including lists of systems, equipment, and component identifiers and names.
5. Manual shall include:
 - a) Technical Information:
 - a. System description.
 - b. Operating routines and procedures.
 - c. Special procedures.

- d. Basic troubleshooting.
- b) Descriptions (specifications) of the equipment and components.
- c) Description of function, as applicable: the function of the equipment, procedures before start-up, functional parameters (input, output) at the design load and at part loads, and performance verification procedures.
- d) Recommended maintenance and lubrication procedures and their recommended frequency for this Project.
- e) Recommended list of spare parts, part numbers, and the place(s) from which they can be obtained.
- f) Original purchase order number; date of purchase; name, address, and the telephone number of the vendor; and warranty information.
- g) Installation information.
- h) Other information needed for the preparation of documents supporting the management of operation and maintenance programs.
- i) Approved submittals.
- j) Certifications
- k) Contractor and equipment warranties.

S. CLOSEOUT DOCUMENTS

1. Record drawings:
 - a) A record of field and as-installed conditions shall be maintained at the site, shall be kept current throughout the Project, and shall be used in the preparation of the final record drawings.
 - b) Upon completion of the Project, submit record drawings indicating as-built conditions of piping and equipment, and incorporating changes made during construction. Submit 1 set of bond prints.
 - c) Reproductions of design drawings shall be used in the preparation of record drawings.
2. Test Reports and Certifications:
 - a) Copies of tests and certifications performed during manufacture and construction, including but not limited to the following:
 - a. Documentation of instruction of operating personnel.
 - b. Certification of plumbing piping leakage tests.
 - c. Certification of backflow prevention devices.
 - d. Results of water system disinfection tests.
 - e. Valve schedules and location drawings.
 - f. Equipment and contractor warranties.

T. MAINTENANCE

1. Equipment operated prior to the date of substantial completion shall be maintained in accordance with manufacturer's recommendations.
2. Clean all strainers prior to turning maintenance responsibility over to the Owner.

U. INSTRUCTION OF OPERATING PERSONNEL

1. Provide the designated Owner's personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of equipment specified in Division 22.

2. Prepare and submit an overview or syllabus of the proposed training program.
3. Coordinate the schedule with the Owner. Owner shall be responsible for ensuring appropriate operating personnel are present for training after the schedule is approved.
4. The appropriate manufacturer's representative shall provide the instructions on each major piece of equipment. This person may be the start-up technician for the piece of equipment, the installing contractor, or manufacturer's representative.
 - a) Training shall include:
 - a. Use of the printed installation, operation and maintenance instruction material included in the operation and maintenance manuals.
 - b. A review of the written operation and maintenance instructions emphasizing safe and proper operating requirements, preventative and routine maintenance, special tools needed and spare parts inventory suggestions. The training shall include start-up, operation in all modes possible, shut-down, seasonal changeover, and any emergency procedures.
 - c. Discussion of relevant health and safety issues and concerns.
 - d. Common troubleshooting problems and solutions.
 - e. Explanatory information included in the operation and maintenance manuals and the location of plans and manuals in the facility.
 - f. Discussion of any peculiarities of equipment installation or operation.
 - g. Explain and demonstrate the operation, function and overrides of local packaged controls not controlled by the central control system.
 - b) Training shall occur after testing is complete, unless approved otherwise by the Owner.
 - c) Obtain a receipt acknowledging completion of training.

END OF SECTION 22 00 10

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SECTION 22 25 00 - PLUMBING PIPING INSULATION

PART 1. GENERAL

A. DESCRIPTION OF WORK

1. The extent of piping insulation work is indicated by drawings and schedules, and by the requirements of this Section.
2. The piping systems to be insulated include:
 - a) Domestic cold water piping.
 - b) Domestic hot water piping.
 - c) Domestic hot water recirculating piping.
 - d) Exposed waste piping and p-trap below any handicapped lavatory.

B. QUALITY ASSURANCE

1. Flame/Smoke Ratings: Provide composite piping insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread rating of 25 or less and a smoke-developed rating of 50 or less, as tested by ASTM E84 (NFPA 255) method.

C. PRODUCT DELIVERY, STORAGE AND HANDLING

1. Protect insulation against dirt, water and chemical and mechanical damage. Do not install damaged insulation, remove from project site.
2. Deliver insulation, coverings, cements, adhesives and coatings to the site in factory fabricated containers with the manufacturer's stamp or label, affixed showing fire hazard ratings of the products.

PART 2. PRODUCTS

A. MANUFACTURERS

1. Manufacturers: Provide piping insulation products produced by one of the following for each type and temperature range of insulation:
 - a) Certainteed Corp.
 - b) Mansville Corp.
 - c) Owens-Corning Fiberglass Corp.
 - d) Armstrong Cork Co.

B. MATERIALS

1. Fiberglass Pipe Insulation: FS HH-I-558, Form D, Type III, Class 12.
 - a) ASTM C547 molded sleeving pipe and tube fitting.
 - b) All service jacket vapor barrier consisting of white Kraft paper bonded to aluminum foil, reinforced with fiberglass yarn, suitable for painting.
 - c) Rated at K-0.25 or less at 100 degrees F. Thickness as indicated.
2. Fiberglass Pipe Fitting: Same as described in paragraph above except for piping fittings. Vapor barrier equivalent to adjoining pipe insulation jacketing.

3. Flexible Unicellular Pipe Insulation: ASTM C534, Class 1 Tubular. The flexible unicellular insulation shall have a “K” factor not to exceed 0.27 at 75 degrees F.
4. PVC Fitting Jackets:
 - a) High impact, UV resistant, 30 mil thick, white polyvinyl chloride (PVC) fitting jackets with formaldehyde-free insulation inserts, and stainless steel attachments. Provide additional insulation inserts as required for larger pipes. Flame and smoke ratings shall comply with Paragraph B.1.
 - b) Manufacturer: Johns Manville Zeston 2000 PVC, or Knauf Proto.
5. Adhesives and Sealers: As recommended by insulation manufacturer for the applications indicated.

PART 3. EXECUTION

A. INSULATION ON COLD PIPING

1. Application Requirements: Insulate piping located in interior space, where there is the possibility of significant condensation (sweating) of uninsulated piping, including (but not necessarily limited to) the following services:
 - a) Interior domestic cold water piping, animal drinking water except where exposed within holding rooms, and high pressure cold water to hose stations.
 - b) Interior waste piping and horizontal soil piping serving water coolers, ice machines, floor drains handling waste from air conditioning equipment and all similar piping handling cold liquids.
 - c) Vertical piping exposed in occupied spaces.
 - d) Vertical piping in mechanical shafts except where indicated as “uninsulated”.
2. Insulation: Insulate each piping system with one of the following types and thicknesses of insulation, except as otherwise indicated. (Installer’s option where more than one type is indicated):
 - a) Fiberglass with vapor barrier, 1” thick up to 3” pipe diameter.

B. INSULATION ON HOT PIPING

1. Application Requirements: Insulate piping which is not buried in soil or otherwise encased, except where indicated as “uninsulated” including (but not necessarily limited to) the following:
 - a) Tempered water piping.
 - b) Domestic hot water piping.
 - c) Domestic hot water recirculating piping.
 - d) Exposed domestic hot water and P-traps at lavatories serving wheelchair patients where water supply temperature exceeds 120 degrees F. Other exposed fixture piping connections are not required to be insulated.
2. Insulate each piping system with one of the following types and thickness of insulation, except as otherwise indicated. (Installer’s option where more than one type is indicated):
 - (1) Fiberglass with vapor barrier; 1” thick for pipe sizes up to and including 3”. 1 ½” thick for pipe sizes 4” and larger.

C. INSTALLATION OF PIPING INSULATION

1. General: Install insulation products in accordance with the manufacturer's written instructions, and in accordance with recognized industry practices to ensure that the insulation serves its intended purpose.
 - a) Scheduled insulation shall be considered a minimum. Pipe insulation shall conform to state or local code should code requirements exceed scheduled minimum.
 - b) Install insulation on pipe systems subsequent to testing and acceptance of tests.
 - c) Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete the run. Do not use cut pieces or scraps abutting each other.
 - d) Install rigid insulation inserts at points where hangers and supports bear on the insulation.
 - e) Clean and dry pipe surfaces prior to insulation. Butt insulation joints firmly together to ensure a complete and tight fit over surfaces to be covered.
 - f) Maintain integrity of vapor-barrier jackets on pipe insulation, and protect to prevent puncture or other damage. Ends of pipe insulation shall be sealed off at all valves, fitting and flanges and every 20 feet of straight runs.
 - g) All seams shall be stapled with outward clinch staples. In order to maintain vapor barrier staples and seams shall be coated or sealed with a vapor barrier mastic.
 - h) Cover valves, flanges, fittings and similar items in each piping system with equivalent thickness and composition of insulation and vapor barrier as applied to adjoining pipe run. Install factory molded, precut or job fabricated units (at installer's option) except where a specified form or type is indicated.
 - i) No mitered pipe insulation joints shall be used. When field fabricated insulation for pipe fittings is used, strips of fiberglass blanket insulation shall be wrapped around fitting and built-up to thickness of regular insulation. All valves and fittings shall be covered with fitting insulation covers consisting of one-piece factory premolded PVC covers. One-piece factory premolded PVC covers with factory precut insulation inserts may be used.
2. Insulated piping exposed within the secure boundary of the vivarium, with the exception of equipment service areas, platforms and mechanical rooms, shall be covered with PVC jacket and fitting covers. Fitting covers shall be a one-piece molded PVC cover of the size required for the fitting and the required insulation thickness. Secure as recommended by the manufacturer. Seal open ends of insulation with a thick mastic coating.

END OF SECTION 22 25 00

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SECTION 22 42 00 - PLUMBING FIXTURES

PART 1. GENERAL

A. DESCRIPTION OF WORK

1. The extent of plumbing fixture work is indicated by drawings and schedules, and by requirements of this Section.

B. QUALITY ASSURANCE

1. Plumbing Fixture Standards:
 - a) Comply with applicable portions of North Carolina State Building Code: Plumbing Code 2018 pertaining to materials and installation of plumbing fixtures.
 - b) Comply with Section 8.2, Plumbing Fixtures and Equipment, of the NIH Design Requirements Manual.
2. ANSI Standards: Comply with applicable ANSI standards pertaining to plumbing fixtures and systems.
 - a) Comply with ANSI A117.1 standard pertaining to plumbing fixtures designated for accessibility.
3. PDI Compliance: Comply with standards established by Plumbing and Drainage Institute pertaining to plumbing fixture supports.
4. Federal Standards: Comply with applicable FS WW-P-541/-Series sections pertaining to plumbing fixtures.

C. SUBMITTALS

1. Product Data: Submit manufacturer's data on plumbing fixtures, including rough-in drawings, templates, instructions and directions for connections with water and soil piping, and anchorages for plumbing fixtures.

D. PRODUCT DELIVERY, STORAGE AND HANDLING

1. Deliver plumbing fixtures individually wrapped in factory fabricated containers.
2. Handle plumbing fixtures carefully to prevent breakage, chipping and scoring the fixture finish. Do not install damaged plumbing fixtures; replace and return damaged units to equipment manufacturer.

PART 2. PRODUCTS

A. PLUMBING FIXTURES

1. General: Provide factory fabricated fixtures of the type, style and material indicated. For each type fixture, provide trim, carrier, seats and valves as indicated by drawings and schedules and as required for a complete installation. Where more than one type is not otherwise indicated, provide fixtures complying with governing regulations.
2. Water fountains and faucets shall have lead-free water ways.

3. Materials

- a) General: Unless otherwise specified, comply with applicable Federal Specification WW-P-541/-specification relative to quality of ware, glazing, enamel, composition and finish of metals, air gaps, and vacuum breakers, even though some plumbing fixtures specified in this section are not described in WW-P-541.
- b) Where fittings, trim and accessories are exposed or semi-exposed, provide bright chrome-plated or polished stainless steel units. Provide copper or brass where not exposed.
- c) Stainless Steel Sheets: ASTM A167, type 302/304, hardest workable temper.
(1) Finish: No. 4, bright, directional polish on exposed surfaces.
- d) Vitreous China: High quality, free from fire cracks, spots, blisters, pinholes and specks; glaze exposed surfaces, and tested for crazing resistance in accordance with ASTM C554.

4. Manufacturers: Firms regularly engaged in manufacture of plumbing fixtures of the type, style and configuration required, whose products have been in satisfactory use in similar service for not less than 5 years.

- a) One manufacturer is normally scheduled as a guide. Similar fixtures by other manufacturers may be substituted subject to the approval of the Engineer. All like fixtures or trim shall be of one manufacturer unless noted otherwise.
- b) For vitreous china and enameled cast iron lavatories, water closets, sinks and urinals approved manufacturers include American Standard, Kohler, Crane, and Eljer.
- c) For stainless steel sinks approved manufacturers include Griffin, Elkay, Kohler and Just.
(1) Approved manufacturers of surgical scrub sinks are Mac Medical, Skytron and Steris.
- d) For electric water coolers approved manufacturers include Halsey Taylor, Haws, Elkay and Oasis.
- e) Toilet seats may be as manufactured by American Standard, Kohler, Eljer, Bemis, or Olsonite.

B. PLUMBING FITTINGS, TRIM AND ACCESSORIES

- 1. General: All like trim, unless otherwise specified, shall be one manufacturer.
- 2. Water Outlets: At locations where water is applied (by manual, automatic or remote control), provide commercial quality faucets, valves or dispensing devices of the type and size indicated, and as required to operate as indicated. Include manual cut-off valves and connecting stem pipes to permit outlet servicing without shutdown of water supply piping systems.
- 3. Water Conservation: Fixtures shall not be installed with a flow rate or flush volume in excess of the following: Water closets, 1.28 gal./flush; Urinals, 0.25 gal/flush; lavatories 0.5 gpm; shower heads 0.5 gpm.
- 4. Flush Valves: All flush valves shall have an approved type vacuum breaker, shall be furnished with quiet flush feature, and solid ring support at all flush valve locations. All flush valves shall be equipped with the water saver option. Flush valves shall be as manufactured by Zurn, Delany, Sloan Royal, or approved equal.

5. Water Closet Seats:
 - a) Elongated Heavy Weight:
 - (1) Solid high impact plastic with open front seat, stainless steel posts, washers and nuts, and check hinges.
 - (2) Manufacturer: Bemis 1955C, Beneke 523, Church 295C, or Olsonite 10CC.
6. Vacuum Breakers: Integral to water outlets equipped for hose attachment.
7. P-Traps: Refer to Section 22 43 00 Plumbing Drainage Systems.
8. Floor drains and floor sinks: Refer to Section 22 43 00 Plumbing Drainage Systems.
9. Supplies for Lavatories, Water Coolers, and Countertop Sinks:
 - a) Angle stops with 0.5" sweat inlet, bell escutcheon, 0.325" od flexible tube riser for faucet connection, and exposed piping and parts chromium-plated.
 - b) Manufacturer: Brass Craft CS-400 A, EBC LA26, or McGuire 170.
10. Supplies for Service Sinks:
 - a) Angle stops with 0.5" sweat inlet, bell escutcheon, 0.5" od tube riser for faucet connection, brass stop with metal handles, and exposed piping and parts chromium-plated.
 - b) Manufacturer: Brass Craft CS-500 AC, EBC LA27, or McGuire 171.
11. Strainers for Service Sinks: Flat top stainless steel, grid strainer for 3.5" opening. Nickel plated brass body with 1.5"x4" tailpiece.
12. Carriers: Provide cast-iron chair carriers for fixtures of either graphitic gray iron, ductile iron, or malleable iron. Carriers shall be as manufactured by Zurn, Wade, Josam, Jones, or Jay R. Smith.
13. Fixture Bolt Caps: Provide manufacturer's standard exposed fixture bolt caps finished to match fixture finish.
14. Exposed Metal Parts: Exposed metal parts of all fittings unless otherwise noted shall be polished chrome finish on nickel plated brass. Install escutcheons for piping through wall.
15. Interior Hose Bibb: Provide Zurn, Josam or Woodford chrome plated hose bibb with vacuum breaker and lock shield and key.
16. For lavatory sink trim, Delta, Kohler, American Standard, Eljer, T&S Brass, or Chicago Faucets are approved manufacturers.
17. For service sinks Chicago Faucets, Water Saver, Nycom, or T&S Brass are approved manufacturers.
18. For premolded acrylic or fiberglass tubs and showers approved manufacturers include Glastec, Aquaglass, Eljer, American Standard, Kohler, and Clarion.
19. Surgical scrub sinks and animal holding room sinks shall have laminar flow, non-aerating outlets.

PART 3. EXECUTION

A. INSPECTION AND PREPARATION

1. Installer of plumbing fixtures must examine roughing-in work of domestic water and waste piping systems to verify actual locations of piping connections prior to installing fixtures. Also examine floors and substrates, and conditions under which fixture work is to be accomplished. Notify the General Contractor in writing of incorrect location and piping, and other unsatisfactory conditions for installation of plumbing fixtures. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.
2. Install plumbing fixtures of types indicated where shown and at indicated heights, in accordance with fixture manufacturer's written instructions, roughing-in drawings and with recognized industry practices. Ensure that plumbing fixtures comply with requirements and serve intended purposes.
3. Where necessary to support or anchor plumbing fixtures, this contractor shall supply and install first quality treated wood blocking in walls or ceiling as required. Steel members shall be used above the ceiling where required.
4. Fasten plumbing fixtures securely to indicated supports or building structure and ensure that fixtures are level and plumb.
5. Apply sealant around wall and floor mounted fixtures.
6. Cutouts in counter tops, cabinetry and tables, will be accomplished under the Building Section of the work. The Plumbing Contractor shall be responsible for the exact size of all cutouts and shall furnish the other Contractor's manufacturers standard cutouts for all sinks furnished under this division.

B. CLEAN AND PROTECT

1. Clean plumbing fixtures of dirt and debris upon completion of installation.
2. Protect installed fixtures from damage during the remainder of the construction period.

C. FIELD QUALITY CONTROL

1. Upon completion of installation of plumbing fixture and after units are water pressurized, test fixtures to demonstrate capability and compliance with requirements.
2. When possible, correct malfunctioning units at the site, then retest to correct malfunctioning units at the site, then retest to demonstrate compliance; otherwise, remove and replace with new and proceed with retesting.
3. Inspect each installed unit for damage to finish. If feasible, restore and match finish to original at site; otherwise, remove fixture and replace with new unit.
 - a) Feasibility and match to be judged by Designer. Remove cracked or dented units and replace with new units.

END OF SECTION 22 42 00

SECTION 22 43 00 – PLUMBING DRAINAGE SYSTEMS

PART 1 - GENERAL

A. QUALITY ASSURANCE

1. Plumbing work shall conform to the North Carolina State Buildings Codes: Plumbing Code 2018.
2. Manufacturers to be ISO 9001 (or equivalent) and ISO 14001 or equivalent certified.
3. Related Sections that pertain to drainage systems included but are not limited to:
 - a) Section 03 30 00, Cast-in-Place Concrete
 - b) Section 31 50 00, Excavation Support and Protection

PART 2 - PRODUCTS

A. PIPING AND FITTINGS

1. General
 - a) Piping and fitting sizes listed are nominal inside diameter.
2. Drain and Vent Piping Below Grade. House Drain and Vent Piping Below Grade:
 - a) Pipe Size 15" and Smaller: Furnish service weight cast iron soil pipe conforming to ASTM A74, hub and spigot type with neoprene rubber compression gaskets conforming to ASTM C564. Piping shall be asphalt coated, inside and out.
3. Soil, waste, vent, and rainwater, 10" and smaller, above slab-on-grade throughout the building:
 - a) Piping: no-hub cast iron, asphalt-coated inside and out, ASME A888, CISPI 301.
 - b) Fittings: no-hub cast iron, DWV pattern, asphalt-coated inside and out, ASME A888.
 - c) Joints: Heavy-duty shielded couplings listed to ASTM C1540 and either FM 1680 Class 1 or IAPMOIGC 237, with type 304 or 316 stainless steel shield and neoprene or approved equivalent virgin elastomeric gasket, no adhesives. Couplings shall be a minimum of 4-band type, unless FM1680 approved otherwise. Lateral bracing and thrust restraint is required for non-buried drainage piping sizes 125 mm (5 in.) and larger.
 - i. Hubless style couplings are not acceptable for pipe size change (reducer) applications; use manufactured pipe fitting.
 - ii. Manufacturer: Fernco, Anaco-Husky, Mission, Clamp-All or Tyler
4. Concealed fixture drain connections from lavatories, water fountains, and service sinks to cast iron:
 - a) Piping: copper tubing, type DWV, hard drawn, ASTM B306-2013.
 - b) Fittings: drainage pattern DWV wrought copper, ASME B16.29-2012.
 - c) Joints: soldered with 95/5 tin/silver using a compatible flux, ASTM B813-2010 and NSF 61-2012.
5. Fixture drain connections from urinals:
 - a) Piping: red brass, schedule 40, ASTM B43-2009.
 - b) Fittings: drainage pattern DWV cast brass.
 - c) Joints: threaded.

6. Indirect Waste Piping:

- a) Seamless copper tube, ASTM B88, Type L Hard drawn up to 3". Wrought copper and bronze drainage pattern fittings, ANSI B16.23 or ANSI B16.29.
- b) ASTM B828 lead-free soldered joints with ASTM B32 Grade HB, Grade HN, or, approved equal solder that is also listed in Section 1 of ASTM B32. ASTM B813 high temperature water soluble flux. Air cooled only, no quenching. System should be rinsed thoroughly as soon as possible after soldering to prevent on-going flux activity. External surface flux residue shall also be removed. Type DWV copper tube with solder-fitting drainage type, cast copper couplings.
- c) Finished Spaces including animal housing: polished or brushed stainless steel, with threaded fittings.

B. P-TRAPS

- 1. For floor drains, floor outlet sinks, and mop basins: deep-seal type or standard type with trap primer, where scheduled.
- 2. For lavatories and water coolers: 1.25" tubular chromium plated brass, with 17 gauge tubing drain to wall, wall flange, cast brass slip nuts, and cleanout plug.
- 3. For sinks: 1.50" tubular chromium plated brass, with 17 gauge tubing drain to wall, wall flange, cast brass slip nuts, and cleanout plug.
 - a) Install stainless steel wall flange in animal research areas including holding rooms and surgical suites.

C. CLEANOUTS

- 1. For concealed piping in mechanical room floors: cast iron with internal cleanout plug, adjustable housing, polished nickel bronze top, and inside caulk outlet. For cleanouts in floors above grade, provide with flange.
 - a) Manufacturer: Josam 56040-1, Smith 4105C, or Zurn ZN-1400-HD-IC.
- 2. For concealed piping in wall construction: no-hub cleanout tee and tapped bronze cleanout plug, with a stainless steel wall access cover.
 - a) Manufacturer: Josam 58910-19 with 58600 cover, Smith 4532S-Y, or Zurn Z-1446-BP-NH.
- 3. Floor cleanouts shall have nickel bronze top. Wall cleanouts shall have stainless steel cleanout cover.

D. DRAINS

- 1. Provide all required extension collars, flashing devices, etc., to suit roof, floor and deck construction in addition to features described for drains.

2. Cover the grate of each drain during construction to prevent construction debris from entering the drainage system. Tape is inadequate covering. Clean drain grate, inside of drain bodies, and sediment buckets prior to substantial completion.
3. Floor sinks in animal research facilities other than mechanical/electrical rooms and toilet rooms shall be type 304 stainless steel, minimum 14 gauge; or chemical resistant, epoxy coated cast iron as scheduled. Grates shall be type 304 stainless steel.

E. ACCESSORIES

1. Bolts and nuts: ASTM A307-2000, Grade B.
2. Insulation kit for handicapped sinks and lavatories: white molded closed cell vinyl, 3-piece for tailpiece, P-trap, and waste arm, and 2-piece for supply stops, risers, and offset tailpiece accessory.
 - a) Manufacturer: EBC 1K, Insul-Tect I-T 101 and/or I-T 102, McGuire PW2125 and/or PW2150, or Truebro 102-W.
3. Air Gap Fitting: Cast bronze fixed air gap with set screw on inlet, 1½-inch thread outlet, inlet size to match connecting pipe size; “Series 3950T-CP” by J. R. Smith, “Series Z1024” by Zurn Industries, Inc., or equal by Josam.
4. Unions:
 - a) For copper piping 2" and smaller: cast bronze or cast copper with copper soldered or threaded connections.
 - b) For piping of dissimilar metals 2" and smaller: provide dielectric unions with solder or threaded connections, nylon insulators, minimum 600 V no flashover, and EPDM gaskets.

PART 3 - EXECUTION

A. PIPING INSTALLATION, GENERAL

1. Workmanship: pipe shall be cut to measurements established at the site and worked into place without springing or forcing. Pipes shall be installed to permit free expansion and contraction without damage to joints, hangers, or the building.
2. Use concentric reducing fittings between different size pipe.
3. Install piping so as to preserve access to valves and equipment and to provide the maximum headroom possible.
4. Branch piping to fixtures and equipment shall be braced so that there is no horizontal or vertical movement in the piping. Pipe supports shall be isolated from copper tubing with rubber sleeves.

B. INSTALLATION OF WASTE AND VENT PIPING

1. The use of ¼ bends (90 degrees) shall be kept to a minimum. Use Wye fittings, 1/8 bends and 1/16 bends wherever possible. Where ¼ bends must be provided, use the long sweep type.
2. Do not use tee branches in drainage piping.
3. Make changes in horizontal direction in gravity drainage piping with drainage pattern fittings.
4. Cleanouts: Install cleanout plugs at each 90 degree change in direction in suspended horizontal piping. Where not otherwise indicated, install cleanouts at 50' intervals in piping 3" and smaller, and at 75' intervals in piping larger than 3". Install floor and wall cleanouts at the locations indicated.
 - a) Wall cleanouts shall be installed between 2 ft and 3 ft above finished floor
5. Flashing Flanges: Install flashing flange and clamping device with each cleanout passing through a waterproof membrane.
6. Minimum Fall (Slope): The minimum fall on all piping runs shall comply with the N.C. State Plumbing Code. In general use, 1/8" slope per foot minimum for pipe 3" diameter or larger and ¼" slope per foot on 2-1/2" diameter and less. Piping shall be installed with sufficient pitch to ensure drainage and venting
7. Horizontal piping runs shall not be less than 2" diameter nor less than the rough-in dimension indicated on the plumbing equipment schedules.

C. HUB AND SPIGOT CAST IRON PIPE AND FITTINGS

1. Install with hubs upstream.
2. Joints and fittings may be made with compression type gaskets or caulked with white oakum and not less than 12 ounces of pure lead for every inch of pipe diameter.

D. NO-HUB CAST IRON PIPE AND FITTINGS

1. Use heavy couplings for aboveground drainage piping, 4" and above. Torque coupling bolts in accordance with manufacturer's recommendations.
2. Use standard duty couplings for aboveground vent piping and waste piping 3" and smaller. Torque coupling bolts in accordance with manufacturer's recommendations.
3. During the torque process, if any one band of the coupling breaks, replace the entire coupling.

E. TRENCHING AND BACKFILLING

1. A trench shall be excavated so as to provide adequate room to make joints, align, and grade the pipe. The trench bottom shall be properly compacted and rock-free and shall support the pipe throughout its entire length.
2. Fill material shall be applied in layers not exceeding 6 inches loose depth and each layer shall be thoroughly compacted. The first 6 inches of fill material shall be rock-free.
3. Piping backfill operations of open-cut trenches closely following layout, jointing and bedding of pipe, and after initial inspection and testing are completed.

F. UNIONS

1. Slip joints are only permitted on fixture side of P-traps.

G. P-TRAPS

1. Set traps true and level.

H. CLEANOUTS

1. Provide cleanouts in drainage piping as indicated on the Drawings, and as follows:
 - a) At the bottom of each exposed fixture trap which is not integral with the fixture.
 - b) At the beginning of each branch drainage line.
 - c) At each change of a horizontal direction greater than 45°.
 - d) In horizontal drain lines at intervals of not more than 50'.
2. Locate cleanouts so that they are accessible, and in compliance with the code.

I. FIXTURES AND EQUIPMENT PROVIDED BY OTHERS

1. For drainage provide drains, tailpieces, P-traps, continuous waste, and escutcheons as required.

J. PIPING AND FIXTURE TESTS

1. Test soil, waste, and vent, systems piping by capping or plugging all openings, and filling each system with a 10' head of water, then allowing to stand filled for 1 hour without any leak down. Where a system is tested in sections, each section shall be subjected to the same test.
2. Piping General:
 - a) Tests shall be made while piping and joints are exposed to view.
 - b) Submit a statement certifying that piping and joints are tight and have passed the specified test.

END OF SECTION 22 43 00

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SECTION 22 44 00 – WATER SYSTEMS

PART 1 - GENERAL

A. DESCRIPTION

1. General provisions are specified in other Sections of Division 22.
2. This Section covers plumbing piping, valves, fixtures, and accessories.
3. Requirements for submittals, hangers and supports, piping and equipment identification, insulation, lab gases, sleeves and seals, and other items are specified in other Sections of Division 22.

B. QUALITY ASSURANCE

1. Plumbing work shall conform to the North Carolina State Building Code: Plumbing Code 2018.
2. Manufacturers to be ISO 9001 (or equivalent) and ISO 14001 or equivalent certified.

PART 2 - PRODUCTS

A. MANUFACTURERS

1. Gate Valve: Jenkins, Crane, Kennedy, Nibco, or approved equivalent.
2. Ball Valve and Check Valves: Conbraco, Nibco, Apollo, Watts, or approved equivalent.
3. Pressure Reducing Valve: Spence, Golden Anderson, Watts, Wilkins, or approved equivalent.
4. Relief Valve: Wilkins, Watts, or approved equivalent.
5. Thermostatic Mixing Valve: Leonard, Bradley, Watersaver, Lawler, Haws, Powers, or approved equivalent.
6. Water Hammer Arrestors: Precision Plumbing Products, Zurn, Wilkins, Sioux Chief, or approved equivalent.
7. Backflow Preventers: Ames, Febco, Watts, Wilkins, Zurn, or approved equivalent.
8. Trap Primers: Precision Plumbing Products, Jay R. Smith, Zurn, Jones, Josam, Wade, MIFAB, or approved equivalent.
9. Expansion Tanks: Amtrol, Wessels, Bell and Gossett, or approved equivalent.
10. Electric water heaters: A.O. Smith, Rheem, State, or Bradford White.

B. WATER PIPING AND FITTINGS (OTHER THAN ANIMAL DRINKING WATER ROOM DISTRIBUTION)

1. General
 - a) Piping and fitting sizes listed are nominal inside diameter.
2. Above grade cold water, make-up water, hot water, hot water circulating, trap primer, relief valve discharge, non-potable water downstream of backflow preventers, animal drinking water, and high pressure (<100 psi) cold water; size 1/2" to 2", except animal drinking water distribution inside animal holding rooms:
 - a) Piping: copper tubing, type L, hard drawn, ASTM B88.
 - b) Fittings: wrought copper and/or cast brass socket fittings, ANSI/ASME B16.22 or B16.18.

- c) Joints: ASTM B828 lead-free soldered joints with ASTM B32 Grade HB, Grade HN, or, approved equal solder that is also listed in Section 1 of ASTM B32. ASTM B813 high temperature water soluble flux. Air cooled only, no quenching. System should be rinsed thoroughly as soon as possible after soldering to prevent on-going flux activity. External surface flux residue shall also be removed.
 - 3. Below grade cold water, 0.5" to 1".
 - a) Piping: Seamless copper tube, ASTM B88, Type K Soft.
 - b) Fittings: wrought copper and/or cast brass socket fittings, ANSI/ASME B16.22 or B16.18.
 - c) Joints: BCuP 3, 4, or 5 brazed joints per Section IX ASME BPVC or ANSI/AWS B2.2. High silver soft soldering (alloys that melt below 449°C (840°F) in lieu of brazing is not acceptable. No flux permitted for copper to copper joints. AWS A5.8 Bag-5 may also be used for copper to brass or bronze. Flux for copper to brass or bronze should be AWS A5.31 Class FB3-A or FB3-C. Lead free copper alloy fittings and valves (including cast) that contain a component that melts below 327°C (620°F), bismuth, or over 15% zinc shall not be brazed. BCuP 9 or BA5-5 shall be used for threaded copper adapters to prevent annealing.
- C. ANIMAL DRINKING WATER DISTRIBUTION, EXPOSED IN ANIMAL HOLDING ROOMS:
- 1. General: Distributes water from a pressure reducing station into and around each animal room and to flush drain points. Pressure rating is 125 psi minimum. Use piping/fitting design to allow mechanical dismantling for repair or replacement of individual components. Electropolish externally and passivate all water contact surfaces to attain a uniform oxide inactive surface film.
 - 2. Stainless steel welded tubing
 - a) 50" OD x .035" minimum wall thickness
 - b) 316 L food grade stainless with a finish of 40 RA both internally and externally.
 - c) Electropolish/passivation process
 - i. Electropolish in 135°F solution of 65% phosphoric - 35% sulfuric acid
 - ii. Passivate in 105°F solution of 20% nitric - 80% water
 - iii. Final rinse with 125°F Reverse Osmosis or deionized water to remove all chemical residues
 - iv. Electropolish and passivate after all fabrication and welding
 - 3. Coupling, elbow, tee fittings
 - a) Clean Fitting or equivalent sanitary type
 - b) 316 L food grade stainless steel
 - c) ID: .to match tubing ID
 - d) Electropolish both internally and externally and passivate to a finish of 40 RA or better on all water contact surfaces
 - e) Joint Seal

- i. High grade FDA approved silicone
 - ii. Seal edge width: .05"
 - iii. ID: .43" for flush internal joint
 - iv. Ferrule: 316 Stainless Steel
 - v. Retainer hex nut: 303 stainless steel
 - vi. Pipe/Coupler Assembly
 - 1) Prefabricated piping assembly with a half coupling fitting welded to one end
 - 2) Clean Fitting connection or equivalent sanitary type
 - 3) Debur open end of pipe to make it Clean Fitting ready for field assembly
- 4. Manifold watering drop: Located in each animal room as shown on drawings and/or to adequately accommodate manifold connection for mobile or stationary racks or kennel/pen arrangements.
 - a) Universal style quick disconnect socket for hose connection of 316 food grade stainless steel.
 - b) Use Pipe/Coupler assembly for all piping runs not requiring I/C connections.
- 5. Detachable Flex Hose: Pen manifold water supply hose assembly which can be detached from the room piping for sanitization or during periods of non-use
 - a) Tubing: Black PVDF (Kynar) (3/8" OD x 1/4" ID, NSF standard 61, FDA Grade, chlorine tolerance of .5 to 50 ppm)
 - b) Hose Length: As shown on drawing
 - c) Autoclavability: Maximum temperature of 250°F
 - d) Quick disconnect couplings - Universal Style
 - i. Quick disconnect plug on upper end
 - ii. Quick disconnect socket on lower end
 - iii. 316 food Grade stainless steel
 - iv. Electropolish both internally and externally and passivate to a finish of 45 RA or better on all machined water contact surfaces
 - e) Quick disconnect Seal: High grade FDA approved silicone
 - f) Push lock barb connection
 - g) Stainless steel spring supports (3" long) both ends.
- 6. Solenoid Flush Valve: Solenoid valve located down stream from the water supply rack connection points at the terminating end of each room distribution piping run for Room Distribution Flushing.

- a) Body Material: Electro-polished 316 stainless steel
- b) Input power: 24 VAC, 0.5 amp
- c) Watertight junction box connection with screw connectors
- d) Coil: Epoxy encapsulated one piece
- e) Ports: 1/2" FPT
- f) Diaphragm: Teflon
- g) Refer to Division 26 plans and specs for timeclock control of the flush valve.

D. VALVES, GENERAL

- 1. Stem packing: asbestos-free.

E. VALVES

- 1. General Characteristics: Provide valves with screwed or flanged ends as required by the piping system in which they are installed and as specified. All valves shall have the name of the manufacturer and working pressure cast or stamped thereon.
- 2. Shutoff Valves 2½ inches and smaller valve size:
 - a) 2-piece bronze body, full port ball valve, with blowout-proof stem, and WOG rated for 400 psig. Valves shall have a stainless steel ball, reinforced tfe seat, stuffing box ring, and soldered or threaded ends. Valves in insulated piping shall have 1.25" extended stems.
 - i. Manufacturer: Apollo, Crane, Hammond, Kitz, Milwaukee, Nibco, or Stockham.
- 3. Shutoff Valves 3 inches and larger line size:
 - a) Gate valve 3 inch and larger size: Iron body, resilient wedge, outside screw and yoke, 200 psi cold working pressure, FDA approved epoxy coating inside and out, flanged pattern, meeting AWWA C-509 standard, UL/FM Listed, FMRC Approved, ; equivalent to "Fig. F-607-RW" by NIBCO, or approved equivalent.
- 4. Check Valves:
 - a) Swing Type: 2½ inches and smaller: Bronze body ASTM B-62, y-pattern swing-type, threaded ends, manufactured in accordance with MSS-SP80, Class 125, with TFE seat disc; "S413-Y" by NIBCO, or approved equivalent by Apollo or Milwaukee.
 - b) 3 inches and larger: Bronze body Class 150, horizontal swing check valve, asbestos-free gasket, stop plug for screwdriver insertion to rotate and regrind seat, flanged ends; "B-342" by Stockham, or approved equivalent.
- 5. Stop and Drain Valve: Bronze body, full port, B16 chrome plated bronze ball, in-line repairable, TFE seats and seals, blowout proof stem design, adjustable packing nut, drain cap, latch lock lever, sweat ends and designed for soft solder and brazing installations.

6. Pressure Reducing Valves:

- a) Pressure Reducing Valve for dead end service. Valve shall be adjustable, diaphragm direct operated, packless, balanced and single seated. Water pressure reducing valve construction: body Cast Iron ASTM 126 Class B, a renewable seat and disc of 304 series stainless steel ASTM 276 Cond. A with a Nitrile disc insert, a Hycar diaphragm, a spring of carbon steel, and a Nylatron-GS gasket. Valve rating: 165-psig at 200F. Shutoff rating: ANSI/FCI 70-2 Class VI Shutoff. Manufacturer: Spence D34, Watts Series 2300, or equal by Apollo, Tyco or Zurn.

7. Mixing Valves:

- a) Multiple fixture mixing valves: thermostatic type mixing valve with bronze or brass body; lockable temperature setting; inlets with integral check stops; 0.50 gpm minimum flow with circulating pump operating; dial thermometers on hot, cold, and outlet; and conforming to ASSE 1070-2004.
 - i. Manufacturer: Leonard, Powers, Acorn, Bradley, Watersaver, or Lawler 570.

8. Relief Valves:

- a) Water pressure relief valves: 0.5" to 0.75", ASME rated, bronze or copper alloy body with a stainless steel spring, adjustable settings, and renewable seat. Valves shall be set for 80 psig pressure relief.
 - i. Manufacturer: Apollo LF10-600, Cash Acme FWL-2-LF, or Watts LF530C.
- b) Vacuum relief valves: 0.5" to 0.75", bronze or brass body with silicone disc, stainless steel springs, and vent cap. Valves shall be in accordance with ANSI Z21.22-1999/CSA 4.4-M99 (R2008), Addenda ANSI Z21.22a-b-2000-2001 (R2008)/CSA 4.4a-b-2000-2001 (R2008), and open at less than 0.5" Hg vacuum relief.
 - i. Manufacturer: Apollo LF14 series, Cash Acme VR-801-LF, or Watts LFN36-M1.
- c) Temperature and pressure relief valves: 0.75" to 2", ASME rated, automatic self-closing pressure and temperature relief type with bronze or copper alloy body, stainless steel springs, non-mechanical seat-to-disc alignment, test lever, thermostat, and stainless steel or FDA approved coated temperature probe. Valves shall be in accordance with ANSI Z21.22-1999/CSA 4.4-M99 (R2008), Addenda ANSI Z21.22a-b-2000-2001 (R2008)/CSA 4.4a-b-2000-2001 (R2008), and shall be set for 80 psig pressure relief and 210°F temperature relief.
 - i. Manufacturer: Apollo LF18C-500, Cash Acme FVX-LF series, or Watts LF series.

F. THERMAL EXPANSION TANKS

- 1. Inline expansion tanks shall be the bladder type with welded steel construction, primed and painted exterior, and designed for potable water. Diaphragms shall be FDA approved elastomeric,

butyl rubber, designed for a maximum operating temperature of 180°F, and a minimum of 100 psig working pressure. Tanks shall be precharged to a minimum of 40 psig.

- a) Manufacturer: Amtrol Therm-X-Trol, Bell & Gossett PTA, or Watts PLT.

G. WATER HEATERS

1. Water heater shall be electric with tank capacity, voltage and elements as scheduled on plans. The heater shall be listed by Underwriters' Laboratories and approved to the NSF Standard 5 by UL. Tank shall have 150 [ASME] psi working pressure and be equipped with extruded high density anode. All internal surfaces of the heater(s) exposed to water shall be glasslined with an alkaline borosilicate composition that has been fused-to-steel by firing at a temperature range of 1400°F to 1600°F. Electric heating elements shall be low watt density, screw-in type. Each element shall be controlled by an individually mounted thermostat and high temperature cut-off switch. All internal circuits shall be fused. The outer jacket shall be of baked enamel finish and shall be provided with control compartment accessible for service and maintenance through hinged front panel. The drain valve shall be located in the front for ease of servicing. Manufacturer shall supply ASME rated temperature and pressure relief valve.
2. Water heater shall meet standby loss requirements of the U. S. Department of Energy and current edition of ASHRAE/IES 90.1.

H. WATER SYSTEM MISCELLANEOUS COMPONENTS

1. Shock Absorbers:
 - a) Pre-charged sealed air chamber, piston type arrester, with EPDM "O" rings in seamless copper tube chamber lubricated by FDA approved silicone compound, meeting or exceeding Plumbing and Drainage Institute Standard PDIWH201, ASSE Standard No. 1010, and ANSI A112.26.1M.
 - b) Properly sized and selected per P.D.I. Standard WH201 and having sufficient displacement volume to dissipate the calculated kinetic energy generated by the piping system in accordance with Plumbing Drainage Institute sizing guidelines.
2. Strainers:
 - a) Strainers 2.5" and smaller: class 125, bronze body, Y-pattern, with a 20 mesh type 304 stainless steel screen, threaded cap, 200 psig non-shock cwp.
 - i. Manufacturer (solder ends): Apollo 59LF-300, Wilkins YBXLC, or Keckley Style F7.
 - ii. Manufacturer (threaded ends): Apollo 59LF-000, Wilkins YBXL, or Keckley Style E7.
 - b) Strainers 3" and larger: class 125, iron body, Y-pattern, with FDA coating inside and outside, type 304 stainless steel screen, bolted cap, with blow-off plug and valve, flange ends, 200 psig non-shock cwp.
 - i. Manufacturer: Apollo 125-YF, Hammond 3030, or NIBCO F-721-A.
3. Pressure Gauges
 - a) Bourdon tube type with metal case, minimum 3" dials, accuracy within 1% of full scale range, equipped with pressure snubbers and brass needle valves for 250 or 400 psig swp. Gauges at pumps shall be liquid-filled.

- | <u>Location</u> | <u>Range</u> |
|------------------------------------|----------------|
| Inlet of pressure reducing valves | 0 to 200 psig. |
| Outlet of pressure reducing valves | 0 to 100 psig. |
- b) Manufacturer: Ashcroft, Marsh, Trerice, Weiss, or Weksler.
4. Thermometers
- a) Blue- or green-reading every-angle, industrial type with aluminum case, glass lens, 9" scale length, and accuracy rating of \pm one scale division. Thermometers installed in insulated piping shall have 6" stems with brass thermowell, filled with heat transfer medium, and extension.
- b) Scale range: 30°F to 240°F.
- c) Manufacturer: Trerice BX9-SPB, Weiss A9VU, Weksler EG5L-9, or Winters 9IT.

I. UNIONS

1. For copper piping 2" or smaller: cast brass or bronze with copper soldered connections.
2. For steel piping 2" or smaller: ground joint with brass-to-iron seat.
3. For piping larger than 2": flange and gasket type. Flanges in steel piping shall be cast iron. Gaskets shall meet NSF 61-2012.

J. BACKFLOW PREVENTERS

1. Reduced pressure type for 0.5" cold water. Bronze body construction with two in-line independent check valves, replaceable check seats with an intermediate relief valve, upstream bronze strainer, union connections, and quarter turn ball valves on inlet and outlet. Maximum working pressure is 175 psi.
 - a) Manufacturer: Watts LF009, or equal by Wilkins or Apollo.
2. Reduced pressure type for cold water 0.75" to 2": with bronze body, stainless steel working parts, check modules, test cocks, relief module, and threaded ends. Provide the assembly with isolation valves, air gap drain device, and separate wye pattern strainer.
 - a) Manufacturer: Apollo RP4ALF, Watts LF919, or Wilkins 975XL.
3. Reduced pressure type for hot water 0.75" to 2": with bronze body, stainless steel working parts, check modules, test cocks, relief module, threaded ends, and all parts designed for 140°F water service. Provide the assembly with isolation valves, air gap drain device, and separate wye pattern strainer.
 - a) Manufacturer: Apollo RP4ALF, Watts LF919-HW, or Wilkins 975XL.
4. Vacuum Breakers:
 - a) Atmospheric vent type, same size as pipe, bronze construction with stainless steel working parts, complete with air gap drain device, strainer, and 2 independently acting spring loaded check valves with vent in between. Use limited to wall hydrant service.
 - i. Manufacturer: Conbraco 40-400, Watts 9D, or equivalent by Wilkins.

- b) Pressure type, same size as pipe, bronze body, complete with check valve, spring-loaded float disc, test cocks, atmospheric vent, and ball type shutoff valves. For continuous pressure applications.
 - i. Manufacturer: Conbraco 40-500, Watts 800QT, or equivalent by Wilkins.
 - 5. Double check valve type, same size as pipe unless otherwise indicated on the Drawings, with stainless steel springs, guides, and fasteners, corrosion-resistant check components and renewable seats, complete with strainer, check modules, isolation valves and test cocks. Assemblies larger than 2" shall be iron body with fused epoxy coating and gate type isolation valves. Assemblies 2" and smaller shall be bronze body construction with ball type isolation valves.
 - a) Manufacturer: Conbraco 40-100 series, or Watts 709 series.
 - 6. Dual check valve type for cold water 0.25" to 0.375": with 316 stainless steel or chromium-plated bronze body, inline spring loaded dual check valves, atmospheric vent port, meeting FDA food service requirements, and complying with ASSE 1022-2003. Provide the unit with an isolation valve, and separate wye pattern strainer.
 - 1. Manufacturer: Apollo DUC4NLF, Watts LFSD-3, or Wilkins 740XL.
- K. HOSE BIBS
 - 1. For all finished areas (except where scheduled otherwise on plans): polished chromium-plated brass with 0.75" inlet, tee handle, built-in atmospheric vacuum breaker, and 0.75" hose thread outlet.
 - a) Manufacturer: Chicago 952XK, T&S B-0722, or Zurn Z875L7 or equal by Woodford, .
 - 2. For mechanical rooms: anti-siphon, bronze body, metal handle, and ¾" hose thread outlet.
 - a) Manufacturer: Zurn 196XL VB or equal by Woodford, T&S Brass, or Chicago.
- L. FREEZE-PROOF HYDRANTS
 - 1. Wall Hydrants (except where scheduled otherwise on plans) shall be non-freeze type with bronze body and casing, 0.75" threaded inlet, 0.75" hose thread outlet, integral vacuum breaker, metal handle, adjustable wall clamp, and chrome finish..
 - a) Manufacturer: Zurn Z-1345-CP3 or equal by Woodford, T&S Brass, or Chicago.
- M. BUILDING DOMESTIC COLD WATER METERING
 - 1. Meter shall be:
 - a) Neptune Compound TRU/FLO for variable flow, 2" pipe and above or NC State approved equal by Zenner.
 - b) Neptune Positive Displacement rotating disc for smaller than 2" pipe or NC State approved equal by Infinity, Sensus, Badger, or Elster Amco.
 - 2. Meters shall have a local display. Connect each meter output to NC State campus network V-LAN via Modbus RTU TCP/IP where possible. Meter shall be provided and capable of measurement of both instantaneous and accumulated water usage.
 - 3. The meters shall record water usage at the service entrance in units of CF or CCF.
 - 4. Meters shall be equipped with a pulse or encoded output and shall be wired into a flow computer. Meter shall include a cover on the register and minimum of 10 feet of wiring sealed within the unit.
 - 5. Flow Computers

- a) Basis-of-Design Product: Subject to compliance with requirements, provide package flow computer, including NEMA 1 enclosure, power disconnect, computer, pre-wired for 120VAC power, Modbus RTU to Ethernet converter. Prewired assembly shall be third party listed. Provide a Kessler-Ellis Products ES762 ST2L11P flow computer or NC State approved equal by Emerson, ABB, Flowmetrics, or Honeywell.
- b) Flow Computer:
 - i. Display: backlit LCD display
 - ii. Keypad: 16-key membrane keypad sealed to NEMA 4
 - iii. Inputs: Analog input, pulse, and four secondary totalizer contact closure inputs.
 - iv. Outputs: 2 relay, 2 analog, RS-485 Modbus RTU, pulse
 - 1) Water: Instantaneous flow (gpm), flow total (gallons)
 - v. Clock: Battery backed non-volatiles real time clock with display of time and date.

PART 3 - EXECUTION

A. PIPING INSTALLATION, GENERAL

1. Workmanship: pipe shall be cut to measurements established at the site and worked into place without springing or forcing. Pipes shall be installed to permit free expansion and contraction without damage to joints, hangers, or the building.
2. Use concentric reducing fittings between different size pipe.
3. Ream steel, alloy steel, brass and copper pipe after cutting, turn on end and knock loose dirt, scale, and filings from interior of pipe.
4. Slope water piping to drain back to the mains.
5. Group exposed pipe together and arrange control valves at fixtures for ease of operation.
6. Solder joint connections shall be cut, deburred, cleaned and assembled in accordance with ASTM B828-2000.
7. Install piping so as to preserve access to valves and equipment and to provide the maximum headroom possible.
8. Provide offsets to maintain ceiling height and to coordinate with other trades.
9. Install exposed piping such that when insulation is applied it will not come in contact with adjacent surfaces.

10. All ferrous to non-ferrous pipe connections shall be made with accepted dielectric pipe or flange union isolating joints to prevent any electrolytic action between dissimilar metals.
11. Branch piping to fixtures and equipment shall be braced so that there is no horizontal or vertical movement in the piping. Pipe supports shall be isolated from copper tubing with rubber sleeves.
12. Mechanically formed tee connections: joints shall be brazed in accordance with the Copper Development Association Copper Tube Handbook using BCuP series filler metal. Mechanics performing mechanically extracted fitting operations shall be certified by the manufacturer.

B. ANIMAL DRINKING WATERING DISTRIBUTION, EXPOSED IN ANIMAL HOLDING ROOMS

1. Attach tubing to the wall, ceilings or other suitable support structure with 18 GA stainless steel clamps and other appropriate brackets. Use stainless steel mounting hardware.
2. Provide a 2-hole clamp at each hose drop station within 2" of the quick disconnect fitting to provide adequate rigidity and support. Provide one-hole clamps at all other mounting points where suitable support can be attained. Space clamps not to exceed 36".
3. Provide plastic stand-off spacers under each clamp for wall mounting applications to mount piping off the wall by 1/2" with plastic screw anchors and stainless steel self tap screws (#10 x 1-1/4").
4. Install the entire piping system at a consistent level throughout. Limit any rises and drops.
5. Provide a stainless steel escutcheon at ceiling penetrations. Use silicone sealant to make an air tight seal around the pipe. Avoid any mechanical joints inside walls.
6. Solenoid flush valve timeclock shall be set to flush every 12 hours for 5 minutes.

C. VALVES

1. General:
 - a) Provide a valve in each water supply connection to pressure reducing valves (up and downstream), freeze-proof wall hydrant, mixing valve, and water heater.
 - b) Install a valve in each water supply to cage/rack washers and tunnel washers unless provided by the manufacturer at the equipment water inlet.
 - c) Install valves in clear locations so that handles and hand wheels are easily accessible for opening and closing of the valves.

D. STRAINERS

1. Install in the inlet to each pressure reducing valve, thermostatic mixing valve, backflow preventer, and as indicated on the Drawings or specified herein.
2. Strainers: after final flushing of the water system, remove strainer baskets and screens for cleaning and disinfection. Reinstall baskets and ensure that caps are leak tight.

E. VACUUM BREAKERS

1. Pressure Type:
 - a) Install where water flow is continuous.
 - b) Install a minimum of 12" above the overflow level of the device being served.
2. Atmospheric Type:
 - a) Install where water flow is intermittent.
 - b) Install a minimum of 6" above the overflow level of the device being served.
3. Install where spillage of water will not cause damage to room surfaces or equipment.

F. BACKFLOW PREVENTERS

1. Provide backflow preventers on potable water services supplying laboratory equipment or fixtures with hose-thread outlets unless provided integral to the equipment.
2. Install reduced pressure type ahead of closed loop HVAC heating systems, water supplies to animal drinking water supply, and liquid ring vacuum pumps. Provide a parallel, redundant, backflow preventer at each of these locations.
 - a) Install in an accessible location. Pipe relief drain out exterior wall to outside of building or to an appropriately sized floor drain. Relief shall be double the diameter of the pipe this is providing backflow prevention on.
 - b) Piping downstream of these locations shall be labeled as Non-potable.
 - c) Backflow preventers shall be certified at project completion. Where backflow preventers are provided as an complete assembly complete with isolation valves on both sides of the backflow preventer, unions or flanges shall be installed between the isolation valves and backflow preventer to permit removal of the backflow preventer without a requirement to drain the system.

G. UNIONS

1. Provide in each connection to each piece of equipment, except where flanges are used, so it may be removed.

H. FIXTURES AND EQUIPMENT PROVIDED BY OTHERS

1. General:
 - a) Provide rough-in for related fixtures.
 - b) For the water supply provide stops (or valves), supplies, escutcheons, and faucets as required.
 - c) Provide pressure rated vacuum breakers for fixture trim having hose connection capabilities and no backflow prevention.
 - d) Provide water hammer arrestors for all equipment which controls water flow with electric solenoid valves.

I. WATER HAMMER ARRESTORS:

1. Provide Water Hammer Arresters in the piping systems and adjacent to all pieces of equipment wherein quick-closing valves are installed.
2. Water Hammer Arresters shall be properly sized and selected per P.D.I. Standard WH201 and having sufficient displacement volume to dissipate the calculated kinetic energy generated by the piping system. Install all units in a vertical position.
3. Provide shut-off valves for each water hammer installation.

J. PIPING AND FIXTURE TESTS

1. Test cold water, hot water, and hot water circulating systems piping by capping all openings and applying a hydrostatic pressure of 125 psig for 24 hours without any drop in pressure. Disconnect the pump source prior to and during testing. Where a system is tested in sections, each section shall be subjected to the same test.
 - a) Where a system is an extension to a single fixture from existing branch piping, system shall be tested at existing building pressure.
2. Piping General:
 - a) Tests shall be made while piping and joints are exposed to view and prior to insulation.
 - b) Submit a statement certifying that piping and joints are tight and have passed the specified test.
3. Piping Test General:
 - a) Soldered and brazed joints that leak shall be taken down and replaced.

K. WATER HEATERS

1. Install heaters level and stable on concrete equipment pad.
2. Pipe relief, full size to nearest drain.
3. Water heater shall be maintained at 140°F. Install mixing valve to maintain water distribution temperature at 125°F
4. Start-up: a factory trained representative shall start-up each water heater. The Contractor shall not start the water heater without the factory trained representative. The representative shall submit a start-up report to the Contractor for inclusion in the Operation and Maintenance Manual.

L. WATER FLOW METERING

1. Install in accordance with manufacturer's instructions.
2. Piped utility meters shall be installed with isolation valves and drain valves. A 20 mesh 316 stainless steel strainer shall be provided upstream of positive displacement and turbine type meters.
3. Assemble and install connections, tubing, and accessories between flow measuring elements and flow meters according to manufacturer's written instructions.

4. Install flow meter elements in accessible positions in piping systems.
5. Install flow meters in proper orientation and with proper flow direction based on manufacturer specifications.
6. Install permanent display indicators on walls or brackets in accessible and readable positions.
7. When possible, meters shall be installed five (5) feet or lower above the finished floor.
8. Connections
 - a) Connect flow meter-system elements to meters.
 - b) Connect flow meter transmitters to meters.

M. CLEANING

1. Hot and Cold Water Piping:
 - a) Clean and disinfect water distribution piping prior to placing the system in operation.
 - b) Purge domestic hot and cold water and hot water circulating and chilled drinking water supply and circulating piping, including heaters, pumps, tanks, and fixtures.
 - c) Flush the piping systems with potable water from the municipal supply system until water runs clear.
 - d) Fill the system with clean water with a water/chlorine solution containing a minimum 50 ppm chlorine. Isolate the piping systems and allow to stand for 24 hours.
 - e) Drain the systems and refill with a water/chlorine solution containing a minimum 200 ppm chlorine. Isolate the piping systems and allow to stand for 3 hours.
 - f) Flush the systems with clean, potable water from the municipal supply system until the chlorine in the system is the same level as the municipal supply system.
 - g) Submit water samples for biological examination by laboratories approved by the local health authority. Samples shall be taken in the presence of the Owner.
 - h) Repeat the procedures and resubmit water samples as required to pass the biological test. Minimum acceptance test results shall be 0.0 colonies of coliform bacteria.
 - i) Provide results of tests.
 - j) Materials and test methods shall comply with AWWA C651-1999.

END OF SECTION 22 44 00

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SECTION 22 60 00 – MEDICAL GAS PIPING AND EQUIPMENT

PART 1 - GENERAL

A. RELATED DOCUMENTS

1. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.
2. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

B. SUMMARY

1. This section includes the furnishing of all labor and materials necessary for complete installation, cleaning, testing and certification of medical vacuum, waste anesthesia gas disposal and gas distribution and monitoring systems, including: piping, inlets, outlets, alarms, valves, supports, labeling, identification and all related accessories. Medical gas systems include Oxygen.
2. **All work described in this section shall be completed under Add Alternate #9. Refer also to specification section 012300, Alternates.**

C. REFERENCE STANDARDS

1. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.
2. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.
3. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:
 - a) NFPA 99 Standard for Health Care Facilities
 - b) NFPA 70 National Electrical Code
 - c) ASTM B819 Seamless Copper Tube for Medical Gas Systems
 - d) AWS A5.8 Brazing Filler Metal
 - e) CGA V-5 Diameter Index Safety System
 - f) NIH Design Requirements Manual, Section 12.5 Veterinary Medical Gas Systems for Animal Research Facilities
 - g) North Carolina State Buildings Codes

D. QUALITY ASSURANCE

1. All materials, equipment, installation, testing and certification shall be in strict accordance with NFPA 99 for Level 1 Medical–Surgical Vacuum, WAGD and Gases.
2. Manufacturer's name and pressure rating shall be permanently marked on valve body.
3. Products of same type shall be by one manufacturer. All valves, valve boxes, inlets, outlets, alarms and associated components shall be supplied by a single manufacturer and shall be fully compatible with existing system and service devices.
4. Verify compatibility of all new components with existing system and services.
5. Prior to any installation Work, the installer of medical vacuum and gas piping shall provide and maintain documentation on the job Site for the qualification of brazing procedures and individual brazers as required by NFPA 99.

E. SUBMITTALS

1. General:
 - a) All submitted data shall be specific to this project and identified as such. Generic submittal data will not be accepted.
2. Product Data:
 - a) Manufacturers descriptive literature, illustrations and installation instructions for all components included within this project indicating compliance with applicable referenced standards, size, dimensions, model number, electrical characteristics and connection requirements.
3. Shop Drawings:
 - a) Wiring diagrams for medical vacuum and gas alarm systems. Differentiate between manufacturer-installed and field-installed wiring.
4. Record Documents:
 - a) Record actual locations of piping, valves, alarm sensors, alarm panels, station inlets and outlets.
 - b) Prepare and provide valve charts.
 - c) Provide record of test procedures and the results of all tests indicating room and area designations, dates of the tests, and names of persons conducting the tests.
 - d) Brazer Certificates: Installation Contractor shall present written documentation (less than 3 years old) from a recognized agency trained in administering and testing brazing techniques as per AWS B2.2 or ASME Section IX, certifying that all brazers have been thoroughly trained and tested in the complete installation of medical gas systems.
 - e) Provide full written description of manufacturer's warranty.

5. Operation and Maintenance Data:

- a) Operation Data: Include manufacturer's installation and operating instructions.
- b) Maintenance Data: Servicing and testing requirements, inspection data, exploded assembly views, Record Documents, inspection data, test reports, installation instructions, replacement part numbers and availability, location and contact numbers of service depot.

F. DELIVERY, STORAGE and HANDLING

- 1. Tubes, valves, fittings, station outlets, and other piping components in medical gas systems shall have been cleaned for oxygen service by the manufacturer prior to installation in accordance with CGA 4.1, Cleaning Equipment for Oxygen Service, except that fittings shall be permitted to be cleaned by a supplier or agency other than the manufacturer.
- 2. Each length of tube shall be delivered plugged or capped by the manufacturer and kept sealed until prepared for installation.
- 3. Fittings, valves, and other components shall be delivered sealed, labeled, and kept sealed until installation.
- 4. Where contamination is known to have occurred, the materials affected must be removed and replaced with new materials that are cleaned and sealed by the manufacturer or supplier.

G. QUALIFICATIONS

- 1. General: Companies specializing in manufacturing, installing, testing, certifying and servicing the products and systems specified in this section shall have minimum five years documented experience.
- 2. Manufacturers: Firms regularly engaged in manufacture of medical gas systems equipment and products, of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years. References may be required.
- 3. Equipment Supplier: The medical vacuum and gas systems equipment supplier shall provide the services of a manufacturer authorized product specialist to periodically coordinate with the installing Contractor during initial installation of the pipeline systems and have a service organization located within 50 miles of the project Site to provide ongoing service support to MD Anderson after project completion.
 - 1) Installer: Firm with at least 5 years of successful installation experience on projects with medical gas systems work similar to that required for project. All installations of the medical gas piping systems shall be done only by, or under the direct supervision of a holder of plumber license. All installers of medical gas system components must be qualified in accordance with the requirements of NFPA 99 and ASSE 6010, Medical Gas Systems Installers Professional Qualifications Standard. In addition, all brazers of medical gas system piping must be qualified in accordance with the requirements of either Section IX, Welding and Brazing Requirements of the ASME Boiler and Pressure Vessel Code, or AWS B2.2, Standard for Brazing Procedure and Performance Qualification.

- 2) System Verification Testing Agency: Testing shall be conducted by a party technically competent and experienced in the field of medical gas and vacuum pipeline testing and meeting the requirements of ANSI/ASSE Standard 6030, Medical Gas Verifiers Professional Qualifications Standard. Quality control standards of testing agency shall be in strict accordance with American National Standards Institute (ANSI) Q-91. Firm shall be regularly engaged in the testing and certification of similar facilities with a minimum of 5 years of experience.

PART 2 - PRODUCTS

A. PRESSURIZED MEDICAL GAS PIPING

1. All pipe shall be Type "K", ASTM B819, hard drawn seamless copper medical gas tubing. Pipe shall be identified by the manufacturer's markings, "OXY," "MED," or "OXY/MED" and with size designated reflecting nominal inside diameter.
2. Turns, offsets, and other changes in direction shall be made with brazed wrought copper capillary fittings complying with ANSI B16.22, Wrought Copper and Copper Alloy Solder-Joint Fittings; or brazed fittings complying with MSS SP-73, Brazed Joints for Wrought and Cast Copper Alloy Solder Joint Pressure Fittings. Cast copper alloy fittings shall not be permitted.
3. Brazed joints shall be made using a brazing alloy that exhibits a melting temperature in excess of 538°C (1000°F). Copper-to-copper joints shall be brazed using a copper-phosphorus or copper-phosphorus-silver brazing filler metal (BCuP series) without flux. Flux shall only be used when brazing dissimilar metals such as copper and bronze or brass, using a silver (BAg series) brazing filler metal. Brazing alloy comply with ANSI/AWS A.5.8, Specification for Brazing Filler Metal.
4. Threaded joints in medical gas distribution piping shall be limited to connections to pressure/vacuum indicators, alarm devices, and source equipment. All threads shall be tapered pipe threads complying with ANSI B1.20.1, Pipe Threads, General Purpose and be made up with polytetrafluoroethylene (such as Teflon™) tape or other thread sealant recommended for oxygen service, with the sealant applied to the male threads only. Where threaded nipples are required these shall be I.P.S. brass.
5. The use of shape memory alloy couplings may be used when making connections to existing piping sizes 2" and smaller. Memory-metal couplings shall have temperature and pressure ratings joints not less than that of a brazed joint. Shape memory alloy couplings shall be manufactured by TW Metals "CryoMed" or AeroFit "CryoFit".
6. Straight-threaded connections, including unions, flared and compression-type connections, including connections to station outlets and inlets, alarm devices, and other components shall not be permitted.
7. All pipe and fittings shall be supplied cleaned and sealed for oxygen service.

B. MEDICAL VACUUM PIPING

1. All vacuum piping sizes 1-1/2" and smaller shall be as specified for pressurized medical gas pipe. Vacuum pipe sizes 2" and larger shall be Type "K" or "L" hard-drawn seamless copper, either ASTM B 819 medical gas tube or ASTM B 88 water tube.
2. Turns, offsets, and other changes in direction shall be made with brazed wrought copper capillary fittings complying with ANSI B16.22, Wrought Copper and Copper Alloy Solder-Joint Fittings; or brazed fittings complying with MSS SP-73, Brazed Joints for Wrought and Cast Copper Alloy Solder Joint Pressure Fittings. Cast copper alloy fittings shall not be permitted.
3. Brazed joints shall be made using a brazing alloy that exhibits a melting temperature in excess of 538°C (1000°F). Copper-to-copper joints shall be brazed using a copper-phosphorus or copper-phosphorus-silver brazing filler metal (BCuP series) without flux. Flux shall only be used when brazing dissimilar metals such as copper and bronze or brass, using a silver (BAg series) brazing filler metal. Brazing alloy comply with ANSI/AWS A.5.8, Specification for Brazing Filler Metal.
4. Threaded joints in medical vacuum distribution piping shall be limited to connections to pressure/vacuum indicators, alarm devices, and source equipment. All threads shall be tapered pipe threads complying with ANSI B1.20.1, Pipe Threads, General Purpose and be made up with polytetrafluoroethylene (such as Teflon™) tape or other thread sealant recommended for oxygen service, with the sealant applied to the male threads only. Where threaded nipples are required, these shall be I.P.S. brass. Close nipples shall not be installed.
5. Mechanically formed, drilled and extruded tee-branch connections shall not be permitted.
6. Couplings and fittings incorporating an o-ring seal shall not be permitted.
7. Roll-grooved joints shall not be permitted.
8. Straight-threaded connections, including unions, flared and compression-type connections, including connections to station outlets and inlets, alarm devices, and other components shall not be permitted.

C. MEDICAL VACUUM AND GAS VALVES

1. General:
 - a) All valves for pressurized gases and valves for vacuum or WAGD services 1-1/2" and smaller shall be supplied cleaned and sealed (bagged) for oxygen service by the manufacturer.
 - b) Valves for vacuum or WAGD service sizes 2" and larger will not be required to be cleaned and sealed for oxygen service.
 - c) Provide quantity and size of valves as indicated on Contract Drawings and as required by NFPA 99.
 - d) Medical vacuum and gas valves, zone valve boxes and related accessories shall be manufactured by Tri-Tech Medical, Patton's Medical, Amico, BeaconMedaes, Ohio Medical, or Owner approved equal.

2. Source, Main, Riser and Service Line Shut-Off Valves:

- a) Shut-off valves shall be full port, double seal, ball-type three piece design, designed for vacuum to 29 inches Hg and working pressures up to 600 WOG with bronze/brass body, blow-out proof stem and chrome plated brass ball and be serviceable in the line. Valve body shall have Teflon (TFE) material ball seat and stem seals. Seats/seals, lubricants and valve material shall be compatible with medical oxygen, nitrous oxide, compressed air, carbon dioxide, nitrogen and mixtures thereof at continuous pressure up to 600 psig and up to 100 degrees Fahrenheit.
- b) Valve shall be provided with and operated by a lever-type handle requiring only a quarter turn from a fully open position to a fully closed position.
- c) All valves shall be equipped with type "K" washed and degreased copper pipe stub extensions at both the inlet and outlet sides of the valve port to facilitate installation. On outlet pipe stub provide 1/8" FPT tap with plug to accept gauge or nitrogen purge connection. Stub extensions shall be supplied to Site capped at both ends
- d) Valve tags showing the appropriate gas services, pressure rating, etc. shall be attached to each valve.
- e) Each shut-off valve shall be provided with locking kit.

3. Zone Valve and Box Assemblies:

- a) Each zone valve cabinet shall be recessed type and consist of the following components: A steel valve box housing single or multiple shut-off ball valves with tube extensions, an aluminum frame, and a pull-out removable window. Boxes shall be provided to accommodate size and type of medical vacuum and gas valves as indicated on Contract Drawings.
- b) The valve box shall be constructed of 18 gauge steel complete with a white epoxy finish and provided with two galvanized steel brackets for the purpose of mounting to structural support. The assembly trim shall accommodate various finished wall thickness of up to one inch and be field adjustable. Cabinets shall be designed to permit box assemblies to be ganged together in a vertical stack.
- c) The doorframe assembly shall be constructed of anodized aluminum mounted to the back box assembly by screws as provided and shall have a sliding removable front consisting of an opaque door with a pre-mounted pullout ring and clear gauge window. Access to the zone shut-off valves shall be by merely pulling the ring assembly to remove the window from the doorframe. The window shall be capable of re-installation without the use of tools and only after the valve handles have been returned to the open position. The window shall be labeled "Caution – Medical Gas Shut-Off Valve - Close Only in Emergency", or equivalent wording in accordance with NFPA 99.
- d) Valves shall be same as specified herein for line shut-off valves except locking devices are not required.

- e) Each valve shall be supplied with an identification bracket bolted directly onto the valve body for the purpose of applying an approved medical gas identification label. A package of labels shall be supplied with each valve box assembly for application by the installer.
- f) All valves shall be securely attached to the box and provided with Type "K" washed and degreased copper pipe stub extensions of sufficient length to protrude beyond the sides of the box for connection to system piping. All pipe stub extensions shall be supplied with 1/8" NPT gauge port located on the terminal outlet side of the valve to register pipeline pressure or vacuum. Suitable plugs or caps shall be installed by the manufacturer to prevent contamination of the assembly prior to installation.
- g) Gauges shall be minimum 1-1/2" diameter, with metal case and ring, and an 1/8" NPT brass stud at the back of the gauge for the purpose of mounting onto pipe stub extension within the box. The pipe stub extension shall be complete with a soldered gauge holder. Gauge holders shall be sealed with a brass plug to prevent contamination prior to mounting gauges. Pressure gauges shall read 0-700 kPa (0-100 psig) for all gases except nitrogen, which shall read 0-2000 kPa (0-300 psig), and vacuum, which shall read -100-0 kPa (0-30" Hg). Gauges shall be visible through the door of the zone valve box.
- h) Valve box may house one to six valves.
- i) Each valve may incorporate a gas specific DISS demand check valve for installation of a DISS specific sensor.

D. MEDICAL VACUUM AND GAS CHECK VALVES

- 1. Check valves shall be center guided, self-aligning, spring loaded ball type check with brass body, Teflon seat, straight-through flow, 400 psi WOG minimum working pressure, having vibration free, silent operation.
- 2. Check valves shall be 100% leak tested and comply with NFPA 99.

E. SERVICE INLETS AND OUTLETS

- 1. General:
 - a) Inlets and outlets shall be UL listed and conform to applicable NFPA and CGA standards.
 - b) Inlets and outlets shall consist of separate roughing-in and finish assemblies and be modular in design for wall recessed type installation and attachment to concealed piping.
 - c) For positive pressure gas services, the outlet shall be equipped with a primary and secondary check valve. The secondary check valve shall be rated at a minimum 1379 KPa (200 psi) in the event the primary check valve is removed for maintenance.
 - d) The roughing-in assembly shall be corrosion resistant with a permanent pin-keying system for each specific gas and be provided with a Type "K", 1/2" outside diameter, 6-1/2" long copper inlet pipe stub, which is silver brazed to the outlet body. The copper tubing inlet shall rotate 360 degrees to allow connection from any direction. The assembly shall allow pressure testing without additional labor to remove plug or adapter after testing.

- e) The finishing assembly shall contain a primary check valve, pin-key indexing, a minimum of 2.5 square inches of color coding and incorporate a plaster adjustment from 3/8" to 3/4" variation in wall thickness. Design shall be such as to ensure absolutely no gas flow until the correct adapter is fully engaged. Each assembly shall have a separate cover plate for ease of service without preventing use of other inlets or outlets.
- f) All inlets and outlets shall be factory assembled, tested, cleaned for oxygen service, and supplied with temporary protective covers and packages to protect outlet during handling and installation at the job Site.
- g) Medical inlets and outlets and related accessories shall be manufactured by Tri-Tech Medical, Patton's Medical, Amico, BeaconMedaes, Ohio Medical or Owner approved equal.

2. Wall Inlets:

- a) Wall inlets for Waste Anesthesia Gas Disposal (WAGD) services shall be quick-connect recessed type and be compatible with Medaes Diamond style pin indexed adapters.
- b) Wall inlets for Vacuum services shall be Diameter Index Safety System (DISS) recessed type and only accept corresponding DISS type gas specific adapters.
- c) Each vacuum outlet shall have an adjacent slide for supporting vacuum bottle assembly.

3. Wall Outlets:

- a) Wall outlets for oxygen service shall be Diameter Index Safety System (DISS) recessed type and only accept corresponding DISS type gas specific adapters.

4. Ceiling Inlets and Outlets with Hose Drops:

- a) Ceiling outlets for oxygen and vacuum and evacuation services shall be Diameter Index Safety System (DISS) recessed type and only accept corresponding DISS type gas specific adapters.
- b) Provide an upper hose assembly with a reel-type retractor kit. Hose shall terminate 6'-4" above finished floor.
- c) Hose assembly shall consist of a UL-listed high-pressure color-coded conductive hose with a DISS nut and gland on the upper end. Provide a DISS Hand-I-Twist check unit on the lower end for all services except WAGD. Provide a Diamond quick-connect on the lower end for the Waste Anesthesia Gas Disposal service.

F. MEDICAL VACUUM AND GAS ALARMS

1. General:

- a) Provide master alarms for source equipment as indicated on Contract Drawings and as required by NFPA 99.

- b) Provide area alarms for station inlets and outlets as indicated on Contract Drawings and as required by NFPA 99.
- c) Master and area alarms may be combined into a single panel for this project.
- d) Alarms shall provide signals as required by the latest edition of NFPA 99. Alarms shall be listed to UL 1069 and CSA C22.2 NO 601.1-M90 and comply with the following electromagnetic compatibility standards: FCC Part 15 Class A, ICES 003 Class A, EN 61326, EN 61000-3-2 and EN 61000-3-3.
- e) All field wiring and signals shall be self-monitoring and on a closed circuit. Fault signals shall activate on an open circuit.
- f) Input power to the alarm panel shall be 100 to 250 VAC 50/60 Hz, double fused on the input side. An internal power supply shall convert the input voltage to low voltage +5 and +24 VDC. All user accessible electronics and wiring shall utilize low voltage. A guard must be removed to access the high voltage wiring.
- g) A green front panel POWER ON indicator shall illuminate when the alarm panel is powered. Each monitored condition shall have a separate red indicator illuminated when in alarm. A red indicator on the alarm silence button shall be illuminated after any audible alarm has been silenced.
- h) Each panel shall provide an audible signal activated by digital display modules or multi-signal alarm modules. The audible signal shall produce a minimum sound pressure level of 90 dBA measured at a distance of 3 feet. The alarm panel shall contain alarm silence, test, and setup buttons.
- i) Each panel shall include a general fault relay for the entire panel, an RS-485 data port and an additional auxiliary relay.
- j) Medical gas alarm panels, sensors and related accessories shall be manufactured by Tri-Tech Medical, Patton's Medical, Amico, BeaconMedaes, Ohio Medical or Owner approved equal.

2. Area Alarms

- a) Area alarm panels shall be provided to monitor all medical gas, medical/surgical vacuum, and piped WAGD systems supplying anesthetizing locations, and other vital life support and critical areas such as post anesthesia recovery, intensive care units, emergency departments, and where indicated on Contract Drawings.
- b) Digital display modules shall provide a digital LED display continuously indicating the pressure or vacuum in the piping system being monitored. The brightness of the LED display shall be adjustable to compensate for ambient lighting. The display shall be programmable to read psig, in Hg, mm Hg, or kPa in increments of 1 psig, 1 in Hg, 1 mm Hg, or 1 kPa respectively.

- c) The digital display module shall provide an audible and visual signal when a fault condition occurs. A front panel alarm mute button shall be provided to silence the audio. A visual signal shall flash until the alarm silence button is pressed, and shall then remain statically illuminated. The visual signal shall automatically cancel when the fault is corrected.
- d) Separate visual signals for system pressure or vacuum are NORMAL (green LED), LOW (red LED), and HIGH (red LED). Signal limits are factory set per NFPA 99 and field programmable without the use of tools. Pressing and holding the front panel TEST button initiates a self-test function to test the LED display, visual indicators, audible alarm, and to view the alarm set points.
- e) Each digital display module shall be equipped with separate relays for high and low alarms. Relays shall be single-pole double-throw type (30 VAC/VDC 2A max). Digital readings from one display module shall be capable of being monitored by another digital display module at a remote panel.
- f) A sensor module shall be provided for each digital display module. Sensor modules shall contain a transducer capable of providing calibrated signals to the digital display module. Sensor modules shall be gas specific. The alarm panel shall be factory configured for sensor mounting within the alarm panel rough-in box (local sensors) or directly to the medical gas pipeline (remote sensors). Remote sensors may be located within zone valve box or readily accessible above ceiling..
- g) Pipeline connections shall be 3/8" nominal (1/2" OD) Type "K" copper tube. Connectors shall be provided for attaching field wiring. Sensors shall be gas specific for periodic testing without interrupting medical gas pipeline pressures or vacuum.

3. Master Alarms

- a) A master alarm system shall be provided to monitor the operation and condition of the source of supply, the reserve source, and the pressure in the main lines of each medical vacuum and gas piping system. The master alarm system shall consist of two or more alarm panels located in at least two separate locations as required by NFPA 99.
- b) Each Multi-signal alarm module shall be capable of monitoring up to a minimum of five (5) dry-contact signals. Each signal shall illuminate a green LED to indicating normal conditions. When a fault occurs, the green LED shall turn off, a red LED shall illuminate, and an audible alarm shall sound. The red LED shall flash until the front panel alarm silence button is pressed. After the alarm silence button is pressed, the red LED shall remain statically illuminated. The red indicator shall automatically turn off and the green LED shall illuminate when the fault is corrected.
- c) LED illumination for unused signals shall be deactivated in the field. Field programming shall be accomplished without the use of tools. Pressing and holding the front panel TEST button shall initiate a self-test function to test the LED indicators and audible alarm. The multi-signal module shall be supplied with five, dry-contact, normally closed relays for connection to a building automation system. Relay ratings shall be 30 VAC/VDC 2A max.
- d) A blank overlay shall be used to fill unused alarm panel locations and/or reserve a module location for future expansion. It shall be removable for installing additional modules.

4. Vacuum and Pressure Switches

- a) Switches shall incorporate UL listed single-pole, double-throw, and snap-action switching elements. Switch shall automatically reset.
- b) Signal setting for low vacuum shall be at 12" HG.
- c) Signal settings for all pressure gases except Nitrogen shall be; Low – 40 psig, High – 60 psig.
- d) Pressure switches shall be cleaned and sealed for oxygen service.

G. LINE GAUGES

1. General:

- a) Gauges shall comply with ANSI/ASME B-40.1 and be constructed of materials compatible with medical vacuum and gas applications. Pressure indicators for medical gas piping systems shall be cleaned for oxygen service.
- b) Gauge housings shall be drawn steel with black, corrosion-resistant paint. Dial shall be 4-1/2" in diameter with white background and black markings. Pointer shall be aluminum with black finish. Gauge movement shall be brass construction. Bottom of gauge shall be provided with 1/4" – 18 NPT – 2A brass connection.
- c) Indicators adjacent to master alarm actuators and area alarms shall be labeled to identify the name of or chemical symbol for the particular piping system that they monitor.
- d) Provide Diameter Index Safety System connection kits with all appropriate fittings for connecting gauges to pipelines.

2. Medical vacuum and gas line gauges and DISS connection kits shall be manufactured by Tri-Tech Medical, Patton's Medical, Amico, BeaconMedaes, Ohio Medical or Owner approved equal.

3. Vacuum Line Gauges

- a) Vacuum bourbon tube shall be beryllium copper and soft soldered.
- b) Gauge shall register 0 – 30 inches HG.

4. Pressure Line Gauges

- a) Pressure bourbon tube shall be phosphor bronze and soft soldered.
- b) Gauge shall register 0 – 100 psig for all medical gases except Nitrogen.
- c) Gauges for positive pressure gases shall be cleaned and sealed for oxygen service.

H. MEDICAL VACUUM PUMP

1. The duplex medical vacuum system shall be fully compliant with the latest edition of NFPA 99. The system shall be suitable for operation as a dual vacuum/evacuation and waste anesthesia gas disposal unit. The package will consist of two oil-free liquid ring vacuum pumps, a control panel, and a receiver sized for appropriate demand all mounted on a common base frame. The receiver shall be ASME rated with a isolation valve to allow for draining of the receiver without interrupting the vacuum service. A manual drain shall be provided on the receiver. The pumps and receiver shall be connected to a common intake manifold. A single point of connection to the intake of the system shall be provided. A single point of connection to the exhaust discharge of the system shall be provided. A single point of connection to the electrical panel of the system shall also be provided.
2. The pumps shall be oil-free, single-stage, positive displacement, and non-pulsating liquid ring type. The pump will be fitted with mechanical seals. Each pump shall be equipped with a check valve to prevent backflow through off-cycle units, a vacuum relief valve and an isolation valve.
3. Vacuum Pump Drive: The pumps shall be direct driven. Torque is transmitted from the motor to the pump through a shaft coupling.
4. Vacuum Pump Motor: The motor shall be a continuous duty, NEMA premium rated, open drip proof, 1800 RPM, with 1.15 service factor suitable for 208V, 60 hertz, 3 phase electrical service.
5. The package shall be completely tested prior to shipment.
6. Re-circulation and Seal Water: Under normal operation, the system shall not use more than 3/4 gpm seal water. The system shall include a reservoir sufficient for up to 48 hours of operation without a fresh water supply. The system shall be self contained and air-cooled. No cooling water is required for the operation of the recirculation system.
7. Intake Piping: Each vacuum pump shall have a factory piped intake. Interconnecting piping shall consist of brass pipe and fittings.
8. Vacuum Receiver: The vacuum receiver shall be rated for a minimum 150 PSIG design pressure. The receiver vessel shall include a sight glass with manual drain and piping to permit tank venting without interrupting vacuum service. Receivers shall have a 0" Hg to 30" Hg vacuum gauge and be designed, constructed, certified, and stamped in accordance with the latest version of ASME BPVC-VIII-1.
9. Control System: The duplex control system shall be NEMA 12 and U.L. labeled. The control system shall provide automatic lead/lag sequencing with circuit breaker disconnects for each vacuum pump with external operators, full voltage motor starters with overload protection, redundant 120V control circuit transformers, visual and audible reserve unit alarm with isolated contacts for remote alarm to the building automation system, hand-off-auto lighted selector switches and runtime hourmeters. A programmable logic controller (PLC) shall control the automatic alternation of both vacuum pumps with provisions for simultaneous operation if required, and automatic activation of reserve unit if required. The control system shall include an automatic minimum run time adjustment to control run time based on demand. A vacuum gauge shall be provided in the control panel.
10. Provide stainless steel flexible pipe connectors and vibration isolators for field installation. Vibration isolators shall be installed on all base or skid mounted pumps.

11. Factory test: each assembly shall be 100% tested at the factory prior to shipment, and certified in writing that it was tested at, and meets, the Project's maximum flow requirement with the Project's scheduled outlet minimum pressure. The test report shall accompany the assembly as part of its official documentation.
12. Documentation: system drawings, description of control panel with wiring diagrams, certification of manufacturer's liability insurance, documentation of third party labeling (that the components are a system for the intended use), factory test report, operation and maintenance manuals with parts list, and system warranty.
13. Warranty: Each system, in whole and in part, shall be warranted in writing by the manufacturer for a period of 30 months from the date of shipment or 24 months from the date of Owner's acceptance, whichever comes first. The warranty shall include defects in the design and construction of the assembly, including parts and components. A warranty covering shipping cost of parts and components to and from the manufacturer to the site, contractor's labor, travel cost, and overtime labor rates (if applicable) for the repairs shall be provided for 18 months from the date of shipment or 12 months from start-up, whichever comes first.
14. Manufacturer: BeaconMedaes, Ohio Medical, Patton's Medical, Amico or Powerex.

I. GAS CYLINDER MANIFOLDS

1. Wall-mounted cabinet with manifold, automatic cylinder-bank change-over with alarm, and designed to accommodate 2 equal banks of oxygen gas cylinders.
2. Enclosures: 16 gauge steel with baked enamel finish, hinged lockable doors, and identification lettering for the gas served.
3. Controls:
 - a) Units shall be controlled by a pressure differential change-over system that switches automatically from cylinder bank-in-use to reserve bank, without any fluctuation in delivery line pressure.
 - b) Provide a visual and audible alarm panel with audible silence button, to alarm at each cylinder bank change-over, and step-down transformer to energize the alarm system.
4. Manifold Components:
 - a) Piping and valves in contact with the gas shall be copper/bronze or stainless steel, and rated for the gas type and pressure being used.
 - b) The left and right bank headers shall include a high pressure rated isolation valve at the control end, and a high pressure check valve at each cylinder connection.
 - c) Bank regulators (one for each cylinder bank) to reduce the gas pressure in each bank line to an intermediate pressure, and two delivery line regulators, set for the system's pressure. Regulators shall be brass or bronze with a stainless steel diaphragm.
 - d) Header and restraints for the number of cylinders as indicated on plans and details.
 - e) Tank restraints shall be attached to structure to result in two restraints per cylinder.
 - f) Delivery line pressure gauges.
 - g) Internal relief valves as required to protect the manifold and control panel piping.

- h) The external header and pigtail connections shall be selected for each specific gas and supplied by the manifold manufacturer. Pigtail connections shall be a minimum 24" long flexible type. Pigtails shall be metal or soft core hose.
- i) Designed for 'H' cylinders to be installed directly underneath the manifold cabinet.
- 5. Provide each assembly with the manufacturer's installation kit, including panel mounting and header wall supports.
- 6. Manifold assemblies shall be oxygen cleaned, and shall conform to NFPA 99.
- 7. Each gas cylinder manifold assembly shall be provided with a one year full manufacturer's warranty against product defects from the time of the Owner's acceptance of the facility.
- 8. Manufacturer: Lifeline (Beacon Medaes) MNE series, or equal by CONCOA, Amico, Ohio Medical, or Western Lab.

PART 3 - EXECUTION

A. INSTALLATION

- 1. Exercise great care in the storage and handling of all materials and in the condition of tools used in cutting and reaming to prevent oil or grease or any contaminants from being introduced into tubing. The interior surfaces of tube ends, fittings, and other components that were cleaned for oxygen service by the manufacturer, but become contaminated prior to being installed, shall be recleaned on-Site by the installer by thoroughly scrubbing the interior surfaces with a clean, hot water–alkaline solution, such as sodium carbonate or trisodium phosphate 450 g to 11 L (1 lb to 3 gal) of potable water and thoroughly rinsing them with clean, hot potable water. Material that has become contaminated internally and is not clean for oxygen service shall not be installed.
- 2. The exterior surface of all tubes, joints and fittings shall be cleaned prior to brazing with non-abrasive pads by washing with hot water after assembly to remove any surface oxides or excess flux and provide for clear visual inspection of brazed connections. A visual inspection of each brazed joint shall be made to assure that the alloy has flowed completely around the joint at the tube-fitting interface. Where flux has been used, assure that solidified flux residue has not formed a temporary seal that could hold test pressure.
- 3. Apply flux sparingly to the clean tube only and in a manner to avoid leaving any excess inside of completed joints. (NOTE: Ensure proper ventilation. Some BAg series filler metals contain cadmium, which, when heated during brazing, can produce toxic fumes.)
- 4. Joints shall be brazed within one hour after the surfaces are cleaned for brazing.
- 5. While being brazed, all vacuum and oxygen piping joints shall be continuously purged with oil-free, dry Nitrogen to prevent the formation of copper oxide on the inside surfaces of the joint. The purge shall be maintained until the joint is cool to the touch. The final connection of new piping to an existing, in-use pipeline shall be permitted to be made without the use of a nitrogen purge.

6. Bury all underground piping at least 3 feet below finished grade and fully encase within schedule 40 PVC piping sleeve. Provide a continuous detectable warning tape immediately above buried lines. Warning tape shall clearly identify the pipeline by specific name. A continuous warning means shall also be provided on tamped backfill above the pipeline at approximately one-half the depth of bury.
7. Do not install piping in the same trench with other buried utilities. The minimum horizontal clearance between medical pipe and parallel buried utility pipe shall be 8 feet. Do not install pipe through catch basins, vaults, manholes or similar underground structures.
8. Piping systems for gases shall not be used as a grounding electrode.
9. Piping shall not be installed in kitchens, electrical switchgear rooms, elevator shafts, and areas with open flames.
10. Memory-metal couplings shall not be installed within eight inches of a brazed joint.
11. Shut-off valves installed for future connections shall be provided with downstream piping closed with a brazed cap and sufficient tubing allowance for cutting and re-brazing.
12. Branch takeoffs from horizontal piping shall be taken off above the centerline of the main or branch pipe and rise vertically or at an angle of not less than 45 degrees from vertical.
13. Support all piping in accordance with NFPA 99 and Contract Documents.
14. Pressure and vacuum indicators shall be readable from a standing position.
15. All alarm sensors shall be installed at readily accessible locations and shall not be obstructed by other building components.
16. Zone valve boxes shall be installed where they are visible and accessible at all time and readily operable from a standing position in the corridor on the same floor they serve.
17. Area alarm panels shall be located where indicated on Contract Drawings at a nurse's station or other location that will provide for continuous responsible surveillance.
18. Locate master alarm panels where indicated on Contract Drawings in at least two separate locations as required by NFPA 99.
19. All alarm panels shall be mounted at a height allowing monitoring and operation from a standing position.
20. Coordinate with Electrical Contractor to insure that power is provided to alarms from the life safety branch of the emergency electrical system as described in NFPA 99. The electrical installation and materials shall comply with Division 26 specifications.
21. Provide low voltage wiring from sensors to alarm panels as required by NFPA 99. All wiring, including low voltage wiring, shall be routed within conduit. Wiring from switches or sensors shall be supervised or protected as required by NFPA 70, National Electrical Code, for emergency system circuits.

B. LABELING AND IDENTIFICATION

1. Label all piping, valves, station inlets and outlets, and alarms in accordance with NFPA 99; North Carolina Fire Code Section 5303.3, Marking; ASME A13.1; and Contract Documents.
2. The gas content of medical gas piping systems shall be readily identifiable by appropriate labeling with the name and pressure contained. Such labeling shall be by means of metal tags, stenciling, stamping, or adhesive markers, in a manner that is not readily removable. Where supplementary color identification of piping is used, it shall be in accordance with the gases and colors indicated in CGA Pamphlet C-9, Standard Color-Marking of Compressed Cylinders Intended for Medical Gas Use.
 - a) Standard colors and abbreviated name shall be as follows:
 - i. Oxygen (O₂) shall have green background with white text or white background with green text.
 - ii. Waste anesthetic gas disposal (WAGD) shall have violet background with white text.
 - iii. Medical-surgical vacuum (Med Vac) shall have white background with black text.
 - b) Piping shall be labeled by stenciling or adhesive markers that identify the medical gas, support gas, or vacuum system and include:
 - i. The name of the gas/vacuum system or the chemical symbol.
 - ii. The gas or vacuum system color code.
 - iii. Flow direction shall be indicated.
 - c) Pipe labels shall be located as follows:
 - i. At intervals of not more than twenty (20) feet.
 - ii. Not less than once in or above every room.
 - iii. On both sides of walls or partitions penetrated by the piping.
 - iv. Not less than once in every story height traversed by risers. [NFPA 99:5.1.11.1.2]
 - v. Where visible through ceiling access doors.
 - vi. Within 3 ft of tees, elbows, and valves.
 - d) Shutoff valves shall be identified as follows:
 - i. The name or chemical symbol for the specific medical gas or vacuum system.
 - ii. The room or areas served.
 - iii. A caution to not close or open valve except in emergency.

- e) Station outlets and inlets shall be identified as to the name or chemical symbol for the specific medical gas or vacuum provided.
- f) All medical gas shutoff valves shall be labeled to reflect the rooms that are controlled by such valves. Valves shall be labeled in substance as follows:
 - i. In-line shutoff valves shall be labeled in substance as follows: CAUTION (NAME OF MEDICAL GAS) VALVE DO NOT CLOSE EXCEPT IN EMERGENCY THIS VALVE CONTROLS SUPPLY TO...
 - ii. Source valves shall be labeled in substance as follows: SOURCE VALVE FOR THE (SOURCE NAME).
 - iii. Main line valves shall be labeled in substance as follows: MAIN LINE VALVE FOR THE (GAS/VACUUM NAME) SERVING THE (NAME OF BUILDING).
 - iv. Riser valve(s) shall be labeled in substance as follows: RISER FOR THE (GAS/VACUUM NAME) SERVING (NAME OF THE AREA/BUILDING SERVED BY THE PARTICULAR RISER).
 - v. Service valve(s) shall be labeled in substance as follows: SERVICE VALVE FOR THE (GAS/VACUUM NAME) SERVING (NAME OF THE AREA/BUILDING SERVED BY THE PARTICULAR VALVE).

C. TESTING AND INSPECTION

1. Inspection and testing shall be performed on all new piped gas systems, additions, renovations, temporary installations, or repaired systems, to assure the facility, by a documented procedure, that all applicable provisions of NFPA 99 have been adhered to and system integrity has been achieved or maintained.
2. After brazing, the outside of all joints shall be cleaned by washing with water and a wire brush to remove any residue and permit clear visual inspection of the joint. Each brazed joint shall be visually inspected after cleaning the outside surfaces. Brazed joints identified as defective shall be repaired or replaced as required by NFPA 99.
3. After installation of the distribution piping and before installation of station outlets/inlets and other system components (e.g., pressure/vacuum alarm devices, pressure/vacuum indicators), piping in medical vacuum and gas distribution systems shall be blown clear by means of oil-free, dry Nitrogen.
4. Installer shall perform initial pressure tests, cross-connection test, piping purge test and standing pressure test prior to third party system verification and in strict accordance with NFPA 99.
5. The rated accuracy of indicators used for testing shall be 1 percent (full scale) or better at the point of reading.
6. System verification tests shall be performed only after all installer performed tests, have been completed. Equipment Vendor or installing Contractor shall not perform system verification, final testing or certification.

7. A Third Party Medical Gas System Verification Testing Agency shall perform standing pressure test, cross-connection test, valve test, alarm test, piping purge test, piping particulate test, piping purity test, final tie-in test, operational pressure test and medical gas concentration test.
8. The Third Party Medical Gas System Verification Testing Agency shall verify the presence and correctness of labeling required by this standard for all components (e.g., station outlets/inlets, shutoff valves, and alarm panels).
9. It shall be the responsibility of the Third Party Medical Gas System Verification Testing Agency to make periodic job Site visits to assure all requirements of this specification and NFPA 99 are strictly adhered to.
10. Certification shall clearly state that the system is approved for patient use and meets all requirements of NFPA-99 inclusive of all referenced and/or related documents. Any exceptions or limitations shall be clearly stated on the same certification document.

D. MEDICAL VACUUM PUMP

1. Set unit level on concrete equipment pad.
2. Install with flexible pipe connectors and vibration isolators shipped with unit.
3. Seal water connections shall be made downstream of a RPZ type backflow preventer.
4. Supply other accessories recommended by the manufacturer for a complete installation.
5. Install loose components shipped by the manufacturer as per manufacturer's instructions.
6. Make final connections to the system.
7. Responsibilities of Equipment Manufacturer
 - a) An authorized representative of the equipment manufacturer shall periodically check with the installing Contractor during initial installation of the pipeline systems and equipment and shall assist the Contractor in final check to make certain that all systems are operating as recommended by the manufacturer, as specified and in accordance with NFPA 99. The equipment manufacturer's representative shall provide a minimum of 4 hours instruction to the Owner in the use of the piping systems and the related equipment operated from those systems.

END OF SECTION 22 60 00

SECTION 23 00 10 – HVAC GENERAL REQUIREMENTS

PART 1 - GENERAL

A. DESCRIPTION

1. These mechanical general provisions specified herein apply to all Sections of Division 23.
2. Refer to the General and Supplementary Conditions and Division 00 and 01 for special requirements and conditions which apply to all Sections of Division 23.
3. Related Sections that pertain to certain Division 23 scope includes the following:
 - a) Section 03 30 00, Cast-in-Place Concrete
 - b) Section 31 50 00, Excavation Support and Protection
 - c) Division 26 Specifications for wiring, raceway and devices for power wiring above 24 V.
4. HVAC Start-up and Commissioning for Equipment and Building Automation System is specified in Section 23 08 01. This Section includes responsibilities and obligations in support of the commissioning process specified therein.
5. This section includes, but is not limited to:
 - a) Submittals
 - b) Hangers and supports,
 - c) Vibration Isolation,
 - d) Identification
 - e) Foundations
 - f) Closeout and Training

B. QUALITY ASSURANCE

1. Conform to the North Carolina State Building Code: Mechanical and Energy Conservation Codes-2018, and NFPA 90A.
2. Conform to NIH Design Requirements Manual (DRM) Rev 1.5, 3/5/2020.
3. Manufacturers shall be ISO 9001 (or equivalent) and ISO 14001 or equivalent certified.
4. Equipment and materials shall, unless otherwise specified herein, be new and shall be of the customary standard and quality furnished by the designated manufacturer for that catalogue number.
5. Materials and equipment shall satisfy the North Carolina Building Code Council (NCBCC) requirements for third party NRTL (nationally recognized testing laboratories) listing of electrical and mechanical equipment. and shall bear the NRTL listing mark on products for which standards have been established and for which listing is regularly furnished by NRTL.
6. Codes, standards and regulations specified herein refer to the edition date. Revisions and addenda to these codes, standards and regulations shall be part of these specifications. Provisions of referenced codes, standards, and regulations do not create duty or responsibility by the Architect or the Owner, unless otherwise specified herein.
7. Codes, standards and regulations referred to are minimum standards. Where the requirements of these specifications or drawings exceed those of the codes, standards and regulations, the drawings or specifications shall govern.
8. Mechanical/Electrical Design Coordination:

- a) The power ratings of motors and other mechanical equipment and the electrical characteristics of electrical systems serving them, as specified herein and indicated on the Drawings, have been established as minimums which will allow that equipment to satisfactorily function while producing the required capacities. These power ratings include a safety factor deemed appropriate to accommodate common differences between design parameters and field construction practices. Under no circumstances shall equipment with power ratings less than those indicated on the Drawings or specified herein be provided.
 - b) Reasonable efforts have been made to coordinate the electrical requirements of the mechanical equipment with the electrical systems serving that equipment. Differences among manufacturers of mechanical equipment make it impossible to produce a single electrical design which will satisfy the varying electrical requirements of those manufacturers. Consequently, the Contractor shall coordinate the electrical requirements of the mechanical equipment actually furnished on this Project and provide the electrical systems required by that equipment. This coordination effort shall be completed prior to the installation of either the mechanical equipment or the electrical systems serving that equipment. Electrical system revisions required to coordinate with the mechanical equipment actually furnished shall be provided at no additional cost to the Owner.
9. Wiring materials and methods as specified under Division 26 shall apply to the installation of all electrical wiring – regardless of installing trade.

C. ASBESTOS MATERIALS

1. Materials containing asbestos or any trace of asbestos related materials shall not be used on this project.

D. CONTINUITY OF EXISTING SERVICE AND SYSTEMS

1. Schedule work so existing systems will not be interrupted when they are required for normal usage of the existing building. Obtain approval from the Owner and Architect at least 7 days prior to any utility interruption or connection. Site utility disruptions will require greater notice and may be required to be completed during a specific season (e.g. in summer for steam and winter for chilled water) to minimize disruption to other buildings.
2. Perform work at such time and in such manner as to cause minimum inconvenience to the Owner and as approved by the Architect. No allowance will be made for lack of knowledge of existing conditions.

E. USE OF THE ENGINEER'S DRAWINGS

1. The Contractor shall obtain, at the Contractor's expense, from the Engineer a set of AutoCAD or compatible format engineering drawings on electronic media where desired by the Contractor and/or required by the Specifications for use in preparing the shop drawings, coordination drawings, and record drawings. The Contractor shall provide to the Engineer a written release of liability acceptable to the Engineer prior to receiving the electronic media files.
2. Drawings are diagrammatic in nature and, unless explicitly dimensioned, indicate approximate locations of apparatus, equipment, ductwork and piping. Changes in the location, and offsets, of same which are not shown on the Drawings but are necessary in order to accommodate building conditions and coordination with the work of other trades, shall be made during the preparation of coordination drawings and prior to initial installation, without additional cost to the Owner.

F. EQUIPMENT ACCESS

1. Clearances around equipment above ceilings, including terminal units, reheat coils and air valves, shall be sufficient to allow inspection, service, repair or replacement without removing elements of permanent construction. All trades shall coordinate and protect the service area around equipment.

2. Clearances around equipment in mechanical rooms shall be sufficient to allow inspection, service, repair or replacement without removing elements of permanent construction. Service space shall include recommended manufacturer provisions for tube cleaning, coil pull, part replacement, etc.

G. RELATED WORK DESCRIBED IN OTHER DIVISIONS

1. Installation of access panels in wall and ceiling construction.
2. Cutting, coring, waterproofing, and patching of walls, floors, ceilings, roofs and structure of existing buildings.
3. Painting, except as specified herein.
4. Fire alarm initiating devices, control modules, and monitoring modules.
5. Curbs, flashing, and pitch pockets for equipment on roof, except as specified herein.
6. Motor control centers.
7. Casework.
8. Concrete.
9. Laboratory equipment and fixtures.
10. Architectural louvers.

H. SUBMITTALS

1. Submittals shall be prepared in a line-by-line format corresponding to these Specifications and shall indicate compliance with each requirement specified herein and indicated on the Drawings.
 - a) Indicate manufacturer's installation instructions.
 - b) Indicate deviations, if any, including any from the manufacturer's installation instructions.
 - c) Reproduction of design drawings shall not be used in the preparation of shop drawings.
 - d) Submittals not specifically required, or not complying with the format requirements, will be returned unreviewed.
 - e) Identify each sheet of printed submittal pages (using arrows, underlining or circling) to show applicable sizes, types, model numbers, ratings, capacities and options actually being proposed. Cross out non-applicable information. Note specified features such as voltages, motor efficiencies, special tank linings, pump seals, materials or paint finishes. Cross out all references to "options". Cross out statements such as "subject to change without notice" or "not for construction". Anything not specifically excluded is assumed to be included.
 - f) Include dimensional data for roughing in and installation, technical data sufficient to verify that equipment meets requirements of the Contract Documents. Include wiring, piping and service connection data, motor sizes complete with voltage ratings and schedules.
2. HVAC submittals include the following.

- a) Controls including control diagrams, control panel layouts, descriptions of operation and cuts of instruments, valves, dampers, actuators, power supplies, and other information specified in Sections 23 09 00 and 23 09 01.
- i. Floor plan drawing showing locations of all BAS control panels that vary from locations indicated on plans.
- b) Grilles, registers and diffusers, including performance data.
- c) Fans and motors.
- d) Terminal units, reheat coils, and air valves.
- e) Humidifiers.
- f) Flexible ductwork.
- g) Filters.
- h) Automatic and Manual valves.
- i) Pressure regulating valves
- j) Water balancing valves and assemblies
- k) Balancing dampers
- l) Motorized dampers and associated actuators
- m) Piping materials, valves and fittings.
- n) Steam traps
- o) Strainers
- p) Air separators and expansion tanks
- q) Relief vents
- r) Pressure regulators
- s) Fire/Smoke dampers
- t) Insulation
- u) Motors
- v) Starters
- w) Variable speed drives
- x) Air handling units
- y) Pumps
- z) Fan Coil Units
- aa) Steam-to-Hot Water Convertors
- bb) Hangers, supports, anchors, and vibration isolators
- cc) Arch tunnels to site steam distribution
- dd) Chemical shot feeder
- ee) Pressure gauges and thermometers

PART 2 - PRODUCTS

A. HANGERS AND SUPPORTS

- 1. General:
 - a) Make all hanger assemblies and channel strut systems complete with hanger rods, nuts, bolts, screw attachments, and upper supports attached to the structure as applicable to project requirements.
 - b) Select hanger assemblies for single piping, using the weight of piping, insulation, and valves being supported.
 - c) Select channel strut systems for gang piping, using the combined weight of the piping, insulation, and valves being supported.

- d) Select supports for equipment with an additional live load of 300 lbs for workers and supplies.
2. Hangers:
- a) General: complete with rods and supports proportioned to the size of piping or equipment to be supported.
 - b) For steel and cast iron pipe: steel or malleable iron, unless specified otherwise herein.
 - c) For copper piping 4" and smaller: copper-plated; B-Line B3170 CT, Grinnell CT-69, or Michigan 106.
 - d) For cast iron pipe, steel pipes 2.5" and smaller, steel plumbing and chilled and condenser water piping 3" and larger, and piping insulated to prevent sweating: galvanized; B-Line B3100, Grinnell 260, or Michigan 400.
3. Hanger Rods:
- a) One-piece steel type, threaded as required.
 - b) Sizes, unless specified otherwise herein, shall be as follows:
- | <u>Pipe Size</u> | <u>Rod Diameter</u> |
|------------------|---------------------|
| 2" and smaller | 0.375" |
| 2.5" and 3" | 0.5" |
| 4" | 0.625" |
| 6"-8" | 0.75" |
- c) Sizes for gang or multiple hangers: calculated for the combined weight of the piping and accessories.
 - d) Sizes for equipment hangers: calculated for the weight of the equipment supported.
4. Expansion Anchors:
- a) In concrete: wedge, self-drilling, or drilled flush type.
 - b) In masonry: sleeve type.
 - c) Manufacturer: Hilti, ITW Ramset/Red Head, or Rawl.
5. Insulation protectors: B-Line B3151, Grinnell 167, or Michigan 125.
6. Channel strut systems for gang piping: minimum 14 gauge galvanized steel strut with factory-punched attachment holes, and galvanized straps, nuts, bolts, washers, and accessories.
- a) Straps shall be designed so that the attachment nut is captive on the shoulder of the strap when tightened, and designed to provide a surface on the turned down edge against the pipe while making positive contact with the side walls of the channel.
 - b) Nuts, bolts, straps, and accessories shall be protected with same finish as channels.
 - c) Trapeze channel strut systems shall be designed for an additional live load of 200 lbs.
 - d) Manufacturer: Anvil, B-Line, Kindorf, Midland-Ross, or Unistrut.
7. Riser Clamps:
- a) For Carbon Steel, Cast Iron or Plastic Pipe - Carbon Steel Riser Clamp
 - b) For Copper Tubing to 4 inches - Copper-Plated Carbon Steel Riser Clamp
 - c) For Stainless Steel Tubing, and Glass and Brass Pipe - Plastic-Coated, Copper-Plated Steel Riser Clamp
8. Pipe Stand Supports:
- a) For chilled water and energy recovery water piping: adjustable pipe saddles, stanchion type with locknut nipple, reducer, flange and baseplate. Provide U-bolt yoke for pipe 12" and smaller.

- a. Manufacturer: Anvil 264, B-Line B3093, or ERICO 723.
- b) For heating water, steam and steam condensate piping: adjustable pipe roll stands with baseplate.
 - a. Manufacturer: Anvil 274, B-Line B3118SL, or ERICO 619.
- 9. Offset Clamps: For Wall, Floor and Structure - Carbon Steel Offset Pipe Clamp. In exposed locations in vivaria, offset pipe clamps shall be stainless steel and shall stand off from the finished surface not less than 1".

B. VIBRATION ISOLATION

1. Apparatus shall be by one manufacturer, except where herein specified otherwise.
2. Vibration bases for fans shall have adjustable motor slide rails, and shall accommodate motor overhang. Bases shall be of welded construction with cross members to form an integral support platform. Steel members shall be I-beams, designed to match supported equipment. Bases for exterior use shall be completely corrosion-resistant.
3. Where spring isolators are exposed to weather, springs shall be cadmium-plated or neoprene-coated and other parts hot-dip galvanized.
4. Isolators:
 - a) Type FS - Free-standing, laterally stable, unhouse spring type with leveling bolts for bolting to the equipment. Spring diameter shall be not less than 0.8 of the compressed height of the spring. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Springs shall be complete with neoprene or fiberglass noise isolation pads, minimum 0.25" thick, bonded to the baseplate.
 - a. Manufacturer: Amber-Booth SW, Kinetics FDS, Mason SLF, Vibration Eliminator OST, or Vibration Mountings & Controls A.
 - b) Type LS - Type FS isolators with addition of vertically restraining limit stops, and welded steel housings. Minimum clearance around the restraining bolts and between the housing and the spring shall be 0.5". Limit stops shall be out of contact with the housing during normal operation.
 - a. Manufacturer: Amber-Booth CT, Kinetics FLS, Mason SLR, Vibration Eliminator KW, or Vibration Mountings & Controls AWRS.
 - c) Type DN - Double-deflection neoprene type, with neoprene-coated metal surfaces, and top and bottom surfaces ribbed. Isolators shall have bolt holes in the base.
 - a. Manufacturer: Amber-Booth RVD, Kinetics RD, Mason ND, Vibration Eliminator T44 or D44, or Vibration Mountings & Controls R or RD.
 - d) Type SH - Combination type hanger with steel spring and double-deflection neoprene element in series. The neoprene element shall have a minimum static deflection of 0.35". Spring diameter shall be not less than 0.8 of the compressed height of the spring. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Hangers shall be designed for a minimum of 15° angular misalignment from vertical before rod contacts housing.
 - a. Manufacturer: Amber-Booth BSRA, Kinetics SRH, Mason 30N, Vibration Eliminator SNRC, or Vibration Mountings & Controls RSH 30A.
 - e) Type PSH - Type SH isolators precompressed to the rated deflection. Hangers shall have a release mechanism to free the spring after installation is complete.
 - a. Manufacturer: Amber-Booth PBSRA, Mason PC 30N, Vibration Eliminator PCSR, or Vibration Mountings & Controls RSHP.
 - f) Type NH - Double-deflection neoprene hanger type, with neoprene grommet between hanger rod and housing. Neoprene element shall have neoprene-coated metal surfaces.
 - a. Manufacturer: Amber-Booth BRD or HRD, Kinetics RH, Mason HD, Vibration Eliminator C, or Vibration Mountings & Controls RH or RHD.

- g) Type NS - Sandwich pad type, with minimum 0.25" thick ribbed or waffled neoprene pad bonded to each side of 16 gauge plate. Isolator pads shall be selected for less than 80% maximum rated load.
 - a. Manufacturer: Amber-Booth SP-NR, Kinetics NG, Mason WSW, Vibration Eliminator NP, or Vibration Mountings & Controls Shear-Flex Flex-Plate.
 - h) Type NP - Neoprene pad type, minimum 0.25" thick ribbed or waffled on both sides. Isolator pads shall be selected for less than 80% maximum rated load.
 - a. Manufacturer: Amber-Booth NR, Kinetics NP, Mason W, Vibration Eliminator N, or Vibration Mountings & Controls Shear-Flex.
 - i) Type NR - Isolator anchor type consisting of a telescopic arrangement of two sizes of steel tubing separated by a minimum 0.5" thick heavy duty neoprene and duck or neoprene isolation material. Vertical restraints shall be provided by similar materials arranged to prevent vertical travel in either direction. Allowable loads on the isolation material shall not exceed 500 psi and the design shall be balanced for equal resistance in any direction.
 - a. Manufacturer: Mason ADA, or Vibration Mountings & Controls MDPA.
 - j) Type PI - Piping isolator type, 30 durometer ribbed neoprene ring, inside diameter sized for piping outside diameter, and mounting bracket.
 - a. Manufacturer: Specialty Products Company, or Stock Drive Products.
 - k) Type SR – Rail type, consisting of a set of structural steel beam, aluminum channel or angle rails to which Type FS isolators are rigidly attached. Bolt holes shall be provided for bolting equipment to the rails. Rail deflection shall be limited to less than 1/360 of unsupported span. Wind and uplift restraints shall be provided as required for exterior installations.
 - a. Manufacturer: Amber-Booth SR, Kinetics SBB, Mason R, RND, Vibration Eliminator AFS, or Vibration Mountings & Controls R.
 - l) Type SC - Curb type, with integral isolators, designed to fit over the roof curb and under the isolated equipment. The extruded aluminum top and bottom members shall contain cadmium-plated springs having a 1" minimum deflection with 50% additional travel to solid. Spring diameter shall be not less than 0.8 of the compressed height of the spring. Springs shall be provided with positive spring retainers with flexible ties to maintain base integrity during shipping and rigging. Wind resistance shall be provided by means of resilient snubbers in the corners with a minimum clearance of 0.25" so as not to interfere with the spring action except in high winds. The weather seal shall consist of continuous closed cell sponge materials both above and below the base and a waterproof, frictionless, flexible neoprene connection joining the outside perimeter of the extruded aluminum members. Upper and lower extruded aluminum members shall have heliarc welded, mitered corners.
 - a. Manufacturer: Amber-Booth RTIR, Kinetics KSR, Mason CMAB, Vibration Eliminator AR, or Vibration Mountings & Controls AXR.
 - m) Type SCH - Curb type, with integral isolators, designed for the roof structure and equipment to be isolated. Lower members shall be rectangular steel tubes with provisions for accommodating roof slope and maintaining equipment level. Upper frame shall provide continuous support for the equipment and shall resiliently withstand wind and seismic forces. Directional snubber bushings shall be minimum 0.25" thick neoprene. Steel springs isolating the upper frame shall be stable unhouse type with a minimum static deflection of 2" 3" with 50% additional travel to solid. Springs shall be adjustable and removable, and shall be mounted on 0.25" thick neoprene pads. Hardware shall be cadmium-plated or galvanized, and springs shall have a corrosion-resistant finish. Weather seal shall consist of a continuous closed cell sponge material on top of the curb and a waterproof flexible aluminum seal joined at the corners by epdm bellows. Lower portion of curb shall be insulated, and curb shall have provisions for flashing and counter flashing.
 - a. Manufacturer: Amber-Booth RTIC, Kinetics KSCR or ESR, Mason RSC, Vibration Eliminator VERC, or Vibration Mountings & Controls P.
5. Caulking: resilient, nonhardening type.
- a) Manufacturer: Dow Corning 790, GE Construction Sealant 1200, or U.S. Gypsum Acoustical Sealant.

C. IDENTIFICATION MATERIALS

1. Pipe identification shall be 5 mil thick, self-adhering vinyl plastic tape. Tape and legend shall be as follows:

<u>Diameter (Including Insulation)</u>	<u>Width</u>	<u>Size of Legend Letters</u>
0.75 - 1.25"	8"	0.5"
1.5 - 2"	8"	0.75"
2.5 - 6"	12"	1.25"

- a) Legends shall be in full or abbreviated form, in contrasting color to background color.
2. Nameplates and signs: laminated plastic, engraved with white letters. Background color shall be:

<u>System</u>	<u>Color</u>
Equipment served by emergency power	Red
Fire protection systems	Red
Other equipment	Black

3. Valve Designation Tags: Brass tags shall be used to identify all valves by distinguishing numbers and letters. Install tags for all valves with numbers and letters on the tags corresponding to those on the charts. Brass tags shall be not less than 1-1/2" in diameter with depressed black-filled numbers not less than 1/2 inch high, and black-fill letters not less than 1/4 inch high. They shall be securely fastened to valves with approved brass "S" hooks, or brass jack chain in a manner to permit easy reading.

- a) Product and Manufacturer: Style 150BL as made by Seton Nameplate Company, or equal product by Brady or 3-M Company.

D. SLEEVES

1. Sleeves shall be standard weight steel pipe except sleeves for concealed piping through floors not in structural members, and through interior drywall construction may be formed from 26 gauge galvanized sheet metal lapped and pop riveted.

E. PENETRATION SEALS

1. Fire Stops:
 - a) Refer to Section 07 8413 specifications
2. General penetration sealant shall be siliconized acrylic latex ASTM C834.
3. Expansion Seals:
 - a) Waterproof, modular, mechanical expansion type consisting of synthetic rubber grommets or interlocking links shaped to continuously fill the annular space between the penetrating item and the opening. Sizing of links and sleeve shall be determined by the manufacturer.
 - b) Manufacturer: Calpico Pipe Linx, Metraflex MetraSeal, or Thunderline Link Seal.

F. ESCUTCHEONS

1. Split hinged type or flat, constructed of chromium-plated steel or cast brass, sized to fit over insulation and to cover sleeve.
2. Escutcheons installed within the secure area of vivaria shall be stainless steel.

G. CONCRETE

1. Normal weight concrete (145 pcf using Type I Portland Cement, 1" maximum size coarse aggregate to provide a minimum 28 day compressive strength of 3000 psi.

H. GROUT

1. Nonshrink type, conforming to ASTM C1107/C1107M-2011 when tested at fluid consistency. Grout shall exhibit zero bleeding at every age when mixed to fluid consistency. Minimum 28 day compressive strength, when mixed to fluid consistency, shall be 7000 psi.
2. Manufacturer: Cormix, or Master Builders.

PART 3 - EXECUTION

A. PROTECTION OF EQUIPMENT AND MATERIALS DURING CONSTRUCTION

1. Provide protective covers, skids, plugs or caps to protect equipment and materials from damage or deterioration during construction.
2. Store equipment and material under cover, and off the ground.
3. Protect coils against damage by installing temporary closure panels over exposed coil faces. Panels shall be minimum 24 gauge sheet metal or 0.375" plywood.
4. Close open ends of fans, terminal units, and ductwork with temporary closures of sheet plastic taped in place.
5. Plug ends of pipes when work is stopped to prevent debris from entering the pipes.
6. Provide dust and debris protection for ductwork, coils, fans, equipment, motors, and bearings operated during construction up to date of substantial completion.
7. Cover open ends of exhaust and return ducts with temporary filter media while fan systems are operating.

B. EQUIPMENT AND INSTALLATION REQUIREMENTS

1. Air systems shall operate without aerodynamic noise generated from the faulty installation of ductwork or any component of the air distribution system.
2. Equipment shall be installed and connected as specified herein or indicated on the Drawings in accordance with the manufacturers' instructions and recommendations for this Project. Furnish and install auxiliary piping, water seals, valves, and electrical connections recommended by the manufacturer for operation.
3. Motor quantities, sizes and equipment wattage ratings specified herein or indicated on the Drawings are the minimum requirements, unless noted otherwise. Motor quantities, sizes and equipment wattage ratings less than those specified herein or indicated on the Drawings are not acceptable. Larger motor sizes and equipment wattage ratings may only be provided if necessary to meet the prescriptive requirements specified herein or indicated on the Drawings. Where multiple motors or motor sizes or equipment wattage ratings larger than specified herein or indicated on the Drawings are furnished, provide and coordinate the corresponding increased number or capacity of feeders and other electrical equipment serving them, at no additional cost to the Owner.
4. Fans, drive sheaves, motors, and pumps shall be statically and dynamically balanced.

5. Low voltage control and sensor wiring shall be installed in conduits separate from line voltage control wiring and power wiring.
6. Where water connection sizes at equipment vary from the pipe size indicated on the Drawings, provide appropriate reducers/increasers directly adjacent to the pipe-equipment unions. Unless otherwise specified herein or indicated on the Drawings, the size of the valves and accessories dedicated to the equipment shall not be less than the pipe size to which they are connected.

C. HANGERS AND SUPPORTS

1. Where several pipes run parallel and in the same plane:
 - a) 2.5" and smaller: may be supported on trapeze-type hangers. Separate copper tubing from ferrous supports with copper-plated steel or 4 psf sheet lead. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size.
 - b) 3" and larger: For the support of two or more pipes of similar temperatures running adjacent to each other at the same elevation and at the same slope, structural steel trapeze hangers are permitted. Limit the longitudinal hanger spacing to suit the smaller diameter pipe.
2. Supports for steel pipe and for copper tubing, 1.25" or larger, shall not be more than 10' apart. Supports for copper tubing 1" and smaller shall be not more than 5' apart. Pipes shall be supported within 1' of each elbow and tee..
3. Size hangers for insulated piping to bear on outside of insulation.
4. For hangers bearing on outside of insulation, provide insulation protectors.
5. Support piping independently of equipment.
6. Adjust hangers and supports so that loading is uniform.
7. Hanger rods shall be suspended from the structure. Do not suspend from other piping, equipment, or ductwork.
8. Expansion Anchors:
 - a) Use for piping and equipment in existing concrete and masonry construction.
9. Support vertical pipe at each floor using riser clamps when no appreciable thermal expansion is anticipated.
10. Support riser piping independently from the connected horizontal piping.
11. Provide isolation hangers as specified below for piping located with specified distance from all power-driven equipment.
12. Provide vertical adjustment under load in hangers for pipe 2-1/2 inches and larger.
13. Do not support piping from ceiling supports, roof decks, ductwork, raised-floor pedestals, equipment, electrical conduit, cable trays or other piping.
14. Cut off excess hanger rod lengths. Secure rods by use of locknuts or elastic stop nuts.
15. Wall brackets may be used where pipes are adjacent to walls or other vertical surfaces which may be used for support. Except that in exposed locations in vivaria, offset pipe clamps shall be used to permit cleaning between the pipe and wall.
16. Pre-insulated pipe supports shall be furnished and installed by the Mechanical Subcontractor. Pre-insulated pipe supports shall be installed as pipe is erected.

17. Support the base of all vertical pipe stacks (except soil pipe stacks, diesel generator exhaust stacks and copper water pipe risers) with a pipe stanchion. Cut the top of the base leg to shape and completely weld to the heel of the base elbow. Weld leg support to a bearing plate and bolt to the floor. Locate base leg on the vertical pipe centerline.
18. Anchor piping where shown to localize expansion or to prevent undue strain on piping and branches. Anchors shall be entirely separate from hangers and of heavy forged or welded construction of approved design. All anchor designs, when submitted for approval, shall include piping reactions which respective anchors are capable of supporting. Provide indicated expansion loop .
 - a) Anchors shall be fabricated using welding steel shapes, plates, and bars to secure piping to the structure.
19. Adjust hangers to obtain pipe slope where specified.
20. Provide hangers and supports not more than 12 inches from both sides of any change in pipe direction.
21. On vertical piping only, attach clamps to piping with clamps projecting through insulation.

D. VIBRATION ISOLATION

1. General:
 - a) Select and locate vibration isolation equipment for uniform loading and deflection, according to weight distribution of equipment.
 - b) Vibration isolators shall be installed and connected as specified herein or indicated on the Drawings in accordance with the manufacturer's written instructions and certified submittal data.
 - c) Installation of vibration isolation equipment shall be supervised by an authorized, factory-trained manufacturer's representative.
 - d) Where recommended by the manufacturer, isolator baseplates shall be bolted to the structure or foundation. Bolting shall incorporate neoprene bushings and washers.
 - e) Installed Type FS isolators shall not incorporate a leveling bolt of greater length than that supplied with the isolators.
 - f) Isolator hangers shall be installed with housings a minimum of 2" below but as close to the structure as possible.
 - g) Vibration isolators shall not cause any change in position of equipment, piping, or ductwork resulting in stresses or misalignment.
 - h) After installation, verify that vibration isolation systems are installed and operating properly. Verify that isolators are adjusted, with springs perpendicular to bases or housing, adjustment bolts are tightened up on equipment mountings, and hangers are not cocked.
2. Equipment Isolation:
 - a) Isolated equipment mounting systems shall permit equipment motion in all directions.
 - b) Provide height saving brackets where recommended by the manufacturer for equipment stability, or operating height requirements.
 - c) Provide spring-loaded thrust restraints for fans and air handling units where movement under any operating condition will exceed 0.375".
 - d) Steam pressure reducing valve assemblies shall be supported with Type SH isolators with a minimum 2" static deflection.
 - e) Mount air compressor on Type NS isolators.
3. Piping Isolation
 - a) Extent of Piping Isolation:
 - i. Pipe stand supports shall be supported on Type LS isolators for the first 2 supports adjacent to the equipment and on Type FS isolators for the remaining isolated pipe length. Isolators shall have a minimum 1" static deflection.

- ii. Piping shall be suspended with Type PSH isolators for the first 3 hangers adjacent to pumps. The remaining isolator hangers shall be Type SH. The first 3 hangers shall have the same minimum static deflection as the equipment isolators, with a maximum of 2". The remaining isolators shall have a minimum 1" static deflection.
 - iii. Vertical
 - 1) Piping shall be isolated from the supporting members or structure with Type FS isolators with a minimum 1" static deflection.
 - b) Heating Water, Steam, and Condensate Piping:
 - i. Horizontal
 - 1) Pipe stand supports shall be supported on Type LS isolators for the first 2 supports adjacent to the equipment and on Type FS isolators for the remaining isolated pipe length. Isolators shall have a minimum 1" static deflection.
 - 2) Piping shall be suspended with Type PSH isolators for the first 3 hangers adjacent to the equipment. The remaining isolator hangers shall be Type SH. The first 3 hangers shall have the same minimum static deflection as the equipment isolators, with a maximum of 2". The remaining isolators shall have a minimum 1" static deflection.
 - 3) Guides shall be isolated from the supporting members or structure with Type NR isolators.
 - 4) Pipe anchors shall be isolated with Type NR isolator anchors with baseplates bolted to structure.
 - ii. Vertical
 - 1) Piping shall be isolated from the supporting members or structure with Type SH isolators with a minimum 1" static deflection.
 - 2) Guides shall be isolated from the supporting members or structure with Type NR isolators.
 - 3) Pipe anchors shall be isolated with Type NR isolator anchors with baseplates bolted to structure.
 - c) Piping attached to air handling units with internal vibration isolators meeting the requirements of these specifications is not considered connected to vibrating equipment.
4. Flexible Pipe Connections:
- a) Provide at piping connections to equipment where indicated on the Drawings.

E. IDENTIFICATION OF PIPING

- 1. Identify piping specified under this Division in accordance with ANSI/ASME A13.1.
- 2. Legends shall be on the lower quarters of the pipe except where such location would be obscured. Arrow tape shall be wrapped completely around the pipe at each end of the legend with arrows pointing in the direction of flow.
- 3. Locate pipe identification as follows:
 - a) Mechanical equipment rooms:
 - i. Within 18" of each valve or valve assembly.
 - ii. Within 3' of each 90° elbow, connection to equipment or vessel, point where pipe enters shafts and pierces outside walls.
 - iii. On not over 20' intervals along exposed piping.
 - b) Above suspended ceilings:
 - i. Within 18" of each valve or valve assembly.
 - ii. At tees within 3' of both main and branch.
 - iii. Within 3' of each 90° elbow.

- iv. On not over 20' intervals.
 - c) Piping concealed in chases or shafts:
 - i. Each pipe visible through an access door or panel.
 - d) Piping exposed in rooms other than mechanical equipment areas:
 - i. Omit identification of sprinkler piping, and piping 0.5" and smaller exposed at connections to equipment.
 - ii. With the above exception, identify at not less than 1 point each piping run visible in each room with identification on not over 20' intervals.
4. Schedule of Piping Identification:
- Where existing piping systems have color-coding or ID system already established, the established IDs shall take precedence over the following:

<u>Piping System and Contents</u>	<u>Tape Color</u>	<u>Paint Color</u>	<u>Legend</u>	<u>Abbreviated Legend</u>
<u>HVAC</u>				
Hot Water	Yellow	Light Grey	Hot Water	HWS & HWR
Chilled Water	Green	Marlin Blue	Chilled Water	CHWS & CHWR
Steam, High Pressure	Yellow	Bright Red	High P Steam	HPS
Steam, Medium Pressure	Yellow	Bright Red	Medium P Steam	MPS
Steam, Low Pressure	Yellow	Dark Red	Low P Steam	LPS
Condensate Return, Low Pressure	Yellow	Light Brown	Low P Cond	LPR
Condensate Return, Med Pressure	Yellow	Light Brown	Medium P Cond	MPR
Pumped Condensate Return	Yellow	Tan	Pumped Cond	PCR
Condensate Drain	Green	-		D
Vent Piping	Green	-		V

F. VALVE TAGS AND SCHEDULES

1. Each valve, except at terminal unit coils, shall have an identifying letter designating the system and an identifying number designating the unit. Identifying letters for various systems shall be, for example, MPS for medium pressure steam, LPS for low pressure steam, etc. Other letter designations shall be first letter of system as above.
2. Where dual control valves or pressure reducing valves are used, these valves shall be tagged as SCV I or IA or PRS or 10A as numbered on the drawings.
3. Charts of all valves shall be furnished in duplicate and include the following items:
 - a) Valve Identification Number
 - b) Location
 - c) Purpose (by letter designation of purpose)
4. One chart shall be mounted in a metal frame with a clear glass front, and secured on a wall in Equipment room, and in a location directed by the architect. A second chart shall be prepared for use outside the equipment room, and shall be provided with an approved transparent plastic closure for permanent protection.
5. Tags on new valves shall continue the numbering sequence of existing valves.
6. Provide for each system a typewritten schedule of valves giving number, location (room number), and function of each with a small scale diagram outlining general piping layout and location of each numbered valves.

G. IDENTIFICATION OF EQUIPMENT

1. General:
 - a) Identification shall consist of upper case letters.
 - b) Each starter, variable speed drive, contactor, push button station, control switch, disconnect, and thermal overload switch shall be appropriately identified by nameplates with 0.25" high letters.
 - i. Identification shall include the equipment designation, circuit (as applicable) and device function, e.g. "CT-1 Water Level Control Disable".
2. HVAC:
 - a) Each access door shall be stenciled, identifying type of device with minimum 2" high letters.
 - b) Each piece of equipment including fans, pumps, air valves, terminal boxes, air handling units, fan coil units, and heat transfer equipment shall be identified by nameplates with its equipment number in a prominent location with minimum 1" high letters.
 - c) Access panels and doors in ductwork and plenums other than access doors immediately upstream of reheat coils, shall be stenciled with minimum 1" high letters to indicate the type of devices accessible therein and the system or fan identification number associated with that ductwork or plenum.

H. SLEEVES

1. Provide where pipes pass through walls, floors and roofs, except in the following circumstances:
 - a) Concealed wall openings of the required diameter in non fire- or smoke-rated construction, unless specified herein to have voids packed with fiberglass and caulking.
 - b) Core drilled concealed openings. Openings in roofs shall not be core drilled. Obtain written permission prior to core drilling.
2. Wall sleeves shall extend 1" on each side of walls.
3. Size sleeves for insulated pipes penetrating nonrated construction to allow full thickness insulation.
4. Sleeves in nonrated construction shall be sized to provide clearance on all sides of piping, including insulation, to accommodate thermal movement. Clearance shall be minimum 0.75".

I. PENETRATION SEALS

1. General:
 - a) Install in accordance with the manufacturer's published instructions to achieve ratings and classifications specified herein. A copy of these instructions shall be maintained and available on site.
2. Fire Stops:
 - a) Close and fire stop penetrations through fire- and smoke-rated construction. Materials used to seal these penetrations shall continue the construction's fire and smoke resistance ratings uninterrupted and shall maintain an effective barrier against the spread of flame, smoke, water and hot gases. Install after installation of ductwork, piping, control tubing and conduits.
 - b) Refer also to fire stopping details on construction drawings and specification section 078413
3. General pipe penetrations:
 - a) Seal all pipe penetrations through walls and ceilings, before sealing perimeter of escutcheons.
 - b) Seal perimeter of escutcheons and wall plates to finished wall or ceiling surfaces.

4. Exterior Wall Seals:

- a) Piping without insulation: use expansion seals between pipes and sleeves. Where walls exceed the width of expansion seals, use two seals, one being flush with the inside sleeve face and the second with the outside sleeve face. Fill the annular void space between the two seals.

J. COORDINATION

1. Drawings indicate locations of fixtures, apparatus, equipment, ductwork and piping. Changes in the location, and offsets, of same to accommodate building conditions, and coordination with the work of other trades, shall be made prior to initial installation, without additional cost to the Owner.
2. Piping, equipment, or ductwork shall not be installed in electrical equipment rooms, elevator equipment rooms, or elevator shafts unless specifically indicated on the Drawings. Piping, equipment, or ductwork shall not be installed directly above or below electrical equipment (switchboards, switchgear, panelboards, motor control centers, variable speed drives, transformers, and starters) from the floor to the structure above.
3. Provide offsets, transitions, and fittings to coordinate the work of each trade with that of other trades, including HVAC, plumbing, fire protection, electrical, structural, and architectural.
4. Adjust location of pipes, ducts, panels, equipment, etc., to accommodate the work to prevent interferences, both anticipated and encountered. Determine the exact route and location of each pipe and duct prior to fabrication.
 - a) Right-of-Way: Lines which pitch have right-of-way over those which do not pitch. For example: condensate, steam, and plumbing drains normally have right-of-way. Lines whose elevations cannot be changed have right-of-way over lines whose elevations can be changed.
 - b) Provide offsets, transitions and changes in direction of pipes and ducts as required to maintain proper head room and pitch on sloping lines. Provide traps, air vents, drains, etc., as required to effect these offsets, transitions and changes in direction.
2. Provide access to equipment and apparatus requiring operation, service or maintenance throughout the life of the system. Install mechanical work to permit removal (without damage to other parts) of hydronic coils, controls, fan shafts and wheels, smoke detectors, filters, belt guards, sheaves and drives, and any other parts requiring periodic replacement or maintenance. Arrange pipes, ducts, and equipment to permit access to valves, cocks, traps, starters, motors, and control components, and to clear the openings of swinging doors and access panels.
3. Changes in the cross-sectional dimensions of ductwork are permissible when required to meet job conditions. Maintain at least the same equivalent cross-sectional duct area in accordance with the latest edition of the ASHRAE Guide. Secure the approval of the Architect prior to fabrication of ductwork requiring these changes.
4. Provide access panels in equipment, ducts, etc., as required for inspection and maintenance of concealed or internal equipment, dampers, plenums, smoke detectors, humidifiers, controls, etc.
5. Coordinate with architect and general contractor for installation of access doors in walls and ceilings in all locations where equipment must be maintained or serviced and is concealed.

K. EXCAVATION AND BACKFILL

1. Provide excavation for the work of this Division. Excavate all material encountered, to the depths indicated on the drawings or required. Remove excavated materials not required or suitable for backfill from the site. Excavations shall be no longer or deeper than necessary. Backfill material shall be free from rocks and debris.
2. Provide grading as may be necessary to prevent surface water from flowing into trenches or other excavations. Remove any water that accumulates. Provide sheeting and shoring as may be necessary for the protection of the work and for the safety of personnel.
3. Provide trenches of widths necessary for the proper execution of the work. Grade bottom of the trenches accurately to provide uniform bearing and support the work on undisturbed soil at every point along its entire length. Backfill overdepths in the rock excavation and unauthorized overdepths with loose, granular, moist earth; sand, or gravel thoroughly machine tamped. Whenever unstable soil that is incapable of properly supporting the work is encountered in the bottom of the trench, remove soil to a depth required and backfill the trench to the proper grade with coarse sand, fine gravel or other suitable material.
4. Excavate trenches for utilities that will provide the required minimum depths of cover from existing grade or from indicated finished grade, whichever is lower, unless otherwise specifically shown.
5. Trenches shall not be placed near foundation or soil surfaces that must resist horizontal forces.
6. Do not backfill trenches until all required tests have been performed and the installation observed by the Engineer. Comply with the requirements of other sections of the specifications. Deposit backfill in 6-inch thick layers and tamp carefully until the work is covered. Backfill and tamp remainder of trench at 1 foot intervals until complete. Uniformly grade the finished surface.
7. Refer also to architectural and structural details for vapor barriers and concrete reinforcing and repair.
8. Refer also to Specification Section 31 50 00, Excavation Support and Protection.

L. UNDERGROUND WARNING TAPE

1. During backfill, install tape continuously along length of piping, 12" to 18" below grade, above the piping for:
 - a) Site chilled water.
 - b) Site steam and steam condensate..

M. FOUNDATIONS

1. Provide concrete foundations for the following floor-mounted equipment:

<u>Equipment</u>	<u>Foundation</u>
Air compressors	4" high pad
Pumps	4" high pad
Centrifugal fans	4" high pad
Air handling units	8" high pad
Heat transfer packages	4" high pad
Exposed ductwork floor penetrations	4" high curb
Equipment located in equipment rooms, not listed above	4" high pad or curb as indicated on the Drawings

- a) Foundation height shall accommodate anchors, steam traps, and condensate P-traps, but shall be not less than the minimum specified above.
2. Foundations shall extend a minimum of 6" beyond the equipment footprint in all directions, including appurtenances, vibration isolators, base elbow supports, and motors.

3. Equipment attached directly to foundations or inertia bases; bases provided with grout holes; and bases consisting of a structural frame shall have voids filled with grout after attachment to foundation.
4. Fill voids between baseplates and foundations, and level equipment, with grout.
5. Refer also to Specification Section 03 30 00, Cast-In-Place Concrete.

N. COORDINATION WITH ELECTRICAL

1. This section delineates the division of work between Divisions 23, 26 and 28 and coordination of work.
2. Power wiring from control panels to motor controllers and from controllers to motors shall be provided by the mechanical contractor in accordance with Division 26 specifications.
3. All individual motor starters and variable speed drives for mechanical equipment (fans, pumps, etc.) shall be furnished and installed under Division 23 unless indicated as a part of a motor control center. Motor starters for mechanical equipment provided in motor control centers shall be furnished under Division 26.
4. Under Division 26, power wiring shall be provided up to a termination point consisting of a junction box, trough, starter, VFD or disconnect switch. Under Division 26 line side terminations shall be provided. Wiring from the termination point to the mechanical equipment, including final connections, shall be provided under Division 23.
5. Duct smoke detectors, if provided per NFPA 90A requirements, shall be furnished and wired by Division 28, installed by Division 23. Fire alarm AHU shut down control modules shall be wired from the fire alarm control panel to a termination point, adjacent to the AHU control, under Division 28. AHU control wiring from the termination point to the equipment shall be under Division 23.
6. Equipment less than 110 Volt, all relays, actuators, timers, seven-day clocks, alternators, pressure, vacuum, float, flow, pneumatic-electric, and electric-pneumatic switches, aquastats, freeze-stats, line and low voltage thermostats, thermals, remote selector switches, remote pushbutton stations, emergency break-glass stations, interlocking, disconnect switches beyond termination point, and other appurtenances associated with equipment under Division 23 shall be furnished, installed and wired under Division 23.
7. All wiring required for controls and instrumentation shall be furnished and installed by Division 23. Low voltage control wiring for connection of temperature controllers, push buttons, interlocks in motor controllers, pneumatic switches and like items are specified in the control section(s) in this Division.
8. All control wiring shall be in conduit except that low voltage wiring may be run in cable tray or on j-hooks where installed above accessible, lay-in ceilings, or in utility corridors. Refer also control section(s) in this Division.
9. Roof exhaust fans with built-in disconnects provided under Division 23 shall be wired under Division 26 to the line side of the disconnect switch, or the outlet. A disconnect switch shall be provided under Division 26 if the fan is not provided with a built-in disconnect switch. In this case wiring from the switch to the fan shall be under Division 23. The built-in switch for the roof top equipment shall be in NEMA 3R enclosure.
10. VFD Cable shall be 3-phase, 3 ground, copper tape spiral shield, galvanized steel interlocked Armor cable for the VFD cable. To ensure system reliability, the cable shall be terminated in connector designed exclusively for ASD/VFD cable and shall provide ground continuity of the cable armor. Pre-wired air handler and energy recovery fan motors shall provide this cable from the motor(s) to a unit-mounted disconnect or termination block.
11. Where electrical wiring is required by trades other than covered by Division 26, specifications for that section shall refer to same wiring materials and methods as specified under Division 26. Exception to that is the low-voltage control wiring. The use of the J-Hooks to support the low voltage control wiring system is acceptable above accessible ceilings.

12. The use of combination starter/disconnects are recommended over the use of individual starter and disconnect switches.
13. Reports showing the sizes of the maximum overcurrent protection (MOCP) and the maximum circuit ampacity (MCA) and overload setting of the devices for all motors; shall be provided by the contractor providing the equipment to the engineer before project final approval and shall be included in project closeout documents.
14. All electrical work shall be performed by companies properly licensed by the NC State Electrical Board of Examiners.
15. Submit wiring diagrams for approval and provide approved diagrams so that the electrical work may be properly accomplished.
16. Furnish all equipment with complete internal control wiring.

O. OPERATING AND MAINTENANCE MANUALS

1. Provide operating instructions and maintenance manuals for all equipment and materials furnished under this Division.
2. Maintenance information shall include complete lubrication, cleaning, and servicing data compiled in clearly and easily understandable format. Show model and serial number of each piece of equipment, complete lists of replacement parts, capacity ratings, and actual loads.
3. Provide the following equipment maintenance information where applicable:
 - a) Identifying name and number
 - b) Locations (where several similar items are used, provide a list)
 - c) Complete nameplate data
 - d) Parts list
 - e) Performance curves and data
 - f) Wiring diagrams
 - g) Lubrication charts
 - h) Manufacturers' recommended operating and maintenance instructions with all non-applicable information deleted
 - i) List of spare parts recommended for normal service requirements
 - j) Assembly and disassembly instructions with exploded view Drawings where necessary
 - k) Trouble shooting diagnostic instructions where applicable
4. Operation and Maintenance Manual shall be indexed and separated with tabs for each major category of equipment.
5. Building Automation System Manual shall be enclosed in a separate volume. Final control drawings shall be printed full size. Laminated control drawings shall be mounted in or near control panels. Refer also to Specification Section 23 0900, BAS General.

P. RECORD DRAWINGS

1. The Contractor shall maintain on a daily basis at the Project site a complete set of Record Drawings. The Record Drawings shall initially consist of a set of prints or AutoCAD files of the Contractor's Coordination Drawings. The prints shall be marked or the AutoCAD files electronically updated to show the precise location of all buried or concealed work and equipment, including embedded piping and valves, and all changes and deviations in the Mechanical work from that shown on the Contract Documents. This requirement shall not be construed as authorization for the Contractor to make changes in the layout or work without definite written instructions from the Architect or Engineer. The updated Coordination

Drawings shall be used to produce the final Record Drawings that shall be delivered to the Owner in AutoCAD electronic format media upon Project completion.

2. Record dimensions clearly and accurately to delineate the work as installed. Suitably identify locations of all equipment by at least two (2) dimensions to permanent structures.
3. Prior to final acceptance of the Work of this Division, the Contractor shall submit Record Drawings to the Architect, Engineer, and Commissioning Agent for review and shall make changes, corrections, or additions as the Architect and/or Engineer may require to the Record Drawings. After the Architect's and Engineer's review, and any required Contractor revisions, the Record Drawings shall be delivered to the Owner. The Architect and Engineer do not assume any responsibility for the accuracy or completeness of the Record Drawings.

Q. CLOSE-OUT TEST REPORTS AND CERTIFICATIONS:

1. Copies of tests and certifications performed during manufacture and construction, including but not limited to the following, shall be provided as part of close-out documentation:
 - a) Results of variable frequency drive burn-in tests and adjustments.
 - b) Certification of installation of vibration isolation.
 - c) Certification of seismic and wind restraints.
 - d) Receipt for spare fuses.
 - e) Receipt for instruction of operating personnel.
 - f) Certification of hydronic and steam system pressure testing.
 - g) Certification of hydronic and steam system cleaning.
 - h) Receipt for extra mechanical seals for pumps.
 - i) Certification of alignment of pumps.
 - j) Certification of alignment of fans.
 - k) Certification of ductwork testing results.
 - l) Seasonal adjustment reports.
 - m) Record drawings.
 - n) Approved submittals.
 - o) Equipment identification charts and schedules.
 - p) Valve schedules and location plans
 - q) Warranty certificates.
 - r) Inspection certificates.
 - s) Test, adjust and balance report.
 - t) Department of Labor pressure vessel certifications.

R. INSTRUCTION OF OPERATING PERSONNEL

1. Provide the designated Owner's personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of equipment specified in Division 23. Conduct formal instruction sessions for operating personnel. Sessions shall be a minimum of 2 hours for

MBRB and 2 hours for GMB for basic HVAC systems, and as specified herein for specialty systems and equipment. Sessions shall be conducted at the site. One session shall be conducted for each building.

2. Prepare and submit an overview or syllabus of the proposed training program.
3. Coordinate the schedule with the Owner. Owner shall be responsible for ensuring appropriate operating personnel are present for training after the schedule is approved.
4. The appropriate manufacturer's representative shall provide the instructions on each major piece of equipment. This person may be the start-up technician for the piece of equipment, the installing contractor, or manufacturer's representative.
 - a) Training shall include:
 - i. Use of the printed installation, operation and maintenance instruction material included in the operation and maintenance manuals.
 - ii. A review of the written operation and maintenance instructions emphasizing safe and proper operating requirements, preventative and routine maintenance, special tools needed and spare parts inventory suggestions. The training shall include start-up, operation in all modes possible, shut-down, seasonal changeover, and any emergency procedures.
 - iii. Discussion of relevant health and safety issues and concerns.
 - iv. Common troubleshooting problems and solutions.
 - v. Explanatory information included in the operation and maintenance manuals and the location of plans and manuals in the facility.
 - vi. Discussion of any peculiarities of equipment installation or operation.
 - vii. Hands-on training shall include start-up, operation in all modes possible, including manual, shut-down and any emergency procedures and preventative maintenance for all pieces of equipment.
 - viii. Explain and demonstrate the operation, function and overrides of local packaged controls not controlled by the central control system.
 - ix. Explain and demonstrate the operation, function and overrides of local packaged controls not controlled by the central control system.
 - b) Training shall occur after testing is complete, unless approved otherwise by the Owner.
 - c) Obtain a receipt acknowledging completion of training.
5. BAS training shall be conducted separately from general HVAC system training and shall be completed as specified in Section 23 0801, Start-up and Commissioning.

END OF SECTION 23 00 10

SECTION 23 00 50 – HVAC MOTORS, STARTERS, AND VARIABLE SPEED DRIVES

PART 1 - GENERAL

A. DESCRIPTION

1. This section includes, but is not limited to:
 - a) Motors,
 - b) Starters, and
 - c) Variable Speed Drives
2. Refer to the General and Supplementary Conditions and Division 00 and 01 for special requirements and conditions which apply to all Sections of Division 23.
3. Refer to HVAC General Requirements Section 230010 for labeling of equipment and coordination of electrical work. Arc flash labeling shall conform to Division 26 specifications.
4. Electrical materials and work installed by the mechanical contractor shall conform to Division 26 specification sections.
5. HVAC Controls commissioning is specified in Section 23 08 01. This Section includes responsibilities and obligations in support of the commissioning process specified therein.

B. QUALITY ASSURANCE

1. Conform to the North Carolina State Building Code: Mechanical and Energy Conservation Codes-2012, and NFPA 90A.
2. Codes, standards and regulations specified herein refer to the edition date. Revisions and addenda to these codes, standards and regulations shall be part of these specifications. Provisions of referenced codes, standards, and regulations do not create duty or responsibility by the Architect or the Owner, unless otherwise specified herein.
3. Codes, standards and regulations referred to are minimum standards. Where the requirements of these specifications or drawings exceed those of the codes, standards and regulations, the drawings or specifications shall govern.
4. Mechanical/Electrical Design Coordination:
 - a) The power ratings of motors and other mechanical equipment and the electrical characteristics of electrical systems serving them, as specified herein and indicated on the Drawings, have been established as minimums which will allow that equipment to satisfactorily function while producing the required capacities. These power ratings include a safety factor deemed appropriate to accommodate common differences between design parameters and field construction practices. Under no circumstances shall equipment with power ratings less than those indicated on the Drawings or specified herein be provided.

- b) Reasonable efforts have been made to coordinate the electrical requirements of the mechanical equipment with the electrical systems serving that equipment. Differences among manufacturers of mechanical equipment make it impossible to produce a single electrical design which will satisfy the varying electrical requirements of those manufacturers. Consequently, the Contractor shall coordinate the electrical requirements of the mechanical equipment actually furnished on this Project and provide the electrical systems required by that equipment. This coordination effort shall be completed prior to the installation of either the mechanical equipment or the electrical systems serving that equipment. Electrical system revisions required to coordinate with the mechanical equipment actually furnished shall be provided at no additional cost to the Owner.

C. RELATED WORK DESCRIBED IN OTHER DIVISIONS

- 1. Fire alarm initiating devices, control modules, and monitoring modules.
- 2. Motor control centers.

PART 2 - PRODUCTS

A. MOTORS

- 1. Motors shall be open drip proof, unless otherwise specified herein or indicated on the Drawings, in compliance with NEMA MG-1, Premium Efficiency.
- 2. Motors on fans installed out of doors or inside air handling units shall be TEFC; others shall be open drip-proof.
- 3. Open Drip proof and totally enclosed motors: 1800 rpm, induction type with a 1.0 service factor, Class F insulation, Class B temperature rise, designed for 40C ambient temperature, unless otherwise specified herein.
- 4. Motors over 1 HP shall be inverter duty designed for use with variable frequency ac controllers. Provide motors above 5HP with a shaft grounding ring (AEGIS SGR or equivalent); soft carbon brushes are not acceptable.
- 5. Motors shall have cast iron frame and end bells. Cast iron inner and outer bearing caps for frames 280TS to 449T/TS. Bearings shall be re-greaseable ball or roller bearings on Frames 280TS-449T/TS. Double shielded bearings on frames 140T-280T.
- 6. Motors shall conform to efficiency standards in accordance with the Integral HP Motor Rule, 10 CFR Part 431, published by the US Department of Energy, Subpart B and Subpart X.
- 7. Motors not furnished integral to equipment shall be by: TECO Westinghouse, WEG Electric, Toshiba, or Siemens.
- 8. Motors shall have 36 month warranty.

B. STARTERS

1. General: Starters located in motor control centers are specified in Division 26.
2. Description: Minimum starter size shall be NEMA Size 0. Each starter shall have appropriately sized thermal overload relays in each phase. Include additional options as specified. As a minimum, include the following:
 - a) Number of poles as be determined by branch circuit.
 - b) Provide starters with two normally open auxiliary contacts.
 - c) Provide 480/120 volt fused control transformer.
 - d) Provide HAND-OFF-AUTO selector switch with a green "motor running" pilot light mounted in face.
 - e) Starters for motors less than 50 hp shall be across-the-line type, full voltage, non-reversing (FVNR), equal to Square D Class 8530 or equivalent by Westinghouse, GE, Allen-Bradley, or Siemens.
 - f) Starters for motors over 10 HP shall be solid state, reduced voltage (soft-start) type.

C. COMBINATION STARTERS

1. Description: Minimum combination starter size shall be NEMA Size 0. Each combination starter shall have fusible disconnect with thermal overload relays in each phase. Include additional options as specified. As a minimum, include the following:
 - a) Number of poles as be determined by branch circuit.
 - b) Provide starters with two normally open auxiliary contacts.
 - c) Provide 480/120 volt fused control transformer.
 - d) Provide HAND-OFF-AUTO selector switch with a green "motor running" pilot light mounted in face.
 - e) Provide dual element time delay fuses sized as recommended by manufacturer of equipment being served.
 - f) Provide lockable handle for disconnect switch.
 - g) Combination starters for motors less than 50 hp shall be across-the-line type, full voltage, non-reversing (FVNR), equal to Square D class 8538 or equivalent by Westinghouse, GE, Allen-Bradley, or Siemens.
 - h) Starters for motors over 20 HP shall be solid state, reduced voltage type.

D. MANUAL STARTERS

1. Manual Motor Sentinel (Manual Starter with Overload Protection)
 - a) Product and Manufacturer: Square D, Type 'F', Class 2510 or equivalent by Westinghouse, GE, Allen-Bradley, or Siemens.
2. Manual Motor Starting Switch
 - a) Product and Manufacturer: Square D, Type 'K', Class 2510 or equivalent by Westinghouse, GE, Allen-Bradley, or Siemens.

E. VARIABLE SPEED DRIVES

1. Manufacturer: Variable Frequency Drives: ABB, Toshiba, Graham/Danfoss, or Square D. For consistency, provide one VFD manufacturer for all equipment requiring VFD's for this project.
2. AC Variable Frequency Drive
 - a) Provide completely assembled VFD, factory-tested by the manufacturer. The VFD shall operate from a line overvoltage of 30 percent over nominal. The undervoltage trip level shall be 35 percent under the nominal voltage as a minimum.
 - b) The alternating current variable speed drive system shall include the microprocessor based variable frequency controller, the required signal logic and control. The electrical drive equipment specified including the variable frequency controller and its associated microprocessor control system shall be of the same manufacturer. Coordinate with driven equipment supplier to ensure compatibility between drive and AC Motors.
 - c) All equipment shall comply with the applicable requirements of the latest standards of ANSI, IEEE, and NEMA as a minimum. The electrical equipment, as well as the design, construction, and installation thereof, shall comply with all the applicable provisions of the National Electrical Code.
 - d) Materials and equipment shall satisfy the North Carolina Building Code Council (NCBCC) requirements for third party NRTL (nationally recognized testing laboratories) listing of electrical and mechanical equipment. and shall bear the NRTL listing mark on products for which standards have been established and for which listing is regularly furnished by NRTL.
 - e) VFD shall be 18 pulse for motors 75 horsepower or greater, and 6 or 12 pulse for motors less than 75 horsepower. VFD shall mitigate total harmonic distortion to a 5% limit for voltage, to a 5% limit for current, and shall allow no individual harmonic to exceed 3% distortion.
 - f) The variable frequency drive shall be mounted in a NEMA 1 enclosure for drives inside the building, NEMA 12 enclosure for drives in air handling plenum spaces, and NEMA 3R enclosure for drives outside the building. The control circuitry shall be isolated from the power circuitry.
 - g) The speed controller shall respond to a speed adjusting potentiometer from the VFD sequence panel when in the manual mode or shall respond to a milliamp or voltage electrical signal when operating in the automatic mode.
 - h) The cabinet shall require front access only. The unit shall be suitable for operation in ambient air at 0 degrees C to 40 degrees C and up to 95 percent RH at rated load and switching frequency.
3. Variable Frequency Controller
 - a) The controller shall be of the pulse width modulated (PWM) type and shall have three sections including a minimum 3 percent line impedance reactor as follows:
 - i. AC-DC section (a 3-phase, full wave, half diode bridge or transistor bridge)
 - ii. Capacitor section
 - iii. 3-phase output module

- b) The controller shall be capable of performing the following functions:
 - i. Adjustable linear timed acceleration and deceleration
 - ii. Plus or minus 0.5 hertz frequency stability
 - iii. 10:1 controlled speed range
 - iv. Manual/automatic operation
 - v. Other functions as described
- c) Include the following protective devices and/or features:
 - i. Regulator with self-contained test module or panel.
 - ii. Contactor shall be vacuum break design to carry specified current (OLT) on continual basis without damage (normal condition), designed to break specified locked rotor ampere current repeatedly without damage (abnormal operation).
 - iii. Entire VFD assembly shall be rated for minimum 100,000 amperes interrupting capacity root mean square symmetrical (AIC RMS).
 - iv. AC overload protection to continuously monitor peak current and shut down the DC module gate signals if the instantaneous electrical trip motor current exceeds 180 percent of the controller full load current rating.
 - v. Monitor lamps or LED read-out on VFD front panel to provide immediate indication of controller functions.
 - vi. Current limiting breaker.
 - vii. Adjustable volts/hertz.
 - viii. Adjustable offset voltage increases starting and accelerating torque capability.
 - ix. All output phase modules shall turn off instantly when a high DC bus occurs or when the current exceeds 150 percent of rated current.
- d) The following controller adjustments shall be contained on one regulator card of microprocessor control board:
 - i. Minimum hertz/maximum hertz
 - ii. Acceleration rate (Adjustable 0 to 125 seconds)
 - iii. Deceleration rate (Adjustable 0 to 125 seconds)
 - iv. Volts/hertz
 - v. Offset voltage
- e) Provide a test panel or module to permit on-line monitoring and troubleshooting of the drive. Monitor the following regulator signals:
 - i. Internal power supplies
 - ii. Ramp generator output
 - iii. DC bus voltage

4. Variable Frequency Drive Safety Controls & Protective Components

- a) The VFD shall be capable of starting into a rotating load (forward or reverse) and accelerate or decelerate to setpoint without safety tripping or component damage (flying start). The VFD shall also be capable of DC injection braking at start to stop a reverse spinning motor prior to ramp.
- b) The VFD shall be equipped with an automatic extended control power loss ride-through circuit, which shall utilize the inertia of the load to keep the drive powered. Typical control power loss ride-through for a fan load shall be 2 seconds minimum.

- c) The overload rating of the drive shall be 110 percent of its normal duty current rating for 1 minute every 10 minutes. The minimum full-load ampere rating shall meet or exceed the values in the NEC/UL table 430-150 for 4-pole motors.
 - d) The VFD shall have an integral 3 percent impedance line reactors to reduce the harmonics to the power line and to add protection from AC line transients.
 - e) The VFD shall be capable of sensing a loss of load (broken belt / broken coupling) and signal the loss of load condition. The drive shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus. Relay output shall include programmable time delays that allow for drive acceleration from zero speed without signaling a false underload condition.
 - f) Provide surge reduction filter for electrical circuit lengths in excess of 200 feet.
 - g) The following shall be provided:
 - i. Load and speed sensitive overtemperature protection and thermal memory retention upon power loss.
 - ii. Enclosure door interlocked disconnect and bypass switch. Disconnect shall be lockable in the 'OFF' position.
 - iii. All coils for relays and contactor shall be suppressed.
 - iv. Automatic Restart: Controller shall automatically attempt to restart five (5) times after a fault. After five (5) restarts, a manual start of the drive equipment is required.
 - v. The following contacts shall be wired to terminal boards of users control and indication:
 - 1) Motor running speed
 - 2) Drive faults
 - 3) Remote stop-starting
 - h) Drive faults shall consist of the following:
 - i. Motor thermal overload.
 - ii. AC input voltage dips to 60 percent or less of its nominal value.
 - iii. Drive output current exceeds 110 percent of controller full load rating.
 - iv. A fault condition in any of the 3 output power module phases.
 - i) An Automatic Motor Adaptation (AMA) function measuring motor stator resistance and reactance to optimize performance and efficiency shall be provided. It shall not be necessary to spin the motor shaft or decouple the motor from the load to accomplish this optimization. Additionally, the parameters for motor resistance and motor reactance shall be user-programmable. AMA assumes the motor is at room temperature and shall be completed during start-up commissioning.
 - j) Where two or more motors operate in parallel, there shall be no automatic bypass feature.
5. Adjustments and Controls
- a) All VFDs shall have the following operator adjustable components:
 - i. Two (2) programmable critical frequency lockout ranges to prevent the VFD from operating the load continuously at an unstable speed.
 - ii. PID Setpoint controller shall be standard in the drive, allowing a pressure or flow signal to be connected to the VFD, using the microprocessor in the VFD for the closed loop control. The VFD shall have 250 milliamp of 24 volts DC auxiliary power and be capable of

- loop powering a transmitter supplied by others. The PID setpoint shall be adjustable from the VFD keypad, analog inputs, or over the communications bus.
 - iii. Two (2) programmable analog inputs shall accept a current or voltage signal.
 - iv. One (1) programmable analog output.
 - v. Two (2) programmable digital Form-C relay outputs. The relays shall include programmable on and off delay times. Default settings shall be for run and not faulted (fail safe).
 - vi. Seven (7) programmable preset speeds.
 - vii. Two independently adjustable acceleration and deceleration ramps.
- 6. Manual operation.
 - a) The keypad shall include Hand-Off-Auto selections. When in “Hand”, the VFD shall be started and the speed will be controlled from the up/down arrows. When in “Off”, the VFD shall be stopped. When in “Auto”, the VFD shall start via an external contact closure and the VFD speed shall be controlled via an external speed reference.
 - b) An integral manual bypass shall be provided to isolate the controller when in the bypass mode. Face-mounted bypass shall be provided with pilot lights, motor overload relays with phase loss protection for both the controller and bypass modes, and door interlocked lockable disconnect switch to provide means of disconnecting power to both the bypass circuitry and controller. A separate starter shall not be required to operate the motor in bypass mode. All safety interlocks will remain active in bypass mode.
- 7. Display shall indicate drive frequency, output voltage or output current. Provide an indication of the activation of the drive protection features and/or status in plain English without the use of code abbreviations as follows:
 - a) Overcurrent
 - b) Overvoltage
 - c) Undervoltage
 - d) Ground Fault
 - e) Motor Overload
- 8. The VFD shall have an RS-485 port as standard. The standard protocol shall be Lonworks unless an alternate protocol such as BACnet is approved by the Owner.
- 9. Serial communication capabilities shall include, but not be limited to, run-stop control; speed set adjustment, proportional/integral/derivative PID control adjustments, current limit, and accel/decel time adjustments. A minimum of 15 field parameters shall be capable of being monitored. The DDC system shall be able to monitor if the motor is running in the VFD mode or bypass mode (if bypass is specified) over serial communications. The drive shall have the capability of allowing the DDC to monitor feedback as a minimum:
 - a) Process variable feedback
 - b) Output speed/frequency
 - c) Current (in amps)
 - d) Percent torque
 - e) Power (kw)
 - f) Kilowatt hours (resettable)
 - g) Operating hours (resettable)
 - h) Relay outputs
 - i) Diagnostic warning and fault information
 - j) Remote VFD fault reset shall be possible

10. The VFD shall allow the DDC to control the drive's digital and analog outputs via the serial interface. The serial communications interface shall allow for DO (relay) control and AO (analog) control. This control shall be independent of any VFD function. The outputs can be used for actuating a damper, initiating an alarm relay, etc. In addition, all drive digital and analog inputs shall be capable of being monitored by the DDC system.
11. The following shall be furnished and mounted by the drive manufacturer and shall be UL Listed by the drive manufacturer as a complete assembly and carry a UL 508 label:
 - a) The following indicating lights (LED type) shall be provided. A test mode or push to test feature shall be provided.
 - i. Power-on
 - ii. External fault
 - iii. Drive mode selected
 - iv. Drive running
 - v. Drive fault
 - vi. H-O-A mode
 - vii. Transfer to bypass selected
 - b) The following relay (form C) outputs shall be provided:
 - i. System running
 - ii. Drive fault
 - iii. Bypass position
 - c) The digital inputs for the system shall accept 24-volt or 115-volt AC (selectable). The bypass shall incorporate internally sourced 24-volt power supply and not require an external control power source.
 - d) Customer Interlock Terminal Strip – provide a separate terminal strip for connection of freeze, fire, smoke contacts, dampers, and external start command. All external safety interlocks shall remain fully functional whether the system is in Hand or Auto modes. The remote start/stop contact shall operate in VFD modes.
 - e) The VFD shall include a "run permissive circuit" that will provide a normally open contact any time a run command is provided (local or remote start command in VFD or bypass mode). The VFD system (VFD or bypass) shall not operate the motor until it receives a dry contact closure from a damper or end-switch). When the VFD system safety interlock (fire detector, freezestat, high static pressure switch, etc) opens, the motor shall coast to a stop and the run permissive contact shall open, closing the damper.
 - f) Class 20 electronic motor overload protection shall be included.
 - g) There shall be an internal switch to select manual or automatic bypass.
12. VFD shall be equipped with a rectifier to maintain power factor near unity regardless of speed and load
13. VFD shall have integral EMI filter(s) to attenuate radio frequency interference conducted to the AC power line.
14. The VFD shall have temperature controlled cooling fans for quiet operation, minimized internal losses, and greatly increased service life.

15. An energy optimization feature to optimize motor magnetization voltage and minimize energy consumption in variable torque applications shall be provided. This feature shall dynamically and continuously adjust output voltage in response to load, independent of speed.

F. ENCLOSURES

1. All separately mounted starters and variable speed drives shall be provided in a surface or flush mounted enclosure.
2. Enclosures shall be NEMA type as required for installed and operating conditions.
3. Where neutral wires are used in the feeder, provide with solid neutral bus.
4. Where ground wires are used in the feeder, provide with ground bus.

PART 3 - EXECUTION

A. INSTALLATION REQUIREMENTS

1. Motor quantities, sizes and equipment wattage ratings specified herein or indicated on the Drawings are the minimum requirements, unless noted otherwise. Motor quantities, sizes and equipment wattage ratings less than those specified herein or indicated on the Drawings are not acceptable. Larger motor sizes and equipment wattage ratings may only be provided if necessary to meet the prescriptive requirements specified herein or indicated on the Drawings. Where multiple motors or motor sizes or equipment wattage ratings larger than specified herein or indicated on the Drawings are furnished, provide and coordinate the corresponding increased number or capacity of feeders and other electrical equipment serving them, at no additional cost to the Owner.
2. Fans, drive sheaves, motors, and pumps shall be statically and dynamically balanced.
3. Field-installed equipment controls or sensor wiring shall be installed in conduit. Low voltage control and sensor wiring shall be installed in conduits separate from line voltage control wiring and power wiring.

B. MOTORS

1. Provide motors for equipment covered in Division 23 unless otherwise specified herein. Select motors for operation not exceeding a 1.0 service factor and within the nameplate amperage and nominal power rating.
2. Anchor each motor assembly to base, adjustable rails, or other support, arranged and sized according to manufacturer's written instructions. Attach by bolting using split bolts.
3. Use glass and vinyl tape on leads.
4. Level and align with load transfer link.
5. All motors shall be mounted on the same base as the rotating equipment it serves.

C. STARTERS

1. General: Secure boxes rigidly to the substrate upon which they are being mounted or solidly embed enclosures in concrete or masonry.
2. Start-up: Test rotation of motors and reverse motor leads as required to obtain proper rotation.
3. Size of heaters shall be coordinated with equipment being served for nameplate full load running amps. Provide typewritten list of motors with schedule of nameplate full load amps, overload part number, and overload current rating range.
1. Duplex motor controllers shall be used on air compressors, condensate return units, and other applications as indicated on the drawings. Motor controller shall include automatic alternation. Two starters shall be installed in a common enclosure.
2. Maintain code required electrical clearance around all starters.

D. VARIABLE SPEED DRIVES

1. The contractor shall install the drive and power wiring shall be completed in accordance with the recommendations of the manufacturer as outlined in the installation manual.
2. Division 23 contractor shall be responsible to provide and install all VFD cable for all VFD driven motors. Refer also to Specification section 26 05 19 Part 2, paragraph C. VFD Cable shall be 3-phase, 3 ground, copper tape spiral shield, galvanized steel interlocked Armor cable. To ensure system reliability, the cable shall be terminated in connector designed exclusively for ASD/VFD cable and shall provide ground continuity of the cable armor. Pre-wired air handler and energy recovery fan motors shall provide this cable from the motor(s) to a unit-mounted disconnect or termination block.
3. Where disconnects are installed, separate from the variable speed drive, the disconnect shall be provided with an auxiliary contact. The auxiliary contact shall be interlocked to the variable speed drives 'safety' circuit.
4. Start-up Service: Provide certified factory-authorized start-up service for purposes of installation inspection, initial drive equipment setting, energization and adjustment. Start-up shall be provided for each drive by a factory authorized service center. A certified start-up form shall be filled out for each drive with a copy provided to the owner.
5. Coordinate with equipment supplier to ensure compatibility between variable frequency drive and the motor supplied with the equipment.
6. Maintain code required and manufacturer recommended clearance around all VFD cabinets.

E. FUSES

1. Provide fuses in equipment furnished under this Division of the specifications.
2. Provide 3 spare fuses of each size, UL class, and voltage rating furnished under this Division of the specifications and turn over to the Owner. Obtain a receipt for same.

END OF SECTION 23 00 50

SECTION 230095 - HVAC TEST-ADJUST-BALANCE

PART 1. GENERAL

A. DESCRIPTION OF WORK

1. Make all necessary tests, trial operations, etc., required and directed by the Architect/Engineer to demonstrate that all work done under these plans and specifications is in complete serviceable condition and will function as intended. All cost of tests shall be under this Division.
2. This contractor shall furnish the services of all factory representatives, service engineers, or others required to place all the facilities in proper condition and operation and shall bear the cost of such assistance.

B. QUALITY ASSURANCE

1. Balancing and adjusting as herein described shall be performed by an independent organization whose major source of income is derived from performance of this service and is a current member of the Associated Air Balance Council (AABC) or National Environmental Balancing Board (NEBB).
2. Air and water balance of laboratories and animal research facilities shall be balanced to +/- 5% of design.

PART 2. PRODUCTS

A. GENERAL

1. The complete heating and cooling system shall be started and maintained in operation for a period of 5 days before tests and measurements are performed.

B. BALANCING AND ADJUSTING OF AIR SYSTEMS

1. Adjust fan speed to slowest speed which will deliver design air volumes with O.A. dampers in minimum set position and R.A. volume dampers in full open position, and E.A. dampers in full closed position with coils and filters restricted to the maximum pressure drop as shown on approved shop drawings.
2. Adjust system volume dampers for design air volumes to minimize throttling of outlet dampers.
3. Adjust the air flow through individual diffusers where more than one diffuser is supplied from a terminal unit.
4. Adjust terminal units for air flow in accordance with manufacturer's recommendations and record inlet pressure, pressure drop, manufacturer's size, and CFM for each unit.
5. Measure air flow in ducts by pitot tube traverse method in accordance with procedure outlined in ASHRAE Guide.
6. Velocities of 1,000 feet per minute or more shall be measured with hot wire or inclined manometers. Openings made in ducts shall be sealed with factory fabricated plugs after air balance is completed.

7. Adjust supply, return and exhaust air terminals for design air quantities. Adjust outlet directional controls for draft free air distribution.
8. Measure air flow at terminals by direct reading velocity meters in accordance with manufacturer's recommendations.

C. WATER BALANCE

1. Pumps shall be adjusted for design water flow by means of water flow measuring devices and control valves in the full open position.
2. Piping system shall be adjusted for design flow with all automatic control valves open.
3. Measure water flow by flow meters; pressure differential across pumps and temperature differentials across heat exchangers. Balancing by temperature difference across air to water heat exchangers shall be done only after air balance is complete. Pressure shall be measured by standard or differential pressure gauges.

D. INSTRUMENTS

1. All instruments used shall be certified as having been calibrated within a six months period prior to use.
2. Manufacturer, model, certificate of calibration, and range of instruments used to make the various readings and measurements shall be listed in the written report.

E. PERFORMANCE TEST

1. After balancing and adjusting is completed, all systems shall be operated to demonstrate performance.
2. Room pressure control operation, as indicated on the mechanical plans, shall be tested and demonstrated.

F. TEST REPORTS

1. Provide three bound copies and an electronic copy of a report which shall contain the following information. Only electronic copies are required until final inspection.
 - a) Fans and Pumps:
 - (1) Manufacturer and model
 - (2) Size, arrangement, class
 - (3) Motor nameplate data
 - (4) R.P.M. - tested
 - (5) CFM and GPM, design and tested
 - (6) Pressure difference across fan or pump
 - (7) Ammeter readings, all phases
 - (8) Voltmeter readings, all phases
 - b) Heat Transfer Equipment:
 - (1) Manufacturer and model
 - (2) Size
 - (3) Entering and leaving water temperature
 - (4) Pressure difference entering and leaving water

- (5) GPM
 - (6) Entering and leaving air temperature
 - (7) CFM
 - (8) Face Velocity
 - c) Heat Transfer Equipment:
 - (1) Manufacturer and model
 - (2) Size
 - (3) Entering and leaving water temperature
 - (4) Pressure difference entering and leaving water
 - (5) GPM
 - (6) Entering and leaving air temperature
 - (7) CFM
 - (8) Face Velocity
 - d) Air Handling Units:
 - (1) O.A. temperatures wet and dry bulb
 - (2) Time of day and date
 - (3) R.A. wet and dry bulb temperatures, where applicable
 - (4) Mixed air wet and dry bulb temperature, where applicable
 - (5) CFM O.A. through O.A. damper
 - (6) Discharge air temperatures downstream of all coils and downstream of supply air fan(s).
 - (7) Pressure drop across filters
 - (8) Information as listed under fans
 - (9) Setting of all temperature control elements
 - (10) Pitot tube traverses of main supply and return ducts
 - e) Main Ducts and Major Branch Ducts:
 - (1) Size
 - (2) Area
 - (3) Number of Pitot readings
 - (4) Average air velocity
 - (5) CFM
 - (6) Static pressure
 - f) Supply, Return, and Exhaust Outlets:
 - (1) Manufacturer and type
 - (2) Size
 - (3) Number of readings
 - (4) Average velocity
 - (5) CFM and room number
2. The report shall include identity and location of all readings required to produce design results.
 3. Provide one set of half size prints neatly marked to indicate as nearly as possible the location of pitot tube readings taken in duct mains and major branches and diffuser design/tested CFM.

END OF SECTION 23 00 95

SECTION 23 08 01 – START-UP AND COMMISSIONING

PART 1 - GENERAL

A. GENERAL DESCRIPTION

1. Commissioning is the process of ensuring that all building systems are installed and perform interactively according to the design intent, the systems are efficient and cost effective and meet the owner's operational needs, the installation is adequately documented, and that the Operators are adequately trained. It serves as a tool to minimize post-occupancy operational problems. It establishes testing and communication protocols in an effort to advance the building systems from installation to full dynamic operation and optimization.
2. Commissioning Authority (CA) and Owner shall work with the Contractor and direct, coordinate, and oversee the Commissioning process and witness functional and performance testing. Contractor is required to coordinate with both the Owner and CA to conduct the work and provide sufficient notification to both parties for all activities related to commissioning.

B. CONTRACTOR RESPONSIBILITIES

1. Completely install and thoroughly inspect, startup, test, adjust, balance, and document all systems and equipment.
2. Assist Commissioning Authority in verification and performance testing. This will generally include the following:
 - a) Attend Commissioning (Cx) progress and coordination meetings, during functional testing, acceptance and punchlist close out. The number of meetings will vary depending on the complexity of the project.
 - b) Prepare and submit required forms and systems information.
 - c) Help establish trend logs of system operation as specified herein.
 - d) Demonstrate system operation.
 - e) Manipulate systems and equipment to facilitate testing.
 - f) Provide instrumentation necessary for verification and performance testing.
 - g) Manipulate control systems to facilitate verification and performance testing.
 - h) Train Owner's BAS Representatives as specified in Part 3 of this section. BAS training shall be conducted separately from general HVAC system training. For general HVAC training refer to Part 3 in Section 23 0010, HVAC General Requirements.
3. Contractor is required to coordinate with both the Owner and CA to conduct the work and provide sufficient notification to both parties for all activities related to commissioning.
4. Provide a BAS Technician to work at the direction of Commissioning Authority for software optimization assistance for a minimum of 24 hours.
5. Compensation for Retesting: Contractor shall compensate Owner for site time necessitated by incompleteness of systems or equipment at time of functional performance testing. All testing failures, which

require on-site time for retesting, will be considered actual damages to the Owner. All parties under contract with the Owner who are affected by the retesting shall be included in the contract modification.

C. MANUFACTURER'S RECOMMENDATIONS

1. Prior to starting equipment or systems, obtain and review manufacturer's installation, operation and starting instructions. Read in conjunction with procedures specified herein.
2. Use manufacturers and suppliers starting personnel where required to maintain manufacturer's warranty.
3. Compare installation to manufacturer's published data. Record discrepancies. Correct deviations detrimental to equipment performance prior to starting equipment.

D. FACTORY TRAINED REPRESENTATIVES

1. Use factory trained representatives and submit manufacturer's check sheets for starting the following specialty equipment:
 - a) Variable speed drives
 - b) Building Automation System (BAS)
 - c) Chemical cleaning and treatment
 - d) Air Handling Units
2. Use manufacturer's factory trained personnel where required to maintain manufacturer's warranties.

E. SEQUENCING

1. The following list outlines the general sequence of events for submittals and commissioning:
 - a) Submit product data and shop drawings and receive approval.
 - b) Develop system graphics.
 - c) Prepare Start-Up Checklists and manufacturer's start-up procedures for all equipment. Provide to CA, Owner or Engineer where requested.
 - d) Install equipment and controls.
 - e) Complete start-up procedures.
 - f) Simulate sequencing and debug BAS program off-line to the extent practical.
 - g) Place systems under BAS control.
 - h) Perform startup and BAS calibrations.
 - i) Prepare and initiate trend log data storage and format trend graphs.
 - j) Submit completed Start-Up Reports and initial draft of the O&M Manuals.
 - k) Demonstrate systems to Commissioning Authority, Engineer and Owner.
 - l) Submit Training Plan.
 - m) Train Owner on BAS and equipment operation and maintenance.

- n) Substantial Completion
- o) Begin Acceptance Phase.
- p) Install framed control drawings.
- q) Provide Level 1 password access to the Owner.
- r) Submit record drawings and O&M Manuals.
- s) Final Acceptance.
- t) Begin Warranty Phase.
- u) Verify opposite season performance.
- v) End-of-Warranty date/period.

PART 2 - PRODUCTS

A. INSTRUMENTATION

1. Instrumentation required to verify readings and test the system and equipment performance shall be provided by Contractor and made available to Commissioning Authority. Generally, no testing equipment will be required beyond that required to perform Contractors work under these Contract Documents. All equipment used for testing and calibration shall be NIST/NBS traceable and calibrated within the preceding 6-month period. Certificates of calibration shall be submitted.

B. TAB & COMMISSIONING PORTABLE OPERATORS TERMINAL

1. Contractor shall provide a portable operators terminal or hand held device to facilitate Testing, Adjusting, and Balancing (TAB) and calibration. This device shall support all functions and allow querying and editing of all parameters required for proper calibration and Startup. Contractor at the completion of the work, shall provide to the Owner all hardware, software, cables, power supplies, converters necessary for operation with the Owner's existing POTs to provide the ability to perform the functions of this device.
2. Connections shall be provided local to the device being calibrated. For instance, for VAV boxes, connection of the operator's terminal shall be provided at the sensor. Otherwise a working wireless system shall be provided to facilitate this local functionality.

PART 3 - EXECUTION

A. FLUID HANDLING EQUIPMENT

1. Pumps:
 - a) Pre-Starting:
 - i. Compare specified and shop drawing data to installed data, including:
 - 1) Make/model/size
 - 2) Impeller size
 - 3) Seal type

- 4) Lubrication fittings
 - 5) Motor size, speed, efficiency, and voltage
 - 6) Flow gallons per minute (gallons per minute)
 - 7) Head feet of water column (feet water column)
 - ii. Ensure pump installation is as specified and as per manufacturer's recommendations. Fill out manufacturer's check sheet including:
 - 1) Pump is level.
 - 2) Isolation valves, strainers, check valves are installed properly.
 - 3) Pump suction has sufficient length of straight run.
 - 4) Air is completely bled off piping system.
 - 5) Expansion tank is charged and on-line.
 - 6) Ensure strainers have screens in place and are clean.
 - 7) Ensure electrical connections are properly made.
 - 8) Ensure nameplate is readily visible.
 - 9) Check clearance space adequately permits removal or servicing.
 - 10) Check voltage to pump motor.
 - 11) Vibration isolators adjusted.
 - iii. Ensure chemical cleaning of piping system is completed.
 - iv. Check and adjust oil levels bearing lubrication.
 - b) Starting:
 - i. Start pumps as per manufacturer's recommendations.
 - ii. Ensure impeller and motor are rotating in the correct direction.
 - c) Post Starting:
 - i. Check chemical treatment status.
 - ii. Run-in pumps for minimum 12 continuous hours.
 - iii. Ensure flows through parallel pumps are equally balanced.
 - iv. Record motor power consumption. Ensure mechanical seals do not leak. Ensure packing gland type seals are wetted.
 - v. Calculate overall pump efficiency.
 - vi. Calculate/check net positive suction head.
 - vii. Verify the motor has sufficient airflow around to allow cooling.
 - viii. Plot operating point at time of starting on pump curve.
 - d) Pre-Interim Acceptance:
 - i. Change pump seals.
 - ii. Clean strainers.
 - iii. Trim pump impeller at the factory and verify flows, based upon information recorded and documented during balancing and adjusting.
2. Heat Exchangers:
- a) Pre-Starting:

i. Compare specified and shop drawing data to the installed data including:

- 1) Make/model/size
- 2) Nameplate heat output/input
- 3) Nameplate flows
- 4) Pressure rating – nameplate
- 5) Clearances:
 - a) Tube bundle removal
 - b) Flanged inlet/outlet
- 6) Piping connections:
 - a) PRVs – piped to drain
 - b) Inlet/outlet sizes – steam
 - c) Inlet/outlet sizes – hot water
- 7) Labels – ASME, UL, OSHA

ii. Visually check for the following:

- 1) Piping completed.
- 2) System cleaning executed.
- 3) Circulating pump starting completed.
- 4) Hot water pumps starting completed.
- 5) Unit clean of foreign matter – remove heads as required.
- 6) Control valves in operation.
- 7) Insulation complete.

B. AIR HANDLING EQUIPMENT

1. Air Handling Units

a) Pre-Starting:

i. Compare specified and shop drawings data to installed data including:

- 1) Make/model/size
- 2) Fan wheel size
- 3) Nameplate flow, static pressure
- 4) Motor size, speed, efficiency, type, and voltage
- 5) Heating coil, cooling coil
- 6) Mixing baffles
- 7) Return, exhaust and outside air motorized dampers, operation and size
- 8) Filters
- 9) Vibration isolation, flexible connections and seismic restraints (internal and external)
- 10) Special features – access doors, liners, inlet vanes, labels
- 11) Ensure variable speed drive is operational

ii. Lubricate bearings on fans as per manufacturer's recommendations. Ensure fan wheel rotates smoothly without binding. Adjust belts to proper alignment and tension.

iii. Vacuum out air system plenums and ductwork.

iv. Ensure temporary filters are installed. Under no circumstances run systems without filters installed.

v. Ensure all balancing and fire/smoke dampers are open and ductwork is complete. For VAV

- vi. systems, ensure that at least 60 percent of terminal units are open.
- vii. Ensure minimum position specified for terminal units are properly set.
- viii. Ensure all coils are in operation.
- ix. On parallel fan systems, ensure backdraft dampers are installed.
- x. Ensure electrical connections are completed and system disconnects are within visual access of unit.
- xi. Ensure controls are operational.
- xi. Ensure inlet and discharge duct geometry are properly installed.

b) Starting:

- i. Follow manufacturer's recommendations.
- ii. Check fan and motor for correct rotation.

c) Post-Starting:

- i. Check vibration isolation and seismic restraints.
- ii. Run for one hour and check filters, coils, and humidifier.
- iii. Determine fan speed, airflow rates, static pressure and record on fan curve.
- iv. Effectiveness of mixing chamber. Measure temperature profile. Adjust mixing baffles.

d) Pre-Interim Acceptance:

- i. Replace temporary filters with permanent filters.
- ii. Vacuum heating coil and cooling coil.
 - 1) Re-lubricate all bearings.
 - 2) Check belt for tension and wear.

2. Fans:

a) Pre-Starting:

- i. Check the specified data and the shop drawing data against the installed data including:
 - 1) Make/model/size
 - 2) Fan wheel size
 - 3) Nameplate airflow, static pressure
 - 4) Motor size, speed, and efficiency
 - 5) Backdraft dampers
 - 6) Accessories
 - 7) Special features
- ii. Lubricate bearings on fans as per manufacturer's recommendations. Ensure wheels rotate freely without binding.
- iii. Ensure ductwork and fan casing is free of dirt or foreign material.
- iv. Ensure electrical connections are properly made and fan disconnects are properly located.
- v. Ensure inlet and discharge duct geometry is properly installed.
- vi. Ensure vibration isolators have been adjusted.

b) Starting:

- i. Follow manufacturer's recommendations.
 - ii. Check fan and motor for correct rotation.
- c) Post-Starting:
 - i. Check isolation and flexible connections.
 - ii. Check radiated and discharge sound power levels.
 - iii. Determine speed, airflow rates, static pressure and record on fan curve.
 - iv. Pre-Interim Acceptance:
 - 1) Re-lubricate all bearings.
 - 2) Perform measurements of discharge, inlet and radiated sound power levels after entire system is balanced and adjusted.

C. MISCELLANEOUS EQUIPMENT

- 1. Variable Speed Drive Units:
 - a) Starting procedures shall only be performed by qualified and factory trained technicians in accordance manufacturer recommendations.
 - b) Refer also to Specification 23 00 50, HVAC Motors, Starters, and Variable Speed Drives.
 - c) Visually inspect for the following items prior to commencing manufacturer's recommended starting procedures:
 - i. Voltage of unit and motor are same.
 - ii. Transformer is properly installed.
 - iii. Unit has UL label.

D. BAS START-UP TESTING, ADJUSTING, CALIBRATION

- 1. Work and/or systems installed under this Division shall be fully functioning prior to Demonstration and Acceptance Phase. Contractor shall start, test, adjust, and calibrate all work and/or systems.
 - a) Inspect the installation of all devices. Review the manufacturer's installation instructions and validate that the device is installed in accordance with them.
 - b) Verify proper electrical voltages and amperages, and verify that all circuits are free from faults.
 - c) Verify integrity/safety of all electrical connections.
 - d) Coordinate with TAB subcontractor to obtain control settings that are determined from balancing procedures. Record the following control settings as obtained from TAB contractor, and note any TAB deficiencies in the BAS Start-Up Report:
 - i. Optimum duct static pressure setpoints for VAV air handling units.
 - ii. Minimum outside air damper settings for air handling units.
 - iii. Optimum differential pressure setpoints for variable speed pumping systems.
 - iv. Calibration parameters for flow control devices such as VAV boxes and flow measuring stations.
 - 1) BAS contractor shall provide hand-held device as a minimum to the TAB and CA to facilitate calibration. Connection for any given device shall be local to it (i.e. at the VAV box or at the thermostat). Hand-held device or portable

operator's terminal shall allow querying and editing of parameters required for proper calibration and start-up.

- v. Commissioning Agent or Engineer may modify some original design setpoints to achieve desired performance. For example biosafety cabinet exhaust volumes may need to be modified as part of cabinet certification or supply/exhaust setpoints may need to be adjusted to maintain positive or negative air pressure control. Such setpoint adjustments shall be made at no additional cost to Owner.
- e) Test, calibrate, and set all digital and analog sensing and actuating devices. Calibrate each instrumentation device by making a comparison between the BAS display and the reading at the device, using an instrument traceable to the National Bureau of Standards, which shall be at least twice as accurate as the device to be calibrated (e.g., if field device is $\pm 0.5\%$ accurate, test equipment shall be $\pm 0.25\%$ accurate over same range). Record the measured value and displayed value for each device in the BAS Startup Report.
- f) Check and set zero and span adjustments for all transducers and transmitters.
- g) For dampers and valves:
 - i. Check for adequate installation including free travel throughout range and adequate seal.
 - ii. Where loops are sequenced, check for proper control without overlap.
- h) For actuators:
 - i. Check to insure that device seals tightly when the appropriate signal is applied to the operator.
 - ii. Check for appropriate fail position, and that the stroke and range is as required.
 - iii. For sequenced electronic actuators, calibrate per manufacturer's instructions to required ranges.
- i) Check each digital control point by making a comparison between the control command at the CU and the status of the controlled device. Check each digital input point by making a comparison of the state of the sensing device and the Operator Interface display. Record the results for each device in the BAS Start-Up Report.
- j) For outputs to reset other manufacturer's devices (for example, VSDs) and for feedback from them, calibrate ranges to establish proper parameters. Coordinate with representative of the respective manufacturer and obtain their approval of the installation.
- k) Verify proper sequences by using the approved checklists to record results and submit with BAS Start-Up Report. Verify proper sequence and operation of all specified functions.
- l) Verify that all safety devices trip at appropriate conditions. Adjust setpoints accordingly.
- m) Tune all control loops to obtain the fastest stable response without hunting, offset or overshoot. Record tuning parameters and response test results for each control loop in the BAS Startup Report. Except from a startup, maximum allowable variance from set point for controlled variables under normal load fluctuations shall be as follows. Within 3 minutes of any upset (for which the system has the capability to respond) in the control loop, tolerances shall be maintained (exceptions noted):

- i. Duct air temperature: $\pm 1^{\circ}\text{F}$.
- ii. Space Temperature: $\pm 2^{\circ}\text{F}$
- iii. Chilled Water: $\pm 1^{\circ}\text{F}$
- iv. Hot water temperature: $\pm 3^{\circ}\text{F}$.
- v. Duct pressure: $\pm 0.25''$ w.g.
- vi. Water pressure: ± 1 psid
- vii. Duct or space Humidity: $\pm 5\%$
- viii. Air flow control: $\pm 5\%$ of setpoint velocity.

n) For interface and DDC control panels:

- i. Ensure devices are properly installed with adequate clearance for maintenance and with clear labels in accordance with the record drawings.
- ii. Ensure that terminations are safe, secure and labeled in accordance with the record drawings.
- iii. Check power supplies for proper voltage ranges and loading.
- iv. Ensure that wiring and tubing are run in a neat and workman-like manner, either bound or enclosed in trough.
- v. Check for adequate signal strength on communication networks.
- vi. Check for standalone performance of controllers by disconnecting the controller from the LAN. Verify that the controlling LAN reconfigures as specified in the event of a LAN disconnection.
- vii. Ensure that all outputs and devices fail to their proper positions/states.
- viii. Ensure that buffered and/or volatile information is held through power outage.
- ix. Check for adequate grounding of all DDC panels and devices.

o) For Operator Interfaces:

- i. Verify that all elements on the LCS are functional and are properly bound to physical devices and/or virtual points.
- ii. Verify that required third party software applications required with the bid are installed and are functional.
- iii. Verify proper interface with fire alarm system.

p) Submit Start-Up Test Report: Report shall be completed, submitted, and approved prior to Substantial Completion.

2. SENSOR CHECKOUT AND CALIBRATION

- a) General Checkout: Verify that all sensor locations are appropriate and are away from causes of erratic operation. Verify that sensors with shielded cable are grounded only at one end. Make a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading is within the tolerances specified for the sensor

3. VALVE STROKE SETUP AND CHECK

- a) For all valve and actuator positions checked, verify the actual position against the Operator Interface readout.

- b) Set pumps to normal operating mode. Command valve closed, verify that valve is closed, and adjust output zero signal as required. Command valve open, verify position is full open and adjust output signal as required. Command the valve to various few intermediate positions. If actual valve position doesn't reasonably correspond, replace actuator.
- c) Verify proper close-off of the valves. Ensure the valve seats properly by simulating the maximum anticipated pressure difference across the circuit.

4. DEMONSTRATION

- a) Demonstrate the operation of the BAS hardware, software, and all related components and systems to the satisfaction of the Commissioning Authority and Owner. Schedule the demonstration with the Owner's representative 2 weeks in advance. Demonstration shall not be scheduled until all hardware and software submittals, and the Start-Up Test Report are approved.

E. BAS OPERATOR TRAINING AND O&M MANUALS

1. Provide complete sets of the approved Operations and Maintenance (O&M) Manuals (hard copy and one electronic copy) to be used for training.
2. Contractor shall submit a Training Plan for the scope of training for which (s)he is responsible. Training Plan shall be forwarded to the Division 23 Contractor who will compile, organize, format, and forward to the Engineer, commissioning provider and UNC for review.
3. On-Site Training: Provide services of controls contractor's qualified technical personnel for four 8-hour days AE to adjust per the project needs to instruct Owner's personnel in operation and maintenance of BAS. Instruction shall be in classroom setting at the project site for appropriate portions of the training. Training may be in non-contiguous days at the request of the Owner. The Owner's representative shall notify contractor 1 week in advance of each day of requested training. The Contractor's designated training personnel shall meet with the Engineer and Owner's representative for the purpose of discussing and fine-tuning the training agenda prior to the first training session. Training agenda shall generally be as follows:
 - a) Basic Local Control Station (LCS) Training – For all potential users of the LCS:
 - i. Brief walk-through of building, including identification of all controlled equipment and condensed demonstration of controller portable and built-in operator interface device display capabilities.
 - ii. Brief overview of the various parts of the O&M Manuals, including hardware and software programming and operating publications, catalog data, controls installation drawings, and DDC programming documentation.
 - iii. Demonstration of LCS login/logout procedures, password setup, and exception reporting.
 - iv. Demonstration of LCS menu penetration and broad overview of the various workstation features.
 - v. Overview of systems installed.
 - vi. Present all site-specific point naming conventions and points lists, open protocol information, configuration databases, back-up sequences, upload/download procedures, and other information as necessary to maintain the integrity of the BAS.
 - vii. Overview of the Sequence of Operation for all systems
 - viii. Overview of LCS reports.
 - b) BAS Hardware Training – For Maintenance and Control Technicians

- i. Review of installed components and how to install/replace, maintain, commission, and diagnose them
- c) BAS Technician Training:
 - i. Introduction to controller programming and overview of the programming application interface.
 - ii. General review of sequence of operation and control logic for the project site, including standalone and fail-safe modes of operation.
 - iii. Uploading/Downloading and backing up programs.
 - iv. Network administration.
 - v. Review of setpoint optimization and fine-tuning concepts.

END OF SECTION 23 08 01

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SECTION 23 09 00 – BUILDING AUTOMATION SYSTEM (BAS) - GENERAL

PART 1 - GENERAL

A. DESCRIPTION OF WORK

1. Contractor shall furnish and install a direct digital control and building automation system (BAS). The new BAS shall utilize electronic sensing, microprocessor-based digital control, and electronic actuation of dampers, valves and devices to perform control sequences and functions specified. Refer also to control drawings, sequences of operation, and point lists.
2. The HVAC distributed digital control (DDC) and building automation system (BAS) defined in these specifications shall furnish and install a complete system utilizing one of the following:
 - a) Or, a BACnet based BAS utilizing ASHRAE 135 standard BACnet protocol. Towards this end, contractor shall provide all specified objects and services and have them configured/mapped as applicable.
3. The BAS defined in these specifications shall interface with an existing central campus server.

B. SYSTEM INTEGRATION

1. The Contractor is required to connect to an existing approved BAS server at EMCS, Giles Horney Building and provide all control variables and network variables for control as described in detail in this and other specifications but generally include:
2. All Input and Output (I/O) points
3. Calibration variables for all I/O points
4. All setpoint variables. The controllers/systems to which these variables are applicable shall be bound and the name of the receiving variable shall be the same for these controllers/systems.
5. Zone Occupancy and setpoint adjustment variables. The controllers/systems to which these variables are applicable shall be bound and the name of the receiving variable shall be the same for these controllers/systems.
6. All system/building mode variables (Occupied, Unoccupied, Warm-up, Cool-down, Optimal Start/stop, etc.).

C. PROCUREMENT

1. The BAS and digital control and communications components installed, as work of this contract shall be an integrated distributed processing system of the following manufacturer. No other vendor's products will be considered as substitutions.
2. Owner Preferred Alternates. The Building Automations System (BAS) and digital control and communications components provided and installed under this contract shall be an integrated distributed processing system of Johnson Controls, Inc or Schneider Electric. No other vendor's products will be considered as substitutions. Refer to Alternates 10 and 11.

D. SUBMITTALS

1. Electronic Submittals: While all requirements for hard copy submittal apply, control submittals and O&M information shall also be provided in electronic format as follows.

- a) Drawings and Diagrams: During the initial submittal approval process the drawings can be submitted in PDF format.
 - b) Graphics pages shall be submitted at least 60 days prior to start of start-up testing and commissioning. All graphics shall be submitted for review and approval by NC State personnel.
2. Product Data: Submit manufacturer's technical product data for each control device, panel, and accessory furnished, indicating dimensions, capacities, performance and electrical characteristics, and material finishes. Also include installation and start-up instructions. System Architecture and System Layout:
 - a) One-line diagram indicating schematic locations of all control units, workstations, LAN interface devices, gateways, etc. All optical isolators, routers, repeaters, end-of-line terminators, junctions, ground locations etc. shall be located on the diagram.
 - b) Provide floor plans and vertical risers drawings locating all control units, workstations, servers, gateways, etc. Include all LAN communication wiring routing, power wiring, power originating sources, and low voltage power wiring. All optical isolators, routers, repeaters, end-of-line terminators, junctions, ground locations etc. shall be located on the floor plans. All remote differential pressure transmitters and sensors (air or water) shall be located on the floor plans. Wiring routing as-built conditions shall be maintained accurately throughout the construction period and the drawing shall be updated to accurately reflect accurate, actual installed conditions.
3. Schematic flow diagram of each air and water system showing fans, coils, dampers, valves, pumps, heat exchange equipment and control devices. Include verbal description of sequence of operation.
4. All physical points on the schematic flow diagram shall be indicated with names and descriptors. Provide a Bill of Materials with each schematic. Indicate device identification to match schematic and actual field labeling, quantity, actual product ordering number, manufacturer, description, size, voltage range, pressure range, temperature range, etc. as applicable.
5. Indicate all required electrical wiring. Electrical wiring diagrams shall include both ladder logic type diagram for motor starter, control, and safety circuits and detailed digital interface panel point termination diagrams with all wire numbers and terminal block numbers identified. Provide panel termination drawings on separate drawings. Ladder diagrams shall appear on system schematic. Clearly differentiate between portions of wiring which is existing, factory-installed and portions to be field-installed.
6. Details of control panels, including controls, instruments, and labeling shown in plan or elevation indicating the installed locations.
7. Sheets shall be consecutively numbered with Table of Contents listing sheet titles and sheet numbers, and legend and list of abbreviations.
8. Control Drawings: Laminated 11 x 17 control drawings including system control schematics, sequences of operation and panel termination drawings, shall be provided in control enclosures. Drawings should be of sufficient size to be easily read.
9. Operation and Maintenance Materials:
 - a) Submit documents under provisions of Section {Insert Appropriate Number typically 3} copies of the materials shall be delivered directly to the Owner's facilities operation staff along with an electronic (PDF format) version, in addition to the copies required by other Sections.
 - b) Submit maintenance instructions and spare parts lists for each type of control device, control unit, and accessory.
 - c) Include all submittals (product data, shop drawings, control logic documentation, hardware manuals, software manuals, installation guides or manuals, maintenance instructions and spare parts lists) in maintenance manual; in accordance with requirements of Division 1.

10. Product Warranty Certificates: submit manufacturers product warranty certificates covering the hardware provided.

E. PROJECT RECORD DOCUMENTS

1. Record copies of product data and control shop drawings updated to reflect the final installed condition.
2. Record copies of approved control logic programming and database on paper and on CD's. Accurately record actual setpoints and settings of controls, final sequence of operation, including changes to programs made after submission and approval of shop drawings and including changes to programs made during specified testing.
3. Record copies of approved project specific graphic software on CDs.
4. Provide as-built network architecture drawings showing all nodes, including Node ID and domain, sub-network and channel addresses.
5. Record copies shall include individual floor plans with controller locations with all interconnecting wiring routing including space sensors, LAN wiring, power wiring, low voltage power wiring. Indicate drawing reference number.
6. Provide record riser diagram showing the location of all controllers.
7. Maintain project record documents throughout the warranty period and submit final documents at the end of the warranty period

F. WARRANTY MAINTENANCE

1. Contractor shall warrant all products and labor for a period of 1 year {change warranty period if different} after Final Project Acceptance (usually 30 days after SCO beneficial occupancy).
2. The Owner reserves the right to make changes (set point changes, deadbands and tuning adjustments) to the BAS during the warranty period. Such changes do not constitute a waiver of warranty. The Contractor shall warrant parts and installation work regardless of any such changes made by the Owner, unless the Contractor provides clear and convincing evidence that a specific problem is the result of such changes to the BAS.
3. At no cost to the Owner, during the warranty period, the Contractor shall provide maintenance services for software, firmware and hardware components.

G. LISTING AND LABELING

1. The BAS and components shall be listed by Underwriters Laboratories (UL 916) as an Energy Management System.

PART 2 - PRODUCTS

A. BUILDING CONTROL UNIT (BCU)

1. Provide a minimum of one (1) BCU per building.
2. The BCU shall be a networking stand alone energy management panel enclosed in a minimum of 18 ga. metal enclosure. The microcomputer shall be 16 bits minimum. The microcomputer shall utilize a multitasking, multi - user operating system. The BCU shall have peripheral ports for a monitor, a printer, network communications, and have storage capacity for the entire database, including set points. The BCU shall have a battery back -up for the clock.

3. The BCU shall be placed on the control vendor's Local Area Network (LAN) configuration within the building via its BUS ports. The LAN's fault tolerant operation shall guarantee that despite failure of individual DDC controllers, remaining units will continue communication uninterrupted. The BCU shall also be connected to the Campus Wide Area Network via Ethernet connection with communications based on TCP/IP protocol. This connection is via one of the Ethernet ports. The BCU shall be furnished with a built in software library.
4. The Ethernet card shall reside in the BCU. It shall communicate with the network via a 100 Mbps network adapter.
5. The BCU shall have an operator interface port that allows a laptop to direct connect to the BCU and the individual local controllers. The interface connection shall provide all necessary communication to allow the laptop to display analog variables, binary (status) condition, adjustment values, automatic operation, trouble, alarm condition and value, and manual or override condition.
6. A standard NC State voice/data outlet is indicated on the plans, adjacent to the BCU. The building control contractor shall be responsible for all Ethernet wiring, routers, or other hardware associated with Ethernet communication within the control system LAN. Control system Ethernet wiring shall not reside in the NC State telecom raceways.
7. A laptop computer shall be provided, including software that is capable of communication with the controls network through the BCU connection.
 1. The laptop shall have all engineering software loaded and operational so that local control sequences can be modified as well as global control and point mapping in the BCU.
 2. The laptop shall be provided with all necessary communication cables and communication adapters to direct connect to local controllers as well as the BCU.
 3. Laptops at a minimum shall be a Windows-compatible laptop with configuration as follows:
 - a) Windows type 17 processor 16 GB RAM 1 MB Cache.
 - b) 1 MB of dedicated video memory graphics.
 - c) Minimum 17" Active matrix, color screen.
 - d) USB port.
 - e) Minimum 80.0 GB hard-disk drive.
 - f) 48x CD/DVDR-RW drive.
 - g) Microsoft Windows 10 Professional Operating System, 64 bit

B. FIELD PANEL STAND-ALONE FUNCTIONALITY

1. General: These requirements clarify the requirement for stand-alone functionality relative to packaging I/O devices with a controller.
2. Functional Boundary: Provide controllers so that all points associated with and common to one unit or other complete system/equipment shall reside within a single control unit. When referring to the controller as pertains to the standalone functionality, reference is specifically made to the processor. One processor shall execute all the related I/O control logic via one operating system that uses a common programming and configuration tool.
3. The following configurations are considered acceptable with reference to a controller's standalone functionality:

- a. Points packaged as integral to the controller such that the point configuration is listed as an essential piece of information for ordering the controller (having a unique ordering number).
- b. Controllers with processors and modular back planes that allow plug in point modules as an integral part of the controller.
- c. I/O point expander boards, plugged directly into the main controller board to expand the point capacity of the controller.
- d. I/O point expansion devices connected to the main controller board via wiring and as such may be remote from the controller and that communicate via a sub LAN protocol. These arrangements to be considered standalone shall have a sub LAN that is dedicated to that controller and include no other controller devices. All wiring to interconnect the I/O expander board shall be:
 - 1) Contained in the control panel enclosure;
 - 2) Or run in conduit. Wiring shall only be accessible at the terminations.

4. Alternate Configuration:

- a) Multiple controllers may be provided to control a single unit or other complete system if the provided Building Automation System manufacturer does not have a single controller (with or without expansion modules) that can be provided to meet the single unit/ system point count.
- b) In this instance, multiple controllers may be provided as long as each controller is still "stand-alone". All points required to execute any subroutine or PID Loop type control shall be contained in a single controller.

B. CONTROLLERS

1. General Requirements for all Controllers:

- a) Controller shall have hardware I/O to support the application. Controller's hardware I/O shall meet the following requirements:
 - i. Digital Outputs (DO): Outputs shall be rated for a minimum 24 VAC or VDC, 1 amp maximum current. Each shall be configurable as normally open or normally closed. Each output shall have an LED to indicate the operating mode of the output and a manual hand off or auto switch to allow for override. Each DO shall be discrete outputs from the controller board (multiplexing to a separate manufacturer's board is unacceptable). Provide suppression to limit transients to acceptable levels.
 - ii. Analog Inputs (AI): AI shall be 0-5 Vdc, 0-10Vdc, 0-20Vdc, and 0-20 mA. Provide signal conditioning, and zero and span calibration for each input. Each input shall be a discrete input to the controller board (multiplexing to a separate manufacturers board is unacceptable unless specifically indicated otherwise). A/D converters shall have a minimum resolution of 8-10 bits depending on application.
 - iii. Digital Inputs (DI): Monitor dry contact closures. Accept pulsed inputs of at least one per second. Source voltage for sensing shall be supplied by the controller and shall be isolated from the main board.
 - iv. Universal Inputs (UI-AI or DI): To serve as either AI or DI as specified above.
 - v. Electronic Analog Outputs (AO) as required by application: voltage mode, 0-5VDC and 0-10VDC; current mode (4-20 mA). Provide zero and span calibration and circuit protection. Where floating control is allowed, transducer/actuator shall be programmable for normally

open, normally closed, or hold last position and shall allow adjustable timing. In addition, use of floating control without any feedback of actual output device position requires the capability to periodically re-zero the output device. Pulse Width Modulated (PWM) analog via a DO and transducer is acceptable only with Owner approval (Generally these will not be allowed on loops with a short time constant such as discharge temperature loops, economizer loops, pressure control loops and the like. They are generally acceptable for standard room temperature control loops.). Where these are allowed, transducer/actuator shall be programmable for normally open, normally closed, or hold last position and shall allow adjustable timing. Each AO shall be discrete outputs from the controller board (multiplexing to a separate manufacturers board is unacceptable). D/A converters shall have a minimum resolution of 8 bits.

- b) Shall be mounted on equipment, in packaged equipment enclosures, or wall mounted in a locking NEMA 1 enclosure, as specified elsewhere.

C. CONTROL PANELS/ENCLOSURES:

1. Control panels shall include power supply, power disconnect, 120V convenience outlet, and UPS where required.
2. Controllers for air handling units, building-wide exhaust systems, and building heating hot water systems shall be provided with uninterruptible power supply. Provide control panels with suitable brackets for wall mounting for each controlled system. Locate panel adjacent to systems served. Mount center of control panels 48"-60" above finish floor.
3. Interior: Fabricate panels of 16-gage steel, totally enclosed on four sides, with removable perforated backplane, hinged door and keyed lock keyed to the NCSU Approved Control Panel Key, with manufacturer's standard shop- painted finish and color.
4. Exterior: NEMA 1 enclosure. Panel shall have hinged door and keyed lock.
5. Entire control cabinet with installed devices shall be third party listed and labeled for use with line voltage components.
6. To address personnel shock hazard concerns: All terminals with a voltage higher than 30 volts must either have shields installed over exposed terminals or be 'finger proof' terminals to prevent inadvertent contact.
7. Control panel shall be completely factory wired and piped, and all electrical connections made to a terminal strip.
8. All gauges and control components shall be identified by means of nameplates.
9. All control tubing and wiring shall be run neatly and orderly in open slot wiring duct with cover.
10. If needed for cable and tubing management provide a 6"x6" metal wiring/tubing trough across the entire width of the panel mounted to the top of the panel with close nipples of sufficient size for additional 50% wiring and tubing capacity. Wiring/tubing troughs shall not be less than 24" in length. Control panel wiring shall be installed and distributed in the trough to minimize routing of wiring and tubing within the control panel.
11. All controllers and panel mounted control devices shall be located in a single enclosure. Additional panels can be used to house the controllers and devices if all devices will not fit in a single, large control panel.
12. Complete 11x17 laminated wiring and tubing termination drawings shall be attached to the interior of each panel of sufficient size to be easily readable.

PART 3 - EXECUTION

A. INSPECTION

1. Examine areas and conditions under which control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

B. DIGITAL CONTROL PANELS AND LOCATION

1. Contractor shall locate BAS panels where indicated on drawings.

C. SURGE PROTECTION

1. The Contractor shall furnish and install any power supply surge protection, filters, etc. as necessary for proper operation and protection of all controllers, operator interfaces, routers, gateways and other hardware and interface devices. All equipment shall be capable of handling voltage variations 10% above or below measured nominal value, with no effect on hardware, software, communications, and data storage.

D. CONTROL POWER SOURCE AND SUPPLY

1. Division 26 contractor shall supply 120V power to BAS panel locations. Controls contractor shall provide step-down transformers and UPS as required. Where required, step-down transformers and UPS shall be installed in enclosures. UPS shall be installed in ventilated enclosures.

E. LABELS AND TAGS

- a) Provide labels for all field devices including sensors, meters, transmitters and relays. Labels shall be plastic laminate and located adjacent to the device.
- b) Labels of field devices (both locally and software ID's) shall be associated with their respective air handler, boiler, chiller, etc.
- c) Junction box covers shall be painted yellow and labeled "DDC"
- d) Devices above ceilings shall be identified with descriptive black letters printed on clear tape affixed to ceiling grid or access door.
- e) Control enclosures shall have engraved labels indicating the function (e.g. AHU-1 CONTROL) or other identifier (e.g. ROOM 1009 ZONE CONTROL).

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PART 1. GENERAL

A. SECTION INCLUDES

1. Wiring
2. Control Valves and Actuators
3. Control Dampers and Actuators
4. Control Panels
5. Sensors
6. Electric Control Components (Switches, EP Valves, Thermostats, Relays, Smoke Detectors, etc.)
7. Transducers
8. Current Switches
9. Nameplates
10. Testing Equipment

B. DESCRIPTION OF WORK

1. Refer to Section 230900 for general requirements.
2. Refer to other Division-23 sections for installation of instrument wells, valve bodies, and dampers in mechanical systems; not work of this section.
3. Provide the following electrical work as work of this section, complying with requirements of Division-26 sections:
 - a) Control wiring between field-installed controls, indicating devices, and unit control panels.
 - b) Interlock wiring between electrically interlocked devices, sensors, and between a hand or auto position of motor starters as indicated for all mechanical and controls.
 - c) Wiring associated with indicating and alarm panels (remote alarm panels) and connections to their associated field devices.
 - d) All other necessary wiring for fully complete and functional control system as specified.

C. WORK BY OTHERS

1. Control Valves furnished under this section shall be installed under the applicable piping section under the direction of Section 230901 Contractor who will be fully responsible for the proper operation of the valve.
2. Control Dampers furnished under this section shall be installed under the applicable air distribution or air handling equipment section under the direction of Section 230901 Contractor who will be fully responsible for the proper operation of the damper
3. Water Pressure Taps, Thermal Wells, Flow Switches, Flow Meters, etc. that will have wet surfaces, shall be installed under the applicable piping Section under the direction of Section 230901 Contractor who will be fully responsible for the proper installation and application.
4. All Power Wiring shall be furnished and installed in accordance with Division 26. Where control involves 120V control devices controlling 120V equipment, Division 23 Contractor shall extend power wiring to the equipment from the equipment disconnect. Section 230901 Contractor shall extend it from the equipment to the control device. Division 26 contractor shall extend 120V power to a junction box in the vicinity of controller enclosures and to motor disconnecting means.
5. Fire alarm contractor will install fire alarm control modules in the vicinity of exhaust fan and AHU controllers.

PART 2. PRODUCTS

A. MATERIALS AND EQUIPMENT

1. General: Provide electronic and electric control products in sizes and capacities indicated, consisting of valves, dampers, controllers, sensors, and other components as required for complete installation. Except as otherwise

indicated, provide manufacturer's standard materials and components as published in their product information; designed and constructed as recommended by manufacturer, and as required for application indicated.

2. DEP Communications: Provide BACnet to Modbus TCP universal gateway to allow transmitting of BAS data to DEP control panel.
3. Instrument Pipe and Tube
 - a) Hydronic and Instruments
 - i. Connection to Main Piping: Provide ½ inch minimum size threadolet, ½" x 2 inch brass nipple, and ½" ball valve for connection to welded steel piping. Provide tee fitting for other types of piping.
 - ii. Remote Instruments: Adapt from ball valve to specified tubing and extend to remote instruments. Provide a union or otherwise removable fitting at ball valve so that connection to main can be cleaned with straight rod. Where manifolds with test ports are not provided for instrument, provide tees with ¼" FPT branch with plug for use as test port. Adapt from tubing size to instrument connection.
 - iii. Line Mounted Instruments: Extend rigid piping from ball valve to instrument. Do not use close or running thread nipples. Adapt from ball valve outlet to instrument connection size. Provide a plugged tee if pipe makes 90 degree bend at outlet of valve to allow cleaning of connection to main with straight rod without removing instrument. Where manifolds with test ports are not provided for instrument, provide tees with ¼" FPT branch with plug for use as test port.
 - iv. Instrument Tubing: Seamless copper tubing, Type K or L, ASTM B 88; with cast-bronze solder joint fittings, ANSI B1.18; or wrought-copper solder-joint fittings, ANSI B16.22; or brass compression-type fittings. Solder shall be 95/5 tin antimony, or other suitable lead free composition solder. Tubing OD size shall be not less than the larger of ¼" or the instrument connection size.
 - v. Rigid Piping for Line Mounted Instruments: Schedule 40 threaded brass, with threaded brass fittings.
 - b) Low Pressure Air Instrument Sensing Lines
 - i. Connections: Use suitable bulkhead type fitting and static sensing tip for static pressure connections. Adapt tubing to instrument connection.
 - ii. Tubing: Virgin polyethylene non-metallic tubing type FR, ASTM D 2737, installed in conduit. Use compression or push-on brass fittings.
4. Communication Wiring: All wiring shall be in accordance with National Electrical Codes and Division 23 of this specification. Communication wiring shall be provided in a customized color jacketing material. Material color shall be as submitted and approved by NCSU. In addition all wiring jackets shall be labeled "BAS" in 3 foot or fewer intervals along the length of the jacket material.
 - a) Contractor shall supply all communication wiring between Controllers, Routers, BPOC(s) and LCS computer.
 - b) Control LAN For any portions of this network required under this section of the specification, contractor shall use Category 5 or better cable as specified in TIA-568B. Media shall be Class 2 plenum rated and installed in accordance with manufacturer's recommendations. Network shall be run with no splices and separate from any wiring over thirty (30) volts.
5. Signal and Output Wiring: Contractor shall run all signal wiring in accordance with National Electric Codes and Division 23 of this Specification.
 - a) Signal wiring to all field devices, including, but not limited to, all sensors, transducers, transmitters, switches, etc. shall be twisted, 100% shielded pair, minimum 18-gauge wire with PVC cover. Signal wiring shall be run with no splices and separate from any wiring above thirty (30) volts.
 - b) Signal wiring shield shall be grounded at controller end only unless otherwise recommended by the controller manufacturer.
 - c) All wiring shall be in conduit. Conduit shall be run parallel or perpendicular to walls and building lines. Junction box covers shall be painted yellow and labeled "DDC".
 - d) Wires shall be labeled with mechanically prepared labels at their connection point to each apparatus point of connection.
 - e) Wiring shall not use the voice/data wire way/conduit systems as pathways.
 - f) Plenum cable shall not be used in lieu of wire installed in conduit.

B. STANDARD SERVICE CONTROL VALVES

1. General: Provide factory fabricated control valves of type, body material and pressure class indicated. Where type or body material is not indicated, provide selection as determined by manufacturer for installation requirements and pressure class, based on maximum pressure and temperature in piping system. Provide valve size in accordance with scheduled or specified maximum pressure drop across control valve. Control valves shall be equipped with heavy-duty actuators, and with proper close-off rating for each individual application. Minimum close-off rating shall be as scheduled and adequate for each application, and shall generally be considered at dead head rating of the pump.
2. Plug-Type Globe Pattern for Water Service:
 - a) Valve Sizing: Where not specifically indicated on the control drawings, modulating valves shall be sized for maximum full flow pressure drop between 50% and 100% of the branch circuit it is controlling unless scheduled otherwise. Two-position valves shall be same size as connecting piping.
 - b) Single Seated (Two-way) Valves: Valves shall have equal-percentage characteristic for typical heat exchanger service and linear characteristic for building loop connections to campus systems unless otherwise scheduled on the drawings. Valves shall have cage-type trim, providing seating and guiding surfaces for plug on 'top-and-bottom' guided plugs.
 - c) Double Seated (Three-way) Valves: Valves shall have linear characteristic. Valves shall be balanced-plug type, with cage-type trim providing seating and guiding surfaces on 'top-and-bottom' guided plugs.
 - d) Temperature Rating: 25°F minimum, 250°F maximum
 - e) Body: Bronze, screwed, 250 psi maximum working pressure for 1/2" to 2"; Cast Iron, flanged, 125 psi maximum working pressure for 2-1/2" and larger.
 - f) Valve Trim: Bronze; Stem: Polished stainless steel.
 - g) Packing: Spring Loaded Teflon or Synthetic Elastomer U-cups, self-adjusting.
 - h) Plug: Brass, bronze or stainless steel, Seat: Brass
 - i) Disc: Replaceable Composition or Stainless Steel Filled PTFE.
 - j) Ambient Operating Temperature Limits: -10 to 150°F (-12.2 to 66 °C)
 - k) Acceptable Manufacturers: Subject to compliance with requirements approved manufacturers are as follows:
 - i. Johnson Controls
 - ii. Schneider Electric-TAC
 - iii. Warren
 - iv. Delta
 - v. Substitutions: *Refer to Specification Section 013300. No substitution requests will be entertained after bidding. Substitution request shall be submitted in writing prior to issuance of final addendum.*
3. Plug-Type Globe Pattern for Steam Service:
 - a) Valve Sizing: Where valve size is not specifically indicated on the drawings, size modulating valves for applications of 15 psig or less for 80% of inlet gage pressure unless scheduled otherwise. Modulating valves for applications of greater than 15 psig shall be sized for 42% of inlet absolute pressure unless scheduled otherwise. Two-position valves shall be same size as connecting piping.
 - b) Characteristics: Modified equal-percentage characteristics. Cage-type trim, providing seating and guiding surfaces for plug on "top and bottom" guided plugs.
 - i. Working Temperature: 250°F minimum for saturated steam applications of 15 psig or less; 366°F minimum for saturated steam applications of greater than 15 psig up to 150 psig.
 - c) Body: Bronze, screwed, 250 psig steam working pressure for 1/2" to 2"; Cast Iron, flanged, 100 psig steam working pressure for 2-1/2" and larger for applications of 50 psig or less.
 - d) Valve Trim, Plug, Seat and Stem: Polished stainless steel.
 - e) Packing: Spring Loaded Teflon.
 - f) Disc: Replaceable Composition or Stainless Steel Filled PTFE.
 - g) Acceptable Manufacturers: Subject to compliance with requirements approved manufacturers are as follows:
 - i. Johnson Controls

- ii. Schneider Electric-TAC
 - iii. Warren
 - iv. Delta
 - v. Substitutions: *Refer to Specification Section 013300. No substitution requests will be entertained after bidding. Substitution request shall be submitted in writing prior to issuance of final addendum.*
4. Butterfly Type: To be used for two-position control only, No Exceptions.
- a) Body: Extended neck epoxy coated cast or ductile iron with full lug pattern, ANSI Class 125 or 250 bolt pattern to match specified flanges.
 - b) Seat: EPDM, except in loop bypass applications where seat shall be metal to metal
 - c) Disc: Bronze or stainless steel, pinned or mechanically locked to shaft
 - d) Bearings: Bronze or stainless steel
 - e) Shaft: 416 stainless steel
 - f) Cold Service Pressure: 175 psi
 - g) Close Off: Bubble-tight shutoff to 150 psi
 - h) Operation: Valve and actuator operation shall be smooth both seating and unseating. Should more than 2 psi deadband be required to seat/unseat the valve, valve shall be replaced at no cost to the Owner.
 - i) Acceptable Manufacturers: Subject to compliance with requirements approved manufacturers are as follows:
 - i. Jamesbury WS815
 - ii. Bray Series 31
 - iii. Invensys
 - iv. Dezurik BGS
 - v. Substitutions: *No substitution requests will be entertained after bidding. Substitution request shall be submitted in writing prior to issuance of final addendum.*
5. Ball Type
- a) Body: Brass or bronze; one-, two-, or three-piece design; threaded ends.
 - b) Seat: Reinforced Teflon
 - c) Ball: Stainless steel.
 - d) Port: 'V' style.
 - e) Stem: Stainless steel, blow-out proof design, extended to match thickness of insulation.
 - f) Cold Service Pressure: 600 psi WOG
 - g) Steam working Pressure: 150 psi
 - h) Acceptable Manufacturers: Subject to compliance with requirements approved manufacturers are as follows:
 - i. Johnson Controls
 - ii. Belimo
 - iii. Conbraco
 - iv. Worcester
 - v. Nibco
 - vi. Jamesbury
 - vii. PBM
 - viii. Invensys
 - ix. Delta
 - x. Approved Equal
6. Pressure Independent Type
- a) Valves shall be pressure independent and shall be used for a water service 2-1/2" and larger unless noted otherwise. The flow through the valve shall not vary more than +/- 5% due to system pressure fluctuations across the valve in the selected operating range. The control valves shall accurately control the flow from 0 to

100% full rated flow. A flow tag, furnished with each valve shall list flows at all the valve positions in 10 degrees rotation increments. A maximum of 5 psi shall be required to operate the valve pressure independently.

- i. Rangeability: The valves shall have a turndown capability of at least 100:1.
 - ii. Body: Bronze, flanged, 125 psi maximum working pressure.
 - iii. Operating Temperature: 250°F.
 - iv. Pressure/Temperature ports (Pete's Plugs): Taps shall be installed at the factory in each valve to measure the pressure drop through the valves to determine the valve flow rate.
 - v. Acceptable Manufacturers: Subject to compliance with requirements. Approved manufacturers are as follows:
 - 1) Delta P Valve by Flow Control Industries, Inc.
 - 2) Belimo.
 - 3) KTM valve by Flow Design.
 - 4) Alternate No. M-04: furnish and install Delta P valve by Flow Control Industries, Inc.
7. Rotary Segmented Ball Type for Steam Pressure Regulating Service:
- a) Characteristics: Modified equal-percentage characteristics with 300:1 rangeability.
 - b) Body: Steel, flanged, 150 psig steam working pressure.
 - c) Ball: Stainless steel segmented ball
 - d) Valve Trim and Stem: Stainless steel.
 - e) Packing: Spring Loaded Teflon.
 - f) Seat: Reinforced Teflon
 - g) Acceptable Manufacturers: Subject to compliance with requirements approved manufacturers are as follows:
 - a) Fisher V150
 - b) Valtek ShearStream
 - c) Neles R-Series

C. AIR VALVES

1. The requirements of this Section shall apply to supply air valves, general exhaust air valves, snorkel exhaust air valves, and fumehood exhaust air valves.
2. Air valves shall be designed for use in laboratory airflow control systems, and shall be provided with factory-mounted electric actuators. Air valves shall be rated for full capacity at 0.6" wg static pressure and leakage in the closed position shall not exceed 1% of the maximum valve rating at 3" wg operating static pressure, when mounted in any position. Air valves shall be pressure independent over the range of 0.6" wg to 3.0" wg.
3. Air valves for supply and general exhaust service shall be minimum 22 gauge galvanized steel or aluminum. Air valves for fumehood, biosafety cabinet, and snorkel exhaust service shall be type 304 stainless steel or 16 gauge aluminum coated with 2 coats of a phenolic coating. Coatings shall be applied after valve assembly. Casing penetrations shall be coated.
4. Discharge sound power levels, in dB re 10^{-12} watts, at 2.0" wg shall not exceed:

Size	Airflow	Octave Band Frequency (Hz)				
		125	250	500	1000	2000
6"	300 cfm 62	65	68	67	62	
10"	900 cfm 71	70	73	71	65	
12"	1500 cfm	76	74	75	71	68
14"	2400 cfm	83	76	72	73	67

5. Individual valves shall not exceed 14" diameter and 2500 cfm, and shall have ANSI standard inlet and outlet flanges. Where larger capacities are required, provide factory assemblies utilizing multiple valves complete with flanged inlet and outlet connections. Multiple valve assemblies shall be sequenced so that only one valve is modulating at a time. Provide individual actuators and positive positioners for each valve in the assembly. Actuators shall be factory-mounted.

6. Valves shall have a minimum 10:1 turndown ratio. Supply valves shall be normally closed and exhaust valves normally open.
7. Manufacturer: Phoenix Controls Accel II, Tek-Air Systems Accuvalve, or TSI Venturi.

D. CONTROL DAMPERS

1. General: Provide factory fabricated automatic control dampers of sizes, velocity and pressure classes as required for smooth, stable, and controllable airflow. Provide parallel or opposed blade dampers as recommended by manufacturers sizing techniques. For dampers located near fan outlets, provide dampers rated for fan outlet velocity and close-off pressure, and recommended by damper manufacturer for fan discharge damper service. Control dampers used for smoke dampers shall comply with UL 555S. Control Dampers used for fire dampers shall comply with UL 555.
2. Where installed in stainless steel ducts, damper frames and blades shall also be stainless steel but will otherwise meet the performance requirements below.
3. For general isolation and modulating control service in rectangular ducts at velocities not greater than 1500 fpm (7.62 m/s), differential pressure not greater than 2.5" w.c. (622 Pa):
 - a) Performance: Test in accordance with AMCA 500.
 - b) Frames: Galvanized steel, 16-gauge minimum thickness, welded or riveted with corner reinforcement.
 - c) Blades: Stainless steel in lab exhausts or where noted and galvanized steel elsewhere, maximum blade size 8 inches (200 mm) wide by 48 inches (1219 mm) long, attached to minimum 1/2 inch (12.7 mm) shafts with set screws, 16 gauge minimum thickness.
 - d) Blade Seals: Synthetic elastomer, mechanically attached, field replaceable.
 - e) Jamb Seals: Stainless steel.
 - f) Shaft Bearings: Oil impregnated sintered bronze, graphite impregnated nylon sleeve or other molded synthetic sleeve, with thrust washers at bearings.
 - g) Linkage: Concealed in frame.
 - h) Linkage Bearings: Oil impregnated sintered bronze or graphite impregnated nylon.
 - i) Leakage: Less than one percent based on approach velocity of 1500 ft./min. (7.62 m/s) and 1 inches wg. (249Pa).
 - j) Maximum Pressure Differential: 2.5 inches wg. (622 Pa)
 - k) Temperature Limits: -40 to 200 °F (-40 to 93 °C).
 - l) Where opening size is larger than 48 inches (1219 mm) wide, or 72 inches (1829 mm) high, provide dampers in multiple sections, with intermediate frames and jackshafts appropriate for installation.
4. For general isolation and modulating control service in rectangular ducts at velocities not greater than 4000 fpm (20.3 m/s), differential pressure not greater than 6" w.c. (1493 Pa):
 - a) Performance: Test in accordance with AMCA 500.
 - b) Frames: Galvanized steel, 16-gauge minimum thickness, welded or riveted with corner reinforcement.
 - c) Blades: extruded aluminum hollow airfoil shape, maximum blade size 8 inches (200 mm) wide by 48 inches (1219 mm) long, attached to minimum 1/2 inch (12.7 mm) shafts, 14 gauge minimum extrusion thickness.
 - d) Blade Seals: Synthetic elastomeric, mechanically attached, field replaceable.
 - e) Jamb Seals: Stainless steel.
 - f) Shaft Bearings: Oil impregnated sintered bronze sleeve, graphite impregnated nylon sleeve, molded synthetic sleeve, or stainless steel sleeve, with thrust washers at bearings.
 - g) Linkage: Concealed in frame.
 - h) Linkage Bearings: Oil impregnated sintered bronze or graphite impregnated nylon.
 - i) Leakage: Less than 0.1 percent based on approach velocity of 4000 ft./min. (20.3 m/s) and 1 inches wg. (249Pa).
 - j) Maximum Pressure Differential: 6 inches wg. (622 Pa)
 - k) Temperature Limits: -40 to 200 °F (-40 to 93 °C).

- l) Where opening size is larger than 48 inches (1219 mm) wide, or 72 inches (1829 mm) high, provide dampers in multiple sections, with appropriately intermediate frames, and jackshafts.
5. For general isolation and modulating control service in rectangular ducts at velocities not greater than 4000 fpm, differential pressure not greater than 12" w.c.:
 - a) Performance: Test in accordance with AMCA 500.
 - b) Frames: Galvanized steel, 12-gauge minimum thickness, welded or riveted with corner reinforcement.
 - c) Blades: Extruded aluminum hollow airfoil shape, maximum blade size 8 inches (200 mm) wide by 48 inches (1219 mm) long, attached to minimum 3/4 inch (19 mm) shafts with set screws
 - d) Shaft Bearings: Oil impregnated sintered bronze or stainless steel, pressed into frame, with thrust washers at bearings.
 - e) Linkage: 10-gauge minimum thickness galvanized steel clevis type crank arms, 3/16" x 3/4" (4.76 mm x 19 mm) minimum thickness tie rods.
 - f) Linkage Bearings: Oil impregnated sintered bronze or graphite impregnated nylon.
 - g) Leakage: Less than 0.2 percent based on approach velocity of 4000 ft./min. (20.3 m/s) and 1 inches wg. (249Pa) differential pressure.
 - h) Maximum Pressure Differential: 12 inches wg. (2984 Pa)
 - i) Temperature Limits: -40 to 300 °F (-40 to 149 °C).
 - j) Where opening size is larger than 48 inches (1219 mm) wide, or 72 inches (1829 mm) high, provide dampers in multiple sections, with appropriately intermediate frames, and jackshafts.
6. For general isolation and modulating control service in round ducts up to 40 inches in size at velocities not greater than 2500 fpm (12.7 m/s), differential pressure not greater than 4" w.c. (994 Pa):
 - a) Performance: Test in accordance with AMCA 500.
 - b) Frames: rolled 12 gauge steel strip for sizes 6 inch and smaller, rolled 14 gauge steel channel for larger sizes, galvanized or aluminum finish.
 - c) Blades: Steel construction, 12 gauge minimum thickness for dampers less than 18 inches (457 mm) in size, 10 gauge minimum thickness for larger dampers.
 - d) Blade Seals: Full circumference neoprene.
 - e) Shaft: 1/2 inch (12.7 mm) diameter zinc or cadmium plated steel.
 - f) Shaft Bearings: Oil impregnated sintered bronze or stainless steel, pressed into frame, with thrust washers at bearings.
 - g) Leakage: Less than 0.2 percent based on approach velocity of 4000 ft./min. (20.3 m/s) and 1 inches wg. (249Pa) differential pressure.
 - h) Maximum Pressure Differential: 4 inches wg. (994 Pa)
 - i) Temperature Limits: -40 to 300 °F (-40 to 149 °C).

E. ACTUATORS

1. General: Size actuators and linkages to operate their appropriate dampers or valves with sufficient reserve torque or force to provide smooth modulating action or 2-position action as specified. Select spring-return actuators with manual override to provide positive shut-off of devices as they are applied.
2. Actuators
 - a) All actuators requiring greater than 150 inch/pounds of torque shall be provided as pneumatic actuators as defined below.
 - b) Ambient Operating Temperature Limits: -10 to 150°F (-12.2 to 66 °C)
 - c) Two Position Electric Actuators: Line voltage (120 volt, 24 volt) with spring return. Provide end switches as required.
 - d) Pneumatic Actuators: Provide heavy-duty actuators with stroke indication and spring return. Actuator shall consist of steel or aluminum cylinder and pistons. Housing shall be protected both internally and externally

with corrosion resistant coating. Provide position feedback positive positioners with adjustable start point and operating range. Positive Positioners shall be provided on all pneumatic valves larger than 1”.

- e) Electronic Actuators: Provide actuators with spring return for two-position (24v), 0-5 Vdc, 0-10 Vdc, 2-10Vdc, 4-20 mA, or network connection as required. Actuators shall travel full stroke in less than 90 seconds (VAV terminal box actuators may be up to 300 second full stroke time). Actuators shall be designed for a minimum of 60,000 full cycles at full torque and be UL 873 listed. Provide stroke indicator. Actuators shall have positive positioning circuit. When two non-networked actuators are required to operate in parallel, or in sequence, provide an auxiliary actuator driver. Actuators shall have current limiting motor protection. Actuators shall have manual override. Modulating actuators for valves shall have minimum rangeability of 40 to 1.
 - i. Close-Off Pressure: Provide the minimum torque required, and spring return for fail positioning (unless otherwise specifically indicated) sized for required close-off pressure. Required close-off pressure for two-way water valve applications shall be the shutoff head of associated pump. Required close-off rating of steam valve applications shall be design inlet steam pressure plus 50 percent for low pressure steam, and 10 percent for high pressure steam. Required close-off rating of air damper applications shall be shutoff pressure of associated fan, plus 10 percent.
 - ii. Acceptable Manufacturers: Subject to compliance with requirements approved manufacturers are as follows:
 - 1) Siemens
 - 2) Schneider Electric-TAC DuraDrive
 - 3) Belimo
 - 4) Johnson Controls
 - 5) Delta
 - 6) Substitutions: Refer to Specification Section 013300. No substitution requests will be entertained after bidding. Substitution request shall be submitted in writing prior to issuance of final addendum.

3. Quarter-Turn Actuators (for ball valves):

- a) Electric
 - i. Motor: Suitable for 24, 120 or 240 Volt single-phase power supply. Insulation shall be NEMA Class F or better. Motor shall be rated for 100 percent duty cycle. Motors shall have inherent overload protection.
 - ii. Gear Train: Motor output shall be directed to a self locking gear drive mechanism. Gears shall be rated for torque input exceeding motor locked rotor torque.
 - iii. Wiring: Power and control wiring shall be wired to a terminal strip in the actuator enclosure
 - iv. Failsafe Positioning: Actuators shall be spring return type for failsafe positioning. For terminal zone reheat valves the actuators can fail in the last position. *Vivarium area actuators shall always fail to last position.* Special research areas may have other requirements.
 - v. Enclosure: Exterior actuator enclosure shall be a NEMA-4 epoxy coated metal enclosure, and shall have a minimum of two threaded conduit entries.
 - vi. Limit Switches: Travel limit switches shall be UL and NCSU approved. Switches shall limit actuator in both open and closed positions.
 - vii. Mechanical Travel Stops: The actuator shall include mechanical travel stops of stainless steel construction to limit actuator to specific degrees of rotation.
 - viii. Manual Override: Actuators shall have manual actuator override to allow operation of the valve when power is off. For valves 4 inches and smaller the override may be a removable wrench or lever or geared handwheel type. For larger than 4” valves, the override shall be a fixed geared handwheel type. An automatic power cut-off switch shall be provided to disconnect power from the motor when the handwheel is engaged for manual operation.
 - ix. Valve Position Indicator: A valve position indicator with arrow and open and closed position marks shall be provided to indicate valve position.
 - x. Torque Limit Switches: Provide torque limit switches to interrupt motor power when torque limit is exceeded in either direction of rotation.

- xi. Position Controller: For valves used for modulating control, provide an electronic positioner capable of accepting 4-20 mA, 0-10 Vdc, 2-10 Vdc, and 135 Ohm potentiometer.
- xii. Ambient Conditions: Actuator shall be designed for operation from -140 to 150 °F ambient with 0 to 100 percent relative humidity.

F. GENERAL FIELD DEVICES

1. Provide field devices for input and output of digital (binary) and analog signals into controllers. Provide signal conditioning for all field devices as recommended by field device manufacturers, and as required for proper operation in the system.
2. Smart sensors or smart actuators shall meet all controller requirements in addition to the relevant sensor or actuator requirements.
3. It shall be the Contractor's responsibility to assure that all field devices are compatible with controller hardware and software.
4. Field devices specified herein are generally 'two-wire' type transmitters, with power for the device to be supplied from the respective controller. If the controller provided is not equipped to provide this power, or is not designed to work with 'two-wire' type transmitters, or if field device is to serve as input to more than one controller, or where the length of wire to the controller will unacceptably affect the accuracy, the Contractor shall provide 'four-wire' type equal transmitter and necessary regulated DC power supply or 120 VAC power supply, as required.
5. For field devices specified hereinafter that require signal conditioners, signal boosters, signal repeaters, or other devices for proper interface to controllers, Contractor shall furnish and install proper device, including 120V power as required. Such devices shall have accuracy equal to, or better than, the accuracy listed for respective field devices.
6. Accuracy: As stated in this Section, accuracy shall include combined effects of nonlinearity, non-repeatability and hysteresis.

G. TEMPERATURE SENSORS (TS)

1. Sensor range: When matched with A/D converter of controller, sensor range shall provide a resolution of no worse than 0.3°F (0.16 °C) (unless noted otherwise). Where thermistors are used, the stability shall be better than 0.25°F over 5 years.
2. Matched Sensors: The following applications shall require matched sensors:
 - a) Hydronic Temperature Difference Calculations: Provide matched supply and return temperature sensors where the pair is used for calculating temperature difference for use in load calculations or sequencing such as across chillers and plants. Sensing element shall be platinum RTD guaranteeing an accuracy of +/- 0.5% of span plus 0.1°C
 - b) Air Handling Unit Sequencing: Provide matched pair for the cooling and heating coil leaving sensors where the sequence includes calculating an offset from the supply air setpoint to maintain a leaving heating coil temperature. Sensing element shall be platinum RTD guaranteeing an accuracy of +/- 0.5% of span plus 0.1°C
3. Room Temperature Sensor: Shall be an element contained within a ventilated cover, suitable for wall mounting. Provide insulated base. Following sensing elements are acceptable:
 - a) Sensing element shall be platinum RTD, thermistor, or integrated circuit, +/- 1.0°F accuracy at calibration point.
 - b) Provide setpoint adjustment with initial normal setpoint 73°F and adjustable range of +/- 1°F. The setpoint adjustment shall be a warmer/cooler indication that shall be scalable via the BAS. Provide an occupancy override button on the room sensor enclosure. This shall be a momentary contact closure
 - c) Provide current temperature indication via an LCD or LED readout.
4. Critical Room Temperature Sensor: Shall be an element contained within a ventilated cover, suitable for wall mounting. Provide insulated base. Following sensing elements are acceptable:
 - a) Sensing element shall be platinum RTD, ±0.1 °C measured at 0 °C.
 - b) Provide setpoint adjustment with initial normal setpoint 73°F and adjustable range of +/- 1°F. The setpoint adjustment shall be a warmer/cooler indication that shall be scalable via the BAS.
 - c) Provide an occupancy override button on the room sensor enclosure. This shall be a momentary contact closure

- d) Provide current temperature indication via an LCD or LED readout.
- e) Vivarium sensors. While most Vivarium controlling sensors are located in exhaust ducts, if they are wall mounted in any animal housing, procedure, cagewash, surgery, and autoclave rooms they shall be critical type. Wall-mount locations are generally limited to isolation cubicles, cagewash areas, surgery, and autoclave rooms.
- f) Wet Location Vivarium Sensor: Shall consist of a sensor, utility box, and watertight gasket to prevent water seepage. Wet locations include cagewash areas and autoclave areas. Wet location sensors shall also be installed in large animal holding rooms where the controlling sensor is not located in the exhaust duct).
 - i. Sensing element shall be platinum RTD, thermistor, or integrated circuit, sensor range shall provide a resolution of no worse than ± 0.1 °C measured at 10 °C.
- 5. Single-Point Duct Temperature Sensor: Shall consist of sensing element, junction box for wiring connections and gasket to prevent air leakage or vibration noise. Temperature range as required for resolution indicated in paragraph A. Sensor probe shall be 316 or 304 stainless steel.
 - a) Sensing element shall be platinum RTD, thermistor, or integrated circuit, ± 0.3 °F accuracy at calibration point
- 6. Critical Single-Point Duct Temperature Sensor: Shall consist of sensing element, junction box for wiring connections and gasket to prevent air leakage or vibration noise. Temperature range as required for resolution indicated in paragraph A. Sensor probe shall be 316 stainless steel.
 - a) Sensing element shall be platinum RTD, ± 0.1 °C measured at 0 °C.
 - b) Duct sensors used to control room temperature in any area within the secure area of the vivarium shall be critical sensors.
- 7. Averaging Duct Temperature Sensor: Shall consist of an averaging element, junction box for wiring connections and gasket to prevent air leakage. Provide sensor lengths and quantities to result in one lineal foot of sensing element for each three square feet of cooling coil/duct face area. Temperature range as required for resolution indicated in paragraph A.
 - a) Sensing element shall be platinum RTD, or thermistor, ± 0.3 °F accuracy at calibration point.
- 8. Liquid Immersion Temperature Sensor shall include brass thermowell, sensor and connection head for wiring connections. Temperature range shall be as required for resolution of 0.15°F.
 - a) Sensing element (chilled water/glycol systems) shall be thermistor or platinum RTD ± 0.3 °C measured at 0 °C.
 - b) Heat transfer putty shall be installed in all sensor wells.
- 9. Pipe Surface-Mount Temperature Sensor: Shall include metal junction box and clamps and shall be suitable for sensing pipe surface temperature and installation under insulation. Provide thermally conductive paste at pipe contact point. Temperature range shall be as required for resolution indicated in paragraph A.
 - a) Sensing element shall be platinum RTD, thermistor, or integrated circuit, ± 0.4 °F accuracy at calibration point.
- 10. Outside Air Sensor: Shall consist of a sensor, sun shield, utility box, and watertight gasket to prevent water seepage. Temperature range shall be as required for resolution indicated in Paragraph A
 - a) Sensing element shall be platinum RTD, thermistor, or integrated circuit, sensor range shall provide a resolution of no worse than ± 0.1 °C measured at 10 °C.

H. HUMIDITY TRANSMITTERS

- 1. Units shall be suitable for duct, wall (room) or outdoor mounting. Unit shall be two-wire transmitter utilizing bulk polymer resistance change or thin film capacitance change humidity sensor. Unit shall produce linear continuous output of 4-20 mA for percent relative humidity (% RH). A combination temperature and humidity sensor may be used for zone level monitoring. Sensors shall have the following minimum performance and application criteria:
 - a) Input Range: 0 to 100% RH.
 - b) Accuracy(% RH): $\pm 2\%$ (when used for outside air, enthalpy calculation, dewpoint calculation or humidifier control) or $\pm 3\%$ (monitoring only) between 20-90% RH at 77°F, including hysteresis, linearity, and repeatability.
 - c) Sensor Operating Range: As required by application

- d) Long Term Stability: Less than 1% drift per year.
- 2. Acceptable Manufacturers: Units shall be Vaisala HM Series, Hy-Cal HT Series or approved equal

I. DIFFERENTIAL PRESSURE TRANSMITTERS (DP)

1. General – For all hydronic Differential Pressure Transmitters, provide a 5 valve bypass assembly for connection between the DP transmitter and the piping system being monitored. The purpose of the connect is to allow air to be efficiently bled from the branch piping and also to allow for easy calibration of the DP transmitter via parallel connection of a test instrument at the “bleed” lines.
2. Water General Purpose:
 - a) General: Two wire transmitter, 4-20 mA or 0-5 volt for runs less than 100’ output with zero and span adjustments.
 - b) Ambient Limits: -40 to 175 °F (-40 to 121°C), 0 to 100% RH.
 - c) Process limits: -40 to 250 °F
 - d) Accuracy: 0.5% overall accuracy,
 - e) Maximum Pressure Rating: 450 psig (3103 KPa) maximum static pressure rating, 200 psid maximum overpressure rating for 6 through 60 psid range, 450 psid for 100 through 300 psid range.
 - f) Kele & Associates Model 360 C, Approved Equal.
3. Water Critical Service:
 - a) General: Two-wire smart DP cell type transmitter, 4-20 mA or 0-5 Vdc user-selectable linear or square root output, adjustable span and zero, stainless steel wetted parts.
 - b) Ambient Limits: -40 to 175 °F (-40 to 121°C), 0 to 100% RH.
 - c) Process limits: -40 to 400 °F (-40 to 205°C).
 - d) Accuracy: less than 0.1%
 - e) Output Damping: Time constant user selectable from 0 to 36 seconds
 - f) Vibration Effect: Less than 0.1% of upper range limit from 15 to 2000 Hz in any axis relative to pipe mounted process conditions.
 - g) Electrical Enclosure: NEMA-4, -4X, -7, -9.
 - h) Approvals: FM, CSA.
 - i) Acceptable Manufacturers: Rosemount Inc. 3051 Series, Foxboro, Johnson-Yokagawa. Substitutions shall be allowed per Division 1.
4. General Purpose Low Pressure Air: Generally for each measurement of duct pressure, filter differential pressure or constant volume air velocity pressure measurement where the range is applicable.
 - a) General: Loop powered two-wire differential capacitance cell-type transmitter.
 - b) Output: two wire 4-20 mA or 0-5 volt for runs less than 100’ output with zero adjustment.
 - c) Overall Accuracy: Plus or minus 1%.
 - d) Minimum Range: 0.1 in. w.c.
 - e) Maximum Range: 10 inches w.c.
 - f) Housing: Polymer housing suitable for surface mounting.
 - g) Acceptable Manufacturers: Units shall be Modus T30, Veris PX Series, or Dwyer Series 616. Substitutions shall be allowed per Division 1.
 - h) Static Sensing Element: Pitot-type static pressure sensing tips similar to Dwyer model A-301 and connecting tubing.
 - i) Range: Select for specified setpoint to be between 25% and 75% full-scale.
5. General Purpose Low Pressure/Low Differential Air: Generally for use in static measurement of space pressure or constant volume air velocity pressure measurement where the range is applicable.
 - a) General: Loop powered, two-wire differential capacitance cell type transmitter.
 - b) Output: Two-wire 4-20 mA or 0-5 volt for runs less than 100’ output with zero adjustment.

- c) Overall Accuracy: Plus or minus 1%.
 - d) Minimum Repeatability: $\pm .25\%$ of reading
 - e) Maximum Range: 0.1, 0.25, or 0.5 inches w.c.
 - f) Housing: Polymer housing suitable for surface mounting.
 - g) Acceptable Manufacturers: Modus T30. Substitutions shall be allowed per Division 1.
 - h) Static Sensing Element: Pitot-type static pressure sensing tips similar to Dwyer model A-301 and connecting tubing.
 - i) Range: Select for specified setpoint to be between 25% and 75% full-scale.
6. VAV Velocity Pressure: Generally for use in variable volume air velocity pressure measurement where the range is applicable.
- a) General: Loop powered two-wire differential capacitance cell type transmitter.
 - b) Output: Two-wire, 4-20 mA output with zero adjustment.
 - c) Overall Accuracy: Plus or minus 0.25%
 - d) Minimum Range: 0 in. w.c.
 - e) Maximum Range: 1 inch w.c.
 - f) Housing: Polymer housing suitable for surface mounting.
 - g) Acceptable Manufacturers: Setra or Approved Equal. Substitutions shall be allowed per Division 1.
 - h) Range: Select for minimum range that will accept the maximum velocity pressure expected.

J. AIRFLOW MEASURING STATIONS (AFMS)

1. Air Flow Traverse Probes – Minimum duct air velocity greater than 400 fpm: Furnish where indicated on the drawings, vortex shedding multi-sensor insertion type, air flow traverse probes. The probes, and placement of the probes, shall provide measurement accuracy within $\pm 2\%$ of actual velocity. Probes shall be aluminum or (where located in a corrosive environment) 304 stainless steel or CPVC. Probes over 18" long shall be provided with an end mounting rod for support. The probe assemblies shall not have a pressure drop greater than 10% of the velocity pressure at the maximum design flow. The probes shall not amplify sound levels in the duct. The vortex-shedding transmitter shall provide a direct proportional and linear signal of airflow volume. Contractor to provide with a straight section of duct meeting upstream and downstream requirements using air flow straighteners as needed and will verify transmitter signal range
 - a) Sensor Accuracy: $\pm 2.0\%$
 - b) Interchangeability: $\pm 0.5\%$
 - c) Velocity Range: 350-7000 fpm (*Designer to verify required range.*)
 - d) Temperature Limits: -20°F to 200°F for SS, -20°F to 140°F for Aluminum
 - e) Material: Aluminum or 304 stainless steel or CPVC (as indicated above).
 - f) Enclosure for Electronics: NEMA 1
 - g) Operating Range: Select minimum range to accommodate the expected flow range of the equipment
 - h) Manufacturer: Tek-Air Systems Inc. 'Vortek' Series VT5000 for large ducts (>4 sq. ft.) or for smaller ducts VT2000.
2. Air Flow Traverse Probes – Minimum duct air velocity less than 400 fpm (especially for Outside Air measurement): Provide either of the following;
 - a) Ebtron Gold Series GTC116-P+. The Air Flow Measurement Station (AFMS) shall use the principle of thermal dispersion with one self-heated and one-zero power bead-in-glass thermistor at each sensing node. Only the thermistor shall be located within the sensing node, all other electronic components shall be outside the airstream
 - i. Sensor Accuracy: $\pm 3\%$ of reading when installed in accordance with the manufacturer's recommended sensor density and placement guidelines.
 - ii. Velocity Range: 0-5000 fpm (*Designer to verify required range.*)
 - iii. Locate and install AFMS per manufacturer's recommendations.

- b) Tek-Air IAQ-TEK Series IAQ series. The number of Tamer Probes required shall be based upon the size and aspect ratio of the duct or other housing at the Probe location. Contractor to provide straight section meeting upstream and downstream requirements using air flow straighteners as needed and will verify transducer range
 - i. Sensor Accuracy: 200-1000 fpm is $\pm 5.0\%$, 75-200 fpm is $\pm 10\%$
 - ii. Velocity Range: 75-1000 fpm (Designer to verify required range.)
 - iii. Temperature Limits: -20°F to 200°F
 - iv. Probe Material: PVC/ABS plastic.
 - v. Enclosure for Electronics: NEMA 4X
 - vi. Operating Range: Select minimum range to accommodate the expected flow range of the equipment.
 - vii. Manufacturer: Tek-Air Systems Inc. 'IAQ-Tek' Series IAQ2000.

K. VALVE BYPASS FOR DIFFERENTIAL PRESSURE SENSORS

1. Provide a five valve bypass kit for protection of DP sensors. Kit shall include high and low pressure isolation valves, high and low pressure vent valves, calibration taps, and a bypass valve.

L. DIFFERENTIAL PRESSURE SWITCHES (DPS)

1. General Service Auto Reset - Air: Diaphragm with adjustable setpoint and differential and snap acting form C contacts rated for the application. Provide manufacturer's recommended static pressure sensing tips and connecting tubing. Acceptable Manufacturer - Dwyer Series 1900 or equal.
2. General Service Manual Reset - Air: Diaphragm with adjustable setpoint and differential and snap acting form C contacts rated for the application. Provide manufacturer's recommended static pressure sensing tips and connecting tubing. Acceptable Manufacturer - Dwyer Series 1900 or equal.
3. General Service - Water: Diaphragm with adjustable setpoint, 2 psig or adjustable differential and snap-acting Form C contacts rated for the application. 60 psid minimum pressure differential range and 0°F to 160°F operating temperature range.

M. PRESSURE SWITCHES (PS)

1. Diaphragm or bourdon tube with adjustable setpoint and differential and snap-acting Form C contacts rated for the application. Pressure switches shall be capable of withstanding 150% of rated pressure.
2. Acceptable Manufacturers: Square D, ITT Neo-Dyn, ASCO, Penn, Honeywell, and Johnson Controls. Substitutions shall be allowed per Division 1.

N. CURRENT SWITCHES (CS)

1. Clamp-On or Solid-Core Design Current Operated Switch (for Constant Speed Motor Status Indication)
 - a) Range: 1.5 to 150 amps.
 - b) Trip Point: Adjustable.
 - c) Switch: Solid state, normally open, 1 to 135 Vac or Vdc, 0.3 Amps. Zero off state leakage.
 - d) Lower Frequency Limit: 6 Hz.
 - e) Trip Indication: LED
 - f) Approvals: UL, CSA
 - g) Max. Cable Size: 350 MCM
 - h) Acceptable Manufacturers: Veris Industries H-708/908; Inc., RE Technologies SCS1150A-LED, or approved equal.
2. Clamp-on or Solid-Core Wire Through Current Switch (CS/CR) (for Constant Speed Motors): Same as CS with 24v command relay rated at 5A @ 240 Vac resistive, 3A @ 240 Vac inductive, load control contact power shall be induced from monitored conductor (minimum conductor current required to energize relay 5A, max. rating of 135A). Acceptable Manufacturers shall be Veris Industries, Inc., Model # H938/735; RE Technologies RCS 1150 or approved equal.

- a) Where used for single-phase devices, provide the CS/CR in a self-contained unit in a housing similar with override switch to Kele RIBX. Substitutions shall be allowed per Division 1.
- 3. Clamp-On Design Current Operated Switch for Variable Speed Motor Status Indication
 - a) Range: 1.5 to 135 Amps.
 - b) Trip Point: Self-calibrating based on VA memory associated with frequency to detect loss of belt with subsequent increase of control output to 60 Hz.
 - c) Switch: Solid state, normally open, 1 to 135 Vac or Vdc, 0.3 Amps. Zero off state leakage.
 - d) Frequency Range: 5-75 Hz
 - e) Trip Indication: LED
 - f) Approvals: UL, CSA
 - g) Max. Cable Size: 350 MCM
 - h) Acceptable Manufacturers: Veris Industries, Inc. H-904, or approved equal.
- 4. Clamp-On Wire Through Current Switch (CS/CR) (for Variable Speed Motors): Same as CS with 24v command relay rated at 5A @ 240 Vac resistive, 3A @ 240 Vac inductive, load control contact power shall be induced from monitored conductor (minimum conductor current required to energize relay 5A, max. rating of 135A). Acceptable manufacturer shall be Veris Industries, Inc., Model # H934. Substitutions shall be allowed per Division 1.
- 5. Variable Speed Status: Where current switches are used to sense the status for variable speed devices, the CT shall include on-board VA/Hz memory to allow distinction between a belt break and subsequent ramp up to 60 Hz, versus operation at low speed. The belt break scenario shall be indicated as a loss of status and the operation at low speed shall indicate normal status.

O. CURRENT TRANSFORMERS (CT)

- 1. Clamp-On Design Current Transformer (for Motor Current Sensing)
 - a) Range: 1-10 amps minimum, 20-200 amps maximum
 - b) Trip Point: Adjustable
 - c) Output: 0-5 VDC.
 - d) Accuracy: $\pm 0.2\%$ from 20 to 100 Hz.
 - e) Acceptable Manufacturers: Veris H221, KELE SA100 or approved equal.

P. ELECTRIC CONTROL COMPONENTS

- 1. Limit Switches (LS): Limit switches shall be UL listed, SPDT or DPDT type, with adjustable trim arm. Limit switches shall be as manufactured by Square D, Allen Bradley. Substitutions shall be allowed per Division 1.
- 2. Electric Solenoid-Operated Pneumatic Valves (EP): EP valves shall be rated for a minimum of 1.5 times their maximum operating static and differential pressure. Valves shall be ported 2-way, 3-way, or 4-way and shall be normally closed or open as required by the application. EPs shall be sized for minimum pressure drop, and shall be UL and CSA listed. Furnish and install gauges on all inputs of EPs. Furnish an adjustable air pressure regulator on input side of solenoid valves serving actuators operating at greater than 30 psig.
 - a) Coil Enclosure: Indoors shall be NEMA-1, Outdoors and NEMA-3, 4, 7, 9.
 - b) Fluid Temperature Rating: Valves for compressed air and cold water service shall have 150 $^{\circ}$ F (66 $^{\circ}$ C) minimum rating. Valves for hot water or steam service shall have fluid temperature rating higher than the maximum expected fluid temperature.
 - c) Acceptable Manufacturers: EP valves shall be as manufactured by ASCO or Parker. Substitutions shall be allowed per Division 1.
 - d) Coil Rating: EP valves shall have appropriate voltage coil rated for the application (i.e., 24 VAC, 120 VAC, 24 VDC, etc.).
- 3. Low Temperature Detector ('Freezestat') (FZ): Low temperature detector shall consist of a 'cold spot' element which responds only to the lowest temperature along any one foot of entire element, minimum bulb size of 1/8" x 20' (3.2mm x 6.1m), junction box for wiring connections and gasket to prevent air leakage or vibration noise, DPDT (4 wire, 2 circuit) with manual reset. Temperature range 15 to 55 $^{\circ}$ F (-9.4 to 12.8 $^{\circ}$ C), factory set at 38 $^{\circ}$ F.

4. High Temperature Detectors ('Firestat') (FS): High temperature detector shall consist of 3-pole contacts, a single point sensor, junction box for wiring connections and gasket to prevent air leakage of vibration noise, triple-pole, with manual reset. Temperature range 25 to 215°F (-4 to 102°C).
5. Surface-Mounted Thermostat: Surface-mounted thermostat shall consist of SPDT contacts, operating temperature range of 50 to 150°F (10 to 65°C), and a minimum 10°F fixed setpoint differential.
6. Low Voltage Wall Thermostat: Wall-mounted thermostat shall consist of SPDT sealed contacts, operating temperature range of 50 to 90°F (10 to 32°C), switch rating of 24 Vac (30 Vac max.), and both manual and automatic fan operation in both the heat and cool modes.
7. Control Relays: All control relays shall be UL listed, with contacts rated for the application, and mounted in minimum NEMA-1 enclosure for indoor locations, NEMA-4 for outdoor locations.
 - a) Control relays for use on electrical systems of 120 volts or less shall have, as a minimum, the following:
 - i. AC coil pull-in voltage range of +10%, -15% or nominal voltage.
 - ii. Coil sealed volt-amperes (VA) not greater than four (4) VA.
 - iii. Silver cadmium Form C (SPDT) contacts in a dustproof enclosure, with 8 or 11 pin type plug.
 - iv. Pilot light indication of power-to-coil and coil retainer clips.
 - v. Coil rated for 50 and 60 Hz service.
 - vi. Acceptable Manufacturers: Relays shall be Potter Brumfield, Model KRPA or approved Equal.
 - b) Relays used for across-the-line control (start/stop) of 120V motors, 1/4 HP, and 1/3 HP, shall be rated to break minimum 10 Amps inductive load. Relays shall be IDEC. Substitutions shall be allowed per Division 1.
 - c) Relays used for stop/start control shall have low voltage coils (30 VAC or less), and shall be provided with transient and surge suppression devices at the controller interface.
 - d) All safety circuits shall be installed to operate individual interposing relays located in the associated equipment control panel. Each safety device (i.e. Freezestat, DP safety, smoke detector, firestat, etc.) wiring circuit shall be installed with individual homeruns back to the associated control panel. See control drawings for details.
8. General Purpose Power Contactors: NEMA ICS 2, AC general-purpose magnetic contactor. ANSI/NEMA ICS 6, NEMA type 1 enclosure. Manufacturer shall be Square 'D', Cutler-Hammer or Westinghouse. Substitutions shall be allowed per Division 1.
9. Control Transformers: Furnish and install control transformers as required. Control transformers shall be machine tool type, and shall be US and CSA listed. Primary and secondary sides shall have replaceable fuses in accordance with the NEC. Transformer shall be proper size for application, and mounted in minimum NEMA-1 enclosure. Transformers shall be sized so that the connected load does not exceed more than 75% of the manufacturer's stated rating.
 - a) Transformers shall be manufactured by Westinghouse, Square 'D', or Jefferson. Substitutions shall be allowed per Division 1.
10. Time Delay Relays (TDR): TDRs shall be capable of on or off delayed functions, with adjustable timing periods, and cycle timing light. Contacts shall be rated for the application with a minimum of two (2) sets of Form C contacts, enclosed in a dustproof enclosure.
 - a) TDRs shall have silver cadmium contacts with a minimum life span rating of one million operations. TDRs shall have solid state, plug-in type coils with transient suppression devices.
 - b) TDRs shall be UL and CSA listed, Crouzet type. Substitutions shall be allowed per Division 1.
11. Electric Push Button Switch: Switch shall be momentary contact, oil tight, push button, with number of N.O. and/or N.C. contacts as required. Contacts shall be snap-action type, and rated for minimum 120 Vac operation. Switch shall be 800T type, as manufactured by Allen Bradley. Substitutions shall be allowed per Division 1.
12. Pilot Light: Panel-mounted pilot light shall be NEMA ICS 2 oil tight, transformer type, with screw terminals, push-to-test unit, LED type, rated for 120 VAC. Unit shall be 800T type, as manufactured by Allen-Bradley. Substitutions shall be allowed per Division 1.
13. Alarm Horn: Panel-mounted audible alarm horn shall be continuous tone, 120 Vac Sonalert solid-state electronic signal, as manufactured by Mallory. Substitutions shall be allowed per Division 1.
14. Electric Selector Switch (SS): Switch shall be maintained contact, NEMA ICS 2, oil-tight selector switch with contact arrangement, as required. Contacts shall be rated for minimum 120 Vac operation. Switch shall be 800T type, as manufactured by Allen-Bradley. Substitutions shall be allowed per Division 1.

Q. NAMEPLATES

1. Provide engraved phenolic or micarta nameplates for all equipment, components, and field devices furnished. Nameplates shall be 1/8 thick, black, with white center core, and shall be minimum 1" x 3", with minimum 1/4" high block lettering. Nameplates for devices smaller than 1" x 3" shall be attached to adjacent surface.
2. Each nameplate shall identify the function for each device.
3. Provide nameplates riveted to ceiling grid for terminal equipment or controllers located above accessible ceilings.

R. TESTING EQUIPMENT

1. Contractor shall test and calibrate all signaling circuits of all field devices to ascertain that required digital and accurate analog signals are transmitted, received, and displayed at system operator terminals, and make all repairs and recalibrations required to complete test. Contractor shall be responsible for test equipment required to perform these tests and calibrations. Test equipment used for testing and calibration of field devices shall be at least twice as accurate as respective field device (e.g., if field device is +/-0.5% accurate, test equipment shall be +/-0.25% accurate over same range).

PART 3. EXECUTION

A. INSPECTION

1. Examine areas and conditions under which control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

B. INSTALLATION OF CONTROL SYSTEMS

1. General: Install systems and materials in accordance with manufacturer's instructions, roughing-in drawings and details shown on drawings. Install electrical components and use electrical products complying with requirements of National Electric Code and all local codes.
2. Control Wiring: The term "control wiring" is defined to include providing of wire, conduit and miscellaneous materials as required for mounting and connection of electric control devices.
 - a) Wiring System: Install complete wiring system for electric control systems. Conceal wiring except in mechanical rooms and areas where other conduit and piping are exposed. Installation of wiring shall generally follow building lines. Install in accordance with National Electrical Code and Division 23 of this Specification. Fasten flexible conductors bridging cabinets and doors, neatly along hinge side, and protect against abrasion. Tie and support conductors neatly.
 - b) Control Wiring Conductors: Install control wiring conductors, without splices between terminal points, color-coded. Install in neat workmanlike manner, securely fastened. Install in accordance with National Electrical Code and Division 23 of this Specification.
 - c) Communication wiring, signal wiring and low voltage control wiring shall be installed separate from any wiring over thirty (30) volts. Signal wiring shield shall be grounded at controller end only, unless otherwise recommended by the controller manufacturer.
 - d) All control network wiring shield shall be terminated as recommended by controller manufacturer. All control network wiring shall be labeled with a network number, Node ID at each termination and shall correspond with the network architecture and floor plan submittals.
 - e) Install all control wiring external to panels in electric metallic tubing or raceway. Installation of wiring shall generally follow building lines. Provide compression type connectors. Provide rigid conduit at all exterior locations and where subjected to moisture. All conduits penetrating partitions, walls or floors shall be sealed with a submitted and approved non-hardening putty material to prevent migration of air through the conduit system.
 - f) Communication cabling shall be provided in a NCSU approved color dedicated to the BAS.
 - g) Number-code or color-code conductors appropriately for future identification and servicing of control system. Code shall be as indicated on approved installation drawings.
3. Control Valves: Install so that actuators, wiring, and tubing connections are accessible for maintenance. Where possible, install with valve stem axis vertical, with operator side up. Where vertical stem position is not possible, or

would result in poor access, valves may be installed with stem horizontal. Do not install valves with stem below horizontal, or down.

4. Room Temperature Sensors: Mount 48" above finished floor.
5. Critical Room Temperature Sensors: Mount 48" above finished floor.
6. Averaging Temperature Sensors: Cover no more than two square feet per linear foot of sensor length except where indicated. Generally where flow is sufficiently homogeneous/adequately mixed at sensing location, consult AE for requirements.
7. Airflow Measuring Stations: Install per manufacturer's recommendations in an unobstructed straight length of duct (except those installations specifically designed for installation in fan inlet). For installations in fan inlets, provide on both inlets of double inlet fans and provide inlet cone adapter as recommended by AFM station manufacturer.
8. Fluid Flow Sensors: Install per manufacturer's recommendations in an unobstructed straight length of pipe.
9. Relative Humidity Sensors: Provide element guard as recommended by manufacturer for high velocity installations. For high limit sensors, position remote enough to allow full moisture absorption into the air stream before reaching the sensor.
10. Water Differential Pressure Transmitters: Provide valve bypass arrangement to protect against over pressure damaging the transmitter and for parallel connection of calibration/ test instrument.
11. Pipe Surface Mount Temperature Sensors: Pipe Surface Mount temperature sensor shall be installed with thermally conductive paste at pipe contact point. Where sensor is to be installed on an insulated pipe Contractor shall neatly cut insulation install sensor, repair or replace insulation and vapor barrier and adequately seal vapor barrier.
12. Pipe Immersion Temperature Sensors: Install a "P/T" port directly next to EACH immersion sensors installed for the project. The Pressure/Temperature test port shall have 1/4" or 1/2" MPT brass body, dual durometer EPDM core, threaded brass cap with o-ring seal and neoprene retainer strap and shall accept standard 1/8" gauge adapter or thermometer stem. Rated to 500 PSI / 3450 kPa, and 250°F / 120°C. Pressure/Temperature Test Port shall be PTV ENTERPRISES Model PT or approved equal.
13. Flow Switches: Where possible, install in a straight run of pipe at least 15 diameters in length to minimize false indications.
14. Current Switches for Motor Status Monitoring: Adjust so that setpoint is below minimum operating current and above motor no load current.
15. Supply Duct Pressure Transmitters:
 - a) General: Install pressure tips with at least 4 'round equivalent' duct diameters of straight duct with no takeoffs upstream. Install static pressure tips securely fastened with tip facing upstream in accordance with manufacturer's installation instructions. Locate the transmitter at an accessible location to facilitate calibration. Provide a capped "T" in line with the pneumatic sensing line for parallel connection of calibration/ test instrumentation. Alternatively, provide a test port in the duct directly next to the DP transmitter sensing location.
 - b) VAV System 'Down-Duct' Transmitters: Locate pressure tips approximately 3/4 of the hydraulic distance to the most remote terminal in the air system where shown on the drawings. Provide a capped "T" in line with the pneumatic sensing line for parallel connection of calibration/ test instrumentation. Alternatively, provide a test port in the duct directly next to the DP transmitter sensing location.
16. Cutting and Patching Insulation: Repair insulation to maintain integrity of insulation and vapor barrier jacket. Use hydraulic insulating cement to fill voids and finish with material matching or compatible with adjacent jacket material.

END OF SECTION 230901

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SEQUENCE OF OPERATION – Table of Contents

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SECTION 230993

SEQUENCE OF OPERATION

PART I. GENERAL

A. SECTION INCLUDES

1. General information regarding sequence of control. Specific system sequences of control are indicated on sheet M608.

B. RELATED DOCUMENTS:

1. Drawings and general provisions of Contract, including the General Conditions and Supplementary Conditions and other Division-1 Specification Sections, apply to this Section.
2. Section 230010 – HVAC General Requirements
3. Section 230900 - Building Automation System (BAS) General
4. Section 230901 - BAS Basic Materials, Interface Devices, and Sensors
5. Section 230903 - BAS Field Panels
6. Section 230904 - BAS Communications Devices
7. Section 230905 - BAS Software and Programming
8. Section 230801 – BAS Commissioning
9. This Section defines the manner and method by which controls function.

C. SUBMITTALS

1. Refer to Section 230900 and Division 1 for requirements for control shop drawings, product data, Record Documents, etc.
2. Programming Manual: Provide DDC system programming manual as well as documentation of site-specific programming prior to the start of Acceptance Phase.

PART II. PRODUCTS

Not Used

PART III. EXECUTION

A. GENERAL

1. Sequences specified herein indicate the functional intent of the systems operation and may not fully detail every aspect of the programming that may be required to obtain the indicated operation. Contractor shall provide all programming necessary to obtain the sequences/system operation indicated.
2. When an air handling unit is not in operation, control devices shall remain in their “off” positions. “Off” positions may differ from the “normal” (meaning failed) position. Except as specified otherwise, “off” and “normal” positions of control devices shall be as follows:

Device	“Off” Position	“Normal” Position
Heating coil valves	closed	open
Cooling coil valves	closed	closed
Steam coil valves	closed	closed
Outside air damper	closed	closed

Variable Frequency Drives: For a VFD dependent on an external input for its output setting (e.g. the VFD gets “Frequency” as an input), loss of that external input shall result in the VFD holding its last value. If the VFD is running its own PID loop and the external input to the VFD is a setpoint (e.g. duct static pressure setpoint), the VFD

shall hold the last setpoint. If the VFD loses its process variable (e.g. duct static pressure), the VFD shall go to its minimum speed setting.

3. Except as specified otherwise, throttling ranges, proportional bands, and cycle differentials shall be centered on the associated setpoint. All modulating feedback control loops shall include the capability of having proportional, integral, and derivative action. Unless the loop is specified “proportional only” or “P+I”, Contractor shall apply appropriate elements of integral and derivative gain to each control loop which shall result in stable operation, minimum settling time, and shall maintain the primary variable within the specified maximum allowable variance.
4. Provide a real time clock and schedule controller with sufficient scheduling capability to schedule all required controllers and sequences. Schedule functionality may reside in BPOC or a controller. If BPOC is used, document scheduling functionality on BPOC submittal, if a controller is used, document scheduling functionality including SNVT names and types on controller points list submittal. Set up initial schedules in coordination with UNC.
5. Scheduling Terminology: When air handlers are scheduled throughout the day, the following defines the terminology used:
 - a. The vivarium is occupied 24/7. No occupied/ unoccupied, preoccupancy, or setback periods apply.
 - b. Normal holding room temperature and humidity varies with species. Normal temperature and humidity for the dominant species is 70°F and 50% RH.
 - i. A wider range of temperature setpoints within the range of 67F to 80F is not unusual and often depends on the current census of animals which can vary widely from year to year. Flexibility within these ranges should be expected in any holding room. Temperatures above or below this range may require additional design consideration and can be difficult to accommodate if not anticipated during original design.
6. Where any sequence or occupancy schedule calls for more than one motorized unit to start simultaneously, the BAS start commands shall be staggered by 5 second (adj.) intervals to minimize inrush current.
7. Wherever a value is indicated as adjustable (adj.), it shall be modifiable, with the proper password level, from the LCS via an LNS plug-in or via a function block menu. For these points, it is unacceptable to have to modify programming statements to change the setpoint.
8. When a power failure is detected in any phase, the BAS start commands shall be retracted immediately from all electrically powered units served by the failed power source. If the associated controller is powered by normal or emergency power, it may monitor its own power source as an indication of power status. If the controller is powered by uninterruptible power supply (UPS), or if it is not capable of monitoring its own power for use in sequences, Contractor shall provide at least one voltage monitor (three phase when applicable) per building. When the BAS detects that normal or emergency power has been restored, all equipment for which the BAS start command had been retracted shall be automatically restarted in an orderly manner on staggered 5 second intervals to minimize inrush current.
9. Where reset action is specified in a sequence of operation, but a reset schedule is not indicated on the drawings, one of the following methods shall be employed:
 - a. Contractor shall determine a fixed reset schedule which shall result in stable operation and shall maintain the primary variable within the specified maximum allowable variance.
 - b. A floating reset algorithm shall be used which increments the secondary variable setpoint (setpoint of control loop being reset) on a periodic basis to maintain primary variable setpoint. The recalculation time and reset increment shall be chosen to maintain the primary variable within the specified maximum allowable variance.
 - c. Primary variable shall control the devices directly using a PID feedback control loop without resetting the secondary variable. However, the control devices shall still

modulate as necessary to maintain upper and lower limits on the secondary variable. Proportional band, integral gain, and derivative term shall be selected to maintain the primary variable within the specified maximum allowable tolerance while minimizing overshoot and settling time. Contractor shall gain prior approval for implementing this method of reset.

10. Where “prove operation” of a device (generally controlled by a digital output) is indicated in the sequence, it shall require that the BAS shall, after an adjustable time delay after the device is commanded to operate (feedback delay), confirm that the device is operational via the status input. If the status point does not confirm operation after the time delay or anytime thereafter for an adjustable time delay (debounce delay) while the device is commanded to run, an alarm shall be enunciated audibly. Upon failure, run command shall be removed and the device shall be locked out until the alarm is manually acknowledged unless specified otherwise.
11. BAS shall provide for adjustable maximum rates of change for increasing and decreasing output from the following analog output points:
 - a. Speed control of variable speed drives
 - b. Control Reset Loop
 - c. Valve Travel Limit
12. Wherever a value is indicated to be dependent on another value (i.e.: setpoint plus 5°F) BAS shall use that equation to determine the value. Simply providing a virtual point that the operator must set is unacceptable. In this case three virtual points shall be provided. One to store the parameter (5°F), one to store the setpoint, and one to store the value which is the result of the equation.

B. AIR HANDLING UNITS - GENERAL

1. **Logic Strategies:** The BAS shall fully control the air handlers. Generally the BAS shall energize the AH (start the fans and activate control loops) as dictated for each air handler. The following indicates when and how the BAS shall energize the AHs and control various common aspects of them. The following “logic strategies” shall be included by reference with each air handler with any specific clarifications required:
 - a. **Freeze Safety:** Upon operation of a freezestat, unit shall be deenergized with the exception of the heating loops. Typically supply and return fans where applicable shall be deenergized via a hardwired interlock, , and an indication of the operation shall be sensed by the BAS. BAS shall enunciate appropriate alarm and remove and lock out the start command, which shall initiate "fan failure" alarms. OA dampers shall close, RA dampers shall open, all hydronic valves shall open and heating loops shall remain active.
 - b. **Smoke Safety (Non-Smoke Control AHs):** Upon indication of smoke by a smoke detector, BAS shall deenergize the AH. Smoke detector shall notify the fire alarm system, shut down the fans, and close the smoke dampers via hard-wired interlock.
 - c. **Smoke Safety (Smoke Control AHs):** Upon indication of smoke by a smoke detector, BAS shall override the AH control as needed for smoke control sequence of operation.
 - d. **High or Low Pressure Safety:** Upon activation of a high or low pressure safety switch, AH shall be deenergized, fans shall be deenergized via a hard wired interlock, and an indication of the operation shall be sensed by the BAS. BAS shall enunciate appropriate alarm and remove and lock out the start command, which shall initiate "fan failure" alarms.

2. The detailed “logic strategies” above shall be required by reference to them in each of the individual sequences specified below.
- C. FLOW TRACKING ZONE WITH HOT WATER REHEAT [REFER TO SHEET M602 AND M608]**
- D. EXHAUST FANS (REFER TO SHEET M603 AND M608)**
- E. FAN COIL UNITS [REFER TO SHEET M604 AND M608]**
- F. 100% OA CV AHU WITH PREHEAT & CHW COIL [REFER TO SHEET M605 AND M608]**
- G. STEAM TO HW CONVERTER WITH CV PUMPS [REFER TO SHEET M606 AND M608]**
- H. CHILLED WATER PUMP AND BYPASS CONTROL [REFER TO SHEET M607 AND M608]**

END OF SECTION 230993

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SECTION 23 10 00 HVAC PIPING, VALVES, AND ACCESSORIES

PART 1 GENERAL

- A. Provide pipe, fittings, valves, and accessories for use with the piping systems described within this Section and as shown on the drawings.

B. DESCRIPTION

1. The requirements of this section apply to the piping systems shown on the drawings, specified in this section and in other related sections.

C. QUALITY ASSURANCE

1. Piping and valves shall be furnished by firms regularly engaged in the manufacture of piping products of types and sizes required, and which have been in satisfactory use for not less than five years in similar service.
2. All piping shall be carefully and uniformly graded, shall be straight and erected in true alignment.
3. All piping and fittings shall meet ANSI/ASTM Standards.
4. Piping connections shall be made strictly in accordance with equipment manufacturer's recommendations, when these are available, and satisfactory to the Architect/Engineer. Provide all drip, drain, traps and other small pipe connections, etc., required to complete the installation in accordance with good practice and as approved by the Architect/Engineer.
5. Welding materials and labor to conform to ASME Code and applicable state Labor Regulations.
6. All welders shall be certified by ANSI B31.1.0-1986 "Standard Qualification Welding Procedures, Welders and Welding Operators" or "Qualification Tests" in Section IX, ASME Boiler and Pressure Vessel Code.
7. Each length of pipe, fitting, trap, fixture or device used in any piping system shall be stamped or indelibly marked with type, weight, quality and manufacturer's name or mark.

D. RELATED SECTIONS

1. Refer to Section 23 09 01 BAS Basic Materials, Interface Devices, and Sensors for HVAC control valves, steam meters, chilled water flow meters, and heating hot water flow meters.

E. PRODUCT HANDLING

1. All piping shall be received in full lengths, shall be straight, clean and undamaged when installed. All defective pipe fittings, etc. shall be removed from the site as soon as discovered. Provide factory-applied plastic end-caps on each length of pipe and tube. Maintain end-caps through shipping, storage and handling as required to prevent pipe-end damage and eliminate dirt and moisture from inside of pipe and tube.
2. Provide factory-applied end-caps on all valves. Maintain end-caps through shipping, storage and handling, in adequate condition to inhibit corrosion, prevent damage and eliminate dirt and moisture from inside the valves. Store valves inside and protected from weather.
3. Store pipe and tube inside and protected from weather. Where necessary to store outside, elevate well above grade and enclose with durable, waterproof wrapping.

4. Protect flanges and fittings from moisture and dirt by inside storage and enclosure, or by packaging with durable, waterproof wrapping.

PART 2 PRODUCTS

A. PIPING MATERIALS

1. Provide pipe and tube of the type, joint type, grade, size and weight (wall thickness or class) indicated for each service. Where type, grade, or class is not indicated, provide proper selection as determined by Installer for installation requirements, and comply with governing regulations and industry standards.

B. MISCELLANEOUS PIPING MATERIALS AND PRODUCTS

1. Insulating (Dielectric) Unions: Provide standard products recommended by the manufacturer for use in the service indicated, and which effectively isolate copper from steel or cast iron, or other ferrous from nonferrous piping (electrical conductance), prevent galvanic action, and stop corrosion.
 - a) For pipe sizes 2" and smaller: It consists of a union nut, two tailpieces, and a gasket that separates the tailpieces to prevent an electric current from occurring. Union and gasket shall be rated 250psig and 180°F.
2. Combination Pressure and Temperature (PT) Test Plugs:
 - a) Plugs shall have brass bodies, and internal valve seat material designed for specific system operating temperature and pressure. Plugs shall be provided with adaptors to connect pressure gauges or thermometers identical to those used elsewhere on the Project.
3. Approved Manufacturers: (Pipe and Fittings) - Except for pipe and fittings on fire protection systems which must be UL listed, the following products and manufacturers are approved for use.
 - a) Iron and Steel Fittings and Flanges - Stockham, Walworth, Grinnell, Vogt, Tube-Line, Bonney Forge.
 - b) Copper and Bronze Fittings and Connectors - Nibco, Parker CPI, Swagelok, Imperial, Mueller.
 - c) Forged Welded Ells, Tees and Branch Connectors - Bonney Forge, Phoenix Forging, ITT Grinnell.
 - d) Dielectric Fittings, Isolation Flanges, Unions and Nipples - Epco Sales, Watts, Perfection Products
 - e) PT Test Plugs - Fairfax, Flow Design, Peterson, or SISCO.
 - f) .Joint Sealing Tape and Paste - 3M, Crane Packing, Permatex, DuPont.

C. PIPING STANDARDS

1. Black Steel Pipe: ASTM A53 or ASTM A106.
2. Copper Water Tube: ASTM B88; Type L above ground, hard-drawn tempered, except as otherwise indicated.

D. PIPE/TUBE FITTING STANDARDS

1. Malleable Iron Threaded Fittings: ASME B16.3
2. Threaded Pipe Plugs: ASME B16.14.
3. Unions: 250 lb. malleable iron, ground joint, bronze to iron for piping 1-1/2 inches and smaller.

4. Copper-Tube Unions: Provide standard products recommended by the manufacturer for use in the service indicated.
5. Fittings for Copper Tubing: Cast-bronze Solder Joint Fittings - ASME B16.18.
6. Wrought-Copper/Bronze Solder-Joint Fittings: ASME B16.22.

E. ABOVE GROUND HOT AND CHILLED WATER

1. Pipe Size 2" and Smaller:
 - a) Pipe:
 - i. Carbon steel pipe, ASTM A53 or A106, Grade B, Type S seamless; or Type E high frequency ERW electric resistance welded (HFW) and full-body normalized after upset; full body post weld ultrasonic or radiography inspection (during manufacturer); Schedule 40, produced by an ISO 9001 or API Q1 certified manufacturing plant. Low frequency type ERW, spiral weld, continuous weld, and laser weld material is not acceptable. Piping shall be provided with a materials test report and be mill-traceable, ERW pipe shall be fully traceable to heat number and lot number. Manufacturer to be ISO 14001 or equivalent certified. Or:
 - ii. Seamless copper tube, ASTM B88, Type L Hard drawn.
 - b) Fittings:
 - i. Steel: Malleable iron threaded fittings, ANSI B16.3. Fittings shall be 57 kg (125 lb minimum) for pressures less than 517 kPa (75 psi) and 136 kg (300 lb) for over 517 kPa (75 psi).
 - ii. Copper: Wrought copper solder cup type fittings, ANSI/ASME B16.22 or B16.18.
 - c) Joints:
 - i. Steel: Threaded using American Standard for Pipe Threads, ANSI B2.1 with thread sealant or Mil Spec 27730A AND AA58092 PTFE premium density tape. Thread sealants shall be especially listed compatible with system contents, pipe materials, and operating conditions.
 - ii. Copper: ASTM B828 lead-free soldered joints with ASTM B32 Grade HB, Grade HN, or, approved equal solder that is also listed in Section 1 of ASTM B32. ASTM B813 high temperature water soluble flux. Air cooled only, no quenching. System should be rinsed thoroughly as soon as possible after soldering to prevent on-going flux activity. External surface flux residue shall also be removed.
 - d) Unions:
 - i. Brass solder unions.
 - e) Dielectric Fittings:
 - i. Unions and couplings.
 - f) Equipment connections shall be made with unions having ground joints, brass seats and hexagonal nuts. No long screws, running threads, lock nuts or packed joints will be permitted.
2. Pipe Size 2.5" and larger:
 - a) Pipe:

- i. Carbon steel pipe, ASTM A53 or A106, Grade B, Type S seamless; or Type E high frequency ERW electric resistance welded (HFW) and full-body normalized after upset; full body post weld ultrasonic or radiography inspection (during manufacturer); Schedule 40, produced by an ISO 9001 or API Q1 certified manufacturing plant. Low frequency type ERW, spiral weld, continuous weld, and laser weld material is not acceptable. Piping shall be provided with a materials test report and be mill-traceable, ERW pipe shall be fully traceable to heat number and lot number. Manufacturer to be ISO 14001 or equivalent certified.
- b) Fittings:
 - i. Steel butt weld fittings, ANSI B16.9, ASTM A234, Grade WPB, long turn ells, ANSI B16.5 weldneck (preferred). Weld-o-lets and thread-o-lets permitted only if branch at least 2 pipe sizes smaller than main. Fittings in accordance with system maximum working pressure ratings, ANSI B31.1.
 - ii. or slip-on forged carbon steel ANSI B16.5 flanges.
- c) Joints:
 - i. Butt weld to ANSI B31.1; including requirements for welding procedure specifications and qualifications records and weld inspection in conformance with ANSI B31.9 or B31.1.
 - ii. Flange Bolting:
 - 1) Alloy steel bolt studs, thread full length with heavy hex nuts.
- d) Dielectric Fittings:
 - i. Isolation flanges, unions, and couplings.
- e) Elbows shall be long radius type. Tees may be standard fittings or Bonney Forge "Weldolets".
- f) Equipment connections shall be flanged.
- g) Valves in welded pipe shall be flanged.

F. CONDENSATE DRAIN PIPING

- 1. Condensate piping shall be Type L hard drawn copper tubing with soldered fittings.

G. UNDERGROUND, DIRECT BURY, CHILLED WATER

- 1. Pipe:
 - a) Ductile iron pipe, Type 2 or Type 5 double thickness NSF-61 cement lined and with NSF-61 sealcoat, ANSI/AWWA C150, C151, AWWA C104, ANSI A21.4, Special Thickness Class 53 or greater, asphalt or fusion bonded epoxy exterior coating. AWWA C105 8-mil polyethylene encasement. Use Type 5 cement for applications with elevated sulfates. Or:
 - b) Ductile iron pipe with factory-applied, 40 mils coal-tar free abrasion-resistant ceramapure epoxy interior lining; Ceramapure also applied to bells and pipe ends (including field cut); ANSI/AWWA C150, C151, AWWA C210; asphalt or fusion bonded epoxy exterior coating. AWWA C105 8-mil polyethylene encasement. Piping shall be manufacturer prepared prior to lining/coating in accordance with lining manufacturer recommendations by certified applicators.
- 2. Fittings:
 - a) Ductile iron Type 2 or Type 5 double thickness NSF-61 cement lined and with NSF-61 sealcoat ANSI/AWWA C110/A21.10; AWWA C104/ANSI A21.4 Minimum Pressure Class 350, all materials NSF-61 compliant, AWWA C105 8-mil polyethylene encasement. Use Type 5 cement for applications with elevated sulfates. NSF-61 Fusion bonded epoxy interior also acceptable. Or:

- b) Ductile iron ANSI/AWWA C110/A21.10; Minimum Pressure Class 350; with factory-applied, 40 mils coal-tar free abrasion-resistant ceramapure epoxy interior lining; ANSI/AWWA C150, C151, AWWA C210; asphalt or fusion bonded epoxy exterior coating. AWWA C105 8-mil polyethylene encasement. Piping shall be manufacturer prepared prior to lining/coating in accordance with lining manufacturer recommendations by certified applicators.
- c) Joints:
 - i. AWWA/ANSI C111/A21.11 compression gasketed joints or AWWA/ANSI C110/A21.10 Type MJ mechanical joint. Where restraint is required, provide corrosion resistant epoxy coated ductile iron wedge-action gland restraint except that restraining gasket may be used in place of wedge action gland restraint where each piping joint is fully extended to engage the thrust restraint, and following manufacturer/DIPRA, and AWWA C600 requirements.
 - 1) Thrust blocks are required at changes in direction.
 - 2) All bolts, nuts, and accessories AWWA C111/ANSI A21.1 compliant grade and type, Cor-Blue fluorocarbon coated low alloy high strength steel bolts/nuts mildly cathodic to the pipe are required for underground applications.
 - 3) Restraint shall be listed for piping working pressure (not calculated restraint force) of at least 3,102 kPa (450 psig), comply with UL standard 194, ductile iron construction and shall not be flow-direction dependent.

H. STEAM PIPING

1. Pipe Size 2" and smaller:

- a) Pipe:
 - i. Carbon steel pipe, ASTM A106, ASME SA106, Grade B, Type S seamless, Schedule 40. Piping shall be provided with a materials test report and be fully traceable to heat number and lot number. Or:
 - ii. Carbon steel pipe, ASTM A106, ASME SA106, Grade B, Type S seamless, Schedule 80 or Schedule 160. Steel shall be mill-traceable. Piping shall be provided with a materials test report and shall be fully traceable to heat number and lot number.
- b) Fittings:
 - i. Required for buried steam tunnels: Steel butt weld fittings, ANSI B16.9, ASTM A234, Grade WPB, long turn ells, ANSI B16.5 weldneck (preferred) or slip-on forged carbon steel ANSI B16.5 flanges, except slip-on not permitted for steam applications above 103 kPa (15 psi), Weld-o-lets and thread-o-lets permitted only if branch at least 2 pipe sizes smaller than main. Cast iron flanges are not acceptable. 136 kg (Class 300) flanges required for steam pressures above 100 kPa (15 psi), 68 kg (Class 150) below 100 kPa. Fittings in accordance with system maximum working pressure ratings, ANSI B31.1 or B31.9 (as applicable) and of wall thickness not less than system piping.
 - ii. Steel socket weld fittings, ASTM A105, ANSI B16.11, wall thickness to match pipe and required system pressure ratings, Class 3000 minimum.
 - iii. Low pressure only. Malleable iron threaded fittings, ANSI B16.3. Fittings shall be 57 kg (125 lb minimum). Steam condensate shall be 136 kg (300 lb) for all pressures.
 - iv. Low pressure only. Cast iron threaded fittings, ANSI B16.4. Fittings shall be 57 kg (125 lb. minimum). Steam condensate shall be 113 kg (250 lb minimum) for all pressures.
Or:
 - v. 150 lb. forged steel slip on flanges; Cast iron flanges are not acceptable
- c) Joints:

- i. Required for buried steam tunnels: Butt weld to ANSI B31.1 including requirements for welding procedure specifications and qualifications records in accordance with ASME Section IX and weld inspection in conformance with ANSI B31.1.
- ii. Socket weld to ANSI B31.9 or ANSI B31.1 as required by application: including requirements for welding procedure specifications and qualifications records and weld inspection in conformance with ANSI B31.9 or B31.1. ANSI B31.1 is required for all medium and high pressure steam. Maintain 1.6 mm (0.0625 in.) clearance between pipe end and socket shoulder. Welded connections; or
- iii. Threaded using American Standard for Pipe Threads, ANSI B2.1 with thread sealant or Mil Spec 27730A AND AA58092 PTFE premium density tape. Thread sealants shall be especially listed compatible with system contents, pipe materials, and operating conditions.Or:
- iv. flanges bolted with alloy steel studs, thread full length with heavy hex nuts.

I. STEAM CONDENSATE RETURN PIPING

1. Pipe Size 2" and smaller:

- a) Pipe:
 - i. Carbon steel pipe, ASTM A106, ASME SA106, Grade B, Type S seamless, Schedule 80 or Schedule 160. Steel shall be mill-traceable. Piping shall be provided with a materials test report and shall be fully traceable to heat number and lot number.
- b) Fittings:
 - i. Required for buried steam tunnels: Steel butt weld fittings, ANSI B16.9, ASTM A234, Grade WPB, long turn ells, ANSI B16.5 weldneck (preferred) or slip-on forged carbon steel ANSI B16.5 flanges, except slip-on not permitted for steam applications above 103 kPa (15 psi), Weld-o-lets and thread-o-lets permitted only if branch at least 2 pipe sizes smaller than main. Cast iron flanges are not acceptable. 136 kg (Class 300) flanges required for steam pressures above 100 kPa (15 psi), 68 kg (Class 150) below 100 kPa. Fittings in accordance with system maximum working pressure ratings, ANSI B31.1 or B31.9 (as applicable) and of wall thickness not less than system piping.
 - ii. Steel socket weld fittings, ASTM A105, ANSI B16.11, wall thickness to match pipe and required system pressure ratings, Class 3000 minimum.
 - iii. Low pressure only. Malleable iron threaded fittings, ANSI B16.3. Fittings shall be 57 kg (125 lb minimum). Steam condensate shall be 136 kg (300 lb) for all pressures.
 - iv. Low pressure only. Cast iron threaded fittings, ANSI B16.4. Fittings shall be 57 kg (125 lb. minimum). Steam condensate shall be 113 kg (250 lb minimum) for all pressures.
Or:
 - v. 150 lb. forged steel slip on flanges up to 15 psi; Cast iron flanges are not acceptable
- c) Joints:
 - i. Required for buried steam tunnels: Butt weld to ANSI B31.1 including requirements for welding procedure specifications and qualifications records in accordance with ASME Section IX and weld inspection in conformance with ANSI B31.1.
 - ii. Socket weld to ANSI B31.9 or ANSI B31.1 as required by application: including requirements for welding procedure specifications and qualifications records and weld inspection in conformance with ANSI B31.9 or B31.1. ANSI B31.1 is required for all medium and high pressure steam. Maintain 1.6 mm (0.0625 in.) clearance between pipe end and socket shoulder. Welded connections; or
 - iii. Threaded using American Standard for Pipe Threads, ANSI B2.1 with thread sealant or Mil Spec 27730A AND AA58092 PTFE premium density tape. Thread sealants shall be especially listed compatible with system contents, pipe materials, and operating conditions.Or:

- iv. flanges bolted with alloy steel studs, thread full length with heavy hex nuts.

J. VALVES, GENERAL

1. General: Unless otherwise indicated, provide factory fabricated valves of the type, body material and pressure class indicated. Where type or body material is not indicated, provide proper selection as determined by Installer for installation requirements, with pressure class selected from MSS or NSI standards based on the maximum pressure and temperature in the piping system.
2. Sizes: Except as otherwise indicated, provide valve size same as connecting pipe size.
3. Identification: All valves shall have the name of the manufacturer and the working pressure cast or stamped on the body of the valve. Manufacturer's figure number shall be on a metal plate under wheel lock nut of valve.
4. Specific products of a manufacturer may be listed to establish level of quality. Equivalent products by B&G, Flow Design, Mueller, Crane, Grinnel, Stockham, Jenkins, Milwaukee, Jamesbury, Vogt, Illinois, Watson-McDaniel, Armstrong, Spence or Nibco are acceptable.

K. CHILLED WATER AND HOT WATER VALVES

ITEM	PIPE SIZE	DESCRIPTION	REFERENCE STANDARDS
Ball Valves	1 1/2 inches and smaller	150 SWP, bronze, serviceable in line, S.S. trim, quarter turn lever, threaded connections. Crane 9302-S.	
	2 to 4 inches	Class 150 ball valve, cast steel body, S.S. trim, flanged ends, double TFE seal, Jamesbury 5150-2236-MT.	
	4 inches and larger	150 pound ball valve, cast steel body, stainless steel ball and stem, double TFE seal, flanged ends, Quartrol Figure Q661-CSSR.	
Ball Valves (Balancing and Shutoff)	2 1/2 inches and smaller	125 pound, bronze body, ball type, threaded or solder connection with memory stop slot. Pressure/temperature taps, meter connections, designed for balancing	
	3 inches and larger	125 pound, Cast iron body, brass ball, bronze seat, S.S. stem, memory stop, flanged ends, double TFE seal, Calibrated orifice or venturi..	
Gate Valves	2 inch and smaller	Class 300, Rising stem, screwed bonnet, inside screw and wedge gate, bronze body and trim with screwed ends	MSS SP-80-2013
	2 1/2 inch and larger	Class 150, Rising stem, bolted bonnet, OS&Y, wedge gate, iron or steel body, bronze trim with flanged ends	MSS SP-70-2011
Butterfly Valves	3 inches and larger	150 pound high-performance butterfly valve, cast steel body, stainless steel disc and stem, TFE seal, threaded lug, Jamesbury Series 815L-2236 (for balancing, add memory stop slot).	
Swing Check Valves	1 1/2 inches and smaller	600 pound, steel body 13% chrome trim, threaded ends, Crane Figure 174	ASTM A 216-84a, Grade WCB.

	2 inches and larger	150 pound, cast steel body, 13% chrome trim, flanged ends, Crane Figure 147-XU.	ASTM A 216-8a Grade WCB
Triple Duty Valves	2 inches and larger	Straight pattern, cast iron body combining the functions of a silent check valve, a balancing valve and a positive shut-off valve. Include a calibrated stem and pointer to indicate valve position. Valve stem shall be capable of being repacked under pressure. 175 psig working pressure at 300°F. Mueller Steam Specialty No. 721 pr B&G 3D.	
Safety Relief Valves	All	125 pound bronze body, threaded connections ASME rated, Watts 174A.	
Back Pressure Valves	2" and smaller	Self-contained, threaded or flanged end. Watson McDaniel Series 3040	
Gaskets	All	Non-asbestos with synthetic fibers and SBR binder, full face on flat flanges, Garlock S type 3200.	

L. STEAM AND STEAM CONDENSATE VALVES

ITEM	PIPE SIZE	DESCRIPTION	REFERENCE STANDARDS
Gate Valves	1 1/2 inches and smaller	Class 300, bronze body, union bonnet, SS seats, non-rising stem, threaded connections.	
	2 inches and larger	Class 150, cast steel, O S & Y, 13% chrome trim, bolted bonnet, wedge disc, rising stem, flanged ends.	
Globe and Angle Valves	1 1/2 inches and smaller	Class 300, bronze body, union bonnet, renewable disc, threaded connections.	
	2 inches	Class 150, cast iron, O S & Y, bolted bonnet, bronze mounted, renewable disc, flanged ends.	
Check Valves	2 inches and smaller	Class 300, swing type with bronze body, stainless steel trim, threaded connections.	
	2 ½ inches and larger	Class 150, swing type with cast steel or forged steel body, flanged ends, flanged and bolted cap, and stainless steel trim	
Gaskets	All	Gaskets shall be of the spiral wound type with an external metal ring to center the gasket on the flange face and act as a compression stop.	

M. MANUAL BALANCING VALVES:

1. Valves 2" and smaller shall have soldered or threaded ends with brass or bronze body; and 2.5" and larger shall have flanged ends with iron body. Valves shall have brass or bronze ball, Teflon or carbon-filled TFE seats, memory stop, meter connections with built-in check valves or pressure/temperature test plugs, and shall be designed for balancing and positive shut off.

2. Valves shall have calibrated orifice or venturi. Provide flow capacity characteristic curves or tables for each valve size. Calibrated orifice devices shall have integral pointer and calibrated nameplate.
3. Manufacturer: Bell & Gossett, Flow Design, Gerand, MEPCO, Taco, or Tour & Andersson.

N. DIELECTRIC FITTINGS

1. Dielectric fittings: threaded, flanged, brazed, grooved, or soldered to match adjacent piping. Metal parts of the union shall be separated so that the electrical current is below 1% of the galvanic current which would exist with metal-to-metal contact.
2. Manufacturer: Bolt-Pak, Epco (with high temperature gasket), Perfection Clearflow, or Watts.

O. WATER PRESSURE GAUGES

1. Description: Gauges shall be for the type service in which they are installed and shall be calibrated to read in PSIG. Gauges shall be glycerine filled to prevent vibration of the scale and needle.
 - a) Pressure gauges shall have a 4" dial; one piece cast brass or chrome plated cast brass case, socket and cover ring; plexiglass or laminated safety glass crystal; phosphor/bronze or beryllium/copper bourdon type; brass movement; 1/4" N.P.T. connection; safety relief valve.
 - b) Install ahead of each gauge a shut-off cock. Each gauge which may see fluctuating pressure such as pump service, shall have snubber and shut-off cock.
 - c) For each gauge, scale shall be for twice the normal pressure of the line in which it is installed.
 - d) Gauge accuracy shall be not less than 1% of scale at mid range.
 - e) Gauges installed on pump suction shall be compound type.
2. Manufacturers: Provide equipment manufactured by Wika, Palmer, U.S. Gauge, Dwyer, or Marshalltown.

P. THERMOMETERS

1. Thermometers: Provide nine inch, mercury filled, red reading thermometers with die cast aluminum or brass case and clear plastic lens. Thermometer shall have stainless steel or brass separable sockets with extension neck, suitable for the insulation specified. All thermometers must be so installed that they are easily readable from floor after completion of job. All thermometers shall be of the adjustable angle type.
2. Temperature ranges shall be as follows:
 - a) Chilled water - 0°F to 100°F
 - b) Condenser water - 0°F to 100°F
 - c) Hot water heating - 0°F to 250°F
3. Stem lengths shall be as large as possible for the pipe size.
4. Manufacturers: Provide equipment manufactured by U.S. Gage Company, Trerice, Weiss, March, Weksler, or Palmer.

Q. STEAM SPECIALTIES

1. Steam Traps:

- a) Float and thermostatic steam traps less than 15 PSIG: Class 30, ASTM A278, cast iron body and bolted cap; renewable, stainless-steel float mechanism with renewable, hardened stainless-steel head and seat; balanced pressure, thermostatic air vent made with stainless steel or monel bellows, and stainless steel head and seat.
 - b) Bucket traps up to 125 PSIG: Cast-iron body and cap, rated for 250 psig; stainless-steel head and seat; stainless steel valve retainer, lever, and guide pin assembly; brass or stainless steel bucket. Integral stainless steel inlet strainer within trap body.
 - c) Thermodynamic Disc Traps: Body shall be stainless steel with screw-in cap. End connections shall be threaded. Disc and seat shall be stainless steel. Maximum operating pressure shall be 600 psig.
 - d) Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - i. Spirax Sarco, Inc.
 - ii. Hoffman
 - iii. Nicholson
2. Float Vents: Cast-iron or brass body; seamless brass float; balanced pressure, thermostatic bellows; replaceable stainless-steel seat, float, and head.
3. Vacuum Breakers:
 - a) 15 PSIG and higher: 150 psig working pressure, 365 deg. F maximum operating temperature, brass body, stainless steel retainer, spring, and ball, with plain or threaded outlet.
 - b) Under 15 PSIG: Class 150 bronze swing check with composition seat.
4. Pressure Regulating Valves: Pilot-actuated, diaphragm type, with adjustable pressure range and positive shutoff; cast-iron body with flanged end connections, hardened stainless steel trim, and replaceable head and seat. Provide main head stem guide fitted with flushing and pressure-arresting device. Provide dirt cover over pilot diaphragm. Factory set for inlet and outlet pressures indicated.
5. Safety Valves:
 - a) Bronze Safety Valves, through 1-1/2": Cast-bronze body, Class 250, with threaded inlet and outlet; forged copper-alloy disc; fully enclosed, cadmium-plated steel spring with adjustable pressure range and positive shutoff, factory set and sealed.
 - b) Cast-Iron Safety Valves, above 2": Cast-iron body, Class 250; forged copper-alloy disc and nozzle; fully enclosed, cadmium plated steel spring with adjustable pressure range and positive shutoff; raised face flanged inlet and threaded outlet connections; factory set and sealed.
6. Double Block and Bleed Valves for double isolation steam/condensate service:
 - a) Cast steel body, with stainless steel seats, discs, bellows, and stems. Graphite laminated stainless steel body/bonnet gaskets. ANSI B 16.5. Class 300. Install ½" bleed valve with threaded, capped discharge. Spirax Sarco DBB3 or equivalent by Bonney Forge, Crane, Stockham or Franklin. Alternately provide and install two isolation valves where double block and bleed is indicated with a drain/bleed valved in between.
7. Flash Tanks
 - a) Shop or factory fabricated of welded steel according to ASME Boiler and Pressure Vessel Code, for 150-psig rating; and bearing ASME label. Fabricate with tappings for low-pressure steam and condensate outlets, high-pressure condensate inlet, air vent, safety valve, and legs or hanging lugs.

8. Steam Pressure Gauges: Gauges shall be for the type service in which they are installed and shall be calibrated to read in PSIG. Gauges shall be glycerine filled to prevent vibration of the scale and needle.
 - a) Pressure gauges shall have a 4" dial; one piece cast brass or chrome plated cast brass case, socket and cover ring; plexiglass or laminated safety glass crystal; phosphor/bronze or beryllium/copper bourbon type; brass movement; 1/4" N.P.T. connection; safety relief valve.
 - b) Install ahead of each gauge a shut-off cock and siphon pipe.
 - c) For each gauge, scale shall be for twice the normal pressure of the line in which it is installed.
 - d) Gauge accuracy shall be not less than 1% of scale at mid range.
 - e) Manufacturers: Provide equipment manufactured by Wika, Palmer, U.S. Gauge, Dwyer, or Marshalltown.

R. STRAINERS

1. Pipeline strainers shall be Y-type or other configuration with removable stainless steel basket, complying with Fluid Controls Institute Standard FCI 73-1. Strainers shall be the same size as the entering pipe. Maximum pressure drop of 4 feet of water in clean strainer and 5 feet of water when two-thirds of perforations are blocked.
2. Provide screwed ends up to 2-inch size, flanged 2½-inch and larger.
3. Body:
 - a) Up to 150 pounds per square inch: Y-type; cast iron body; bolted or threaded screen retainer tapped for a blowoff valve; threaded body in sizes through 2-inch and rated at not less than 175 psi WOG; flanged body in sizes over 2-inch and rated at not less than 125 psi WOG at 240 degrees F. Cast iron body with clamped cover, tapped for a blowoff valve; 125 psig flanged body for 2½-inch and larger.
 - b) Up to 150 pounds square inch, basket type: Cast iron body with clamped cover; body tapped for a blowoff valve; 125 psig flanged body for 2½-inch and larger.
 - c) Steam service up to 100 psig: Y type; steel body, bolted or threaded screen retainer tapped for a blowoff valve; threaded or flanged in sizes through 2-inch; flanged in sizes over 2-inch; rated at not less than 250 psi at 400 degrees F.
4. Strainer screen shall be 316 stainless steel or monel, reinforced, with free area not less than 2½ times inlet area.
 - a) Perforations:
 - i. Water:
 - 1) Up to 2-inch: 1/32 inches
 - 2) 2½-inch to 8 inch: 1/8 inches
 - ii. Steam and Condensate:
 - 1) To 2-inch: 1/64 inches
 - 2) 2½-inch to 4-inch: 1/32 inches
 - 3) 5-inch and up: 3/64 inches

S. CENTRIFUGAL AIR SEPARATORS

1. Provide as indicated on Drawings, a centrifugal type air separator. Provide with inlet and outlet connections tangential to the vessel shell. Vessel shell diameter to be minimum three times the nominal inlet/outlet pipe diameter.

2. Provide an internal stainless steel air collector tube with 5/32-inch diameter perforations and 63 percent open area designed to direct accumulated air to an external air vent via an NPT connection at top of unit.
3. Construct the unit with a removable galvanized steel system strainer with 3/16-inch diameter perforations and a free area of not less than five times the cross-sectional area of the connecting pipe. Provide a blow down connection to facilitate routine cleaning of the strainer.
4. Manufacturer shall provide data sheet specifying air collection efficiency and pressure drop at rated flow.
5. Provide a Manufacturer's Data Report for Pressure Vessels, Form U-1 as required by the provisions of the ASME Boiler and Pressure Vessel Code for each air separator.
6. Manufacturer: Bell & Gossett, Armstrong, Taco, or Wessels.

T. INLINE AIR SEPARATORS (SMALL SYSTEMS):

1. Furnish and install as shown on plans a straight or angle, line size, air separator designed to effectively separate free air in hydronic heating systems. The air separator shall be heavy duty cast iron designed to function satisfactorily at working pressures up to 150 psi (10.3 bar) and liquid temperatures up to 250°F (121°C). The air separator shall have an internal diffuser and a coalescing medium design that will trap and collect air bubbles to be released at the top of the separator.
 - a) The Air Separator shall also assist in eliminating free air from the system by directing the air to a large capacity air vent while deaerated water is circulated to the system. The Air Separator shall allow expansion of the system fluid to be directed to a precharged bladder or diaphragm expansion tank.
 - b) Manufacturer: Bell & Gossett EAS or equivalent by Armstrong, Bell & Gossett, or Taco.

U. EXPANSION TANKS (SMALL SYSTEMS):

1. Furnish and install as shown on plans a pre-charged vertical steel expansion tank with integral heavy duty Butyl rubber diaphragm. The tank shall have 1/2" NPT system connection(s), and a .302"-32 charging valve connection (standard tire valve) to facilitate the on-site charging of the tank to meet system requirements. The tank must be constructed in accordance with Section VIII of the ASME Boiler and Pressure Vessel Code and stamped 125 PSI (862 kPa) working pressure at a temperature of 240 deg F. Tank may be installed in horizontal or vertical position.
2. Manufacturer: Bell & Gossett D15-V or equivalent by MEPCO, Taco, Wessels, or Wheatley.

V. WATER TREATMENT CHEMICAL FEEDER

1. Water Treatment Systems
 - a) Bypass chemical feeders: steel construction, minimum 2 gal capacity, with a pressure rating of 125 psig. Tank shall have inlet, outlet, filter, and fill cap with minimum 3.5" opening.
 - b) Supplier: Filter-feeder shall be Neptune FTF-5150DB or equivalent by Anderson, Dearborn Chemical, Garratt-Callahan, Diversity Water Technologies, Nalco, National Chemical, Superior, or Technical Specialties.

W. BUILDING CHILLED WATER METERING

1. Meter shall be one of the following:
 - a) Siemens Ultrasonic Clamp-on Flow FS230 7ME3723 when the straight pipe upstream is 10 or more pipe diameters and downstream is 5 or more pipe diameters or equivalent by Flexim.

- b) Rosemount Magnetic Flow 3051S when the straight pipe upstream and downstream is between 5 and 10 pipe diameters.
- 2. Meters shall have a local display. Connect each meter output to NC State campus network V-LAN via Modbus RTU TCP/IP. Meter shall be provided and capable of measurement of both instantaneous and accumulated flow and energy usage.
- 3. Thermo-wells (316S) shall not be mounted closer than 10 pipe diameters upstream or five (5) pipe diameters downstream from flow element.
- 4. See 'Flow Computer' section below.
- 5. All pressure and temperature transmitters and magnetic meters shall be provided with HART communications.
- 6. All temperature transmitters shall provide linear output with temperature within accuracy of 0.15 deg. F, over the calibrated range.

X. BUILDING STEAM METERING

- 1. Steam Meters shall be Veris Accelabar by Armstrong differential pressure flow meter with flanged connections. Select for horizontal or vertical pipe mounting as applicable.
- 2. Meter shall be sized to permit capture of the entire steam flow range, from low to high. The low to high flow range must be correctly identified in the submittal.
- 3. Meters shall have a local display. Connect each meter output to NC State campus network V-LAN via Modbus RTU TCP/IP. Meter shall be provided and capable of measurement of both instantaneous and accumulated energy usage.
- 4. Accuracy: +/-0.5% of rate.
- 5. Transmitter signal: 4-20mA.
- 6. 304 stainless steel body.
- 7. For process pressures 80 psi and below use ANSI B16.5 Cast Iron - Class 150 Flanges
- 8. The transmitter to measure differential pressure (DP) is to be a direct mount integral to the Accelabar with a 3-valve manifold. The transmitter shall be a Foxboro IDP10S.
- 9. A RTD mounted in the meter shall be used to send signals to the flow computer to register temperature. A puck style transmitter shall be used between the RTD and the flow computer.
- 10. The flow computer shall be provided for interface to campus energy management.
- 11. All pressure/temperature transmitters shall be provided with HART communications.
- 12. All temperature transmitters shall provide linear output with temperature within accuracy of 0.15 deg. F, over the calibrated range.
- 13. The final adjustments on the flow computer and transmitters shall be certified by an authorized technician representing the manufacture of the meter. This technician shall deliver a summary of findings to Energy Management on the status of the settings on the flow computer and transmitters.

14. The serial number(s) of the meter shall be provided to Energy Management so that the meter data may be transmitted via the campus LAN.
15. When needed, impulse lines shall be 316 stainless steel and 0.049" wall providing a minimum rating of 2,000 psig.
16. When needed, supports at 12 inch to 16 inch intervals shall be provided to support impulse lines at the meters from walls or device mounting supports.
17. Each pressure sensing transmitter the meters shall be provided with a three (3)-valve manifold.

Y. FLOW COMPUTERS FOR METERING

1. Basis-of-Design Product: Subject to compliance with requirements, provide package flow computer, including NEMA 1 enclosure, power disconnect, computer, pre-wired for 120VAC power, Modbus RTU to Ethernet converter. Prewired assembly shall be third party listed. Provide a Kessler-Ellis Products ES762 ST2L11P flow computer or NC State approved equal by Emerson, ABB, Flowmetrics, or Honeywell.
2. Flow Computers:
 - a) Display: backlit LCD display
 - b) Keypad: 16-key membrane keypad sealed to NEMA 4
 - c) Stored information: Steam Tables, and Fluid properties of water
 - d) Inputs: Analog input, pulse, and four secondary totalizer contact closure inputs.
 - e) Outputs: 2 relay, 2 analog, RS-485 Modbus RTU, pulse
 - i. Chilled Water: Instantaneous flow (gpm), Energy total (decatherms), energy rate (decatherms/hr), flow total (gallons), supply water and return water temperature.
 - ii. Steam: Pressure (psig), flow (Lb/hr), flow total (klbs), differential pressure (in wg).
 - f) Clock: Battery backed non-volatiles real time clock with display of time and date.

PART 3 EXECUTION

A. INSTALLATION - GENERAL

1. The piping systems have been designed to provide the most economical installation possible, taking into consideration accessibility and appearance. The Contractor must comply with the drawings. If it is impossible or obviously inadvisable to install the work in accordance with the plans and specifications, the Contractor shall notify the Architect or Engineer before proceeding.
2. The Contractor shall verify all measurements at the site before beginning fabrication, and shall be responsible for the correct location of all pipe. He shall also check the sizes of all outlets of the equipment, including the dimensions and drilling of flanges, etc., before beginning cutting or fabricating work.
3. Install pipe, tube and fittings in accordance with recognized industry practices which will achieve permanently-leakproof piping systems, capable of performing each indicated service without piping failure. Install each run with a minimum of joints and couplings, but with adequate and accessible unions for disassembly and maintenance/replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings. Align piping accurately at connections, within 1/16" miss-alignment tolerance.

4. Fittings must be used throughout the job. Changes in pipe sizes must be made with suitable factory-made fittings. No bushings will be allowed for flow piping except that these shall be permitted for final connections to terminal boxes. Install eccentric reducers in all piping where air would otherwise be trapped.
5. Locate piping runs, except as otherwise indicated, vertically and horizontally (pitched to drain) and avoid diagonal runs wherever possible. Orient horizontal runs parallel with walls and column lines. Locate runs as shown or described by diagrams, details and notations or, if not otherwise indicated, run piping in the shortest route which does not obstruct usable space or block access for servicing the building and its equipment. Hold piping close to walls, overhead construction, columns, and other structural and permanent-enclosure elements of the building; limit clearance to 0.5" where furring is shown for enclosure or concealment of piping, but allow for insulation thickness, if any. Where possible, locate insulated piping for 1.0" clearance outside insulation. Wherever possible, in finished and occupied spaces, conceal piping from view by locating in column enclosures, in hollow wall construction or above suspended ceilings; do not conceal horizontal runs in solid partitions, except as indicated.
6. Before installing pipe or accessories in any part of the system, the pipe or accessories shall be cleaned and made free of oil, dirt or any foreign matter.
 - a) Ream all pipe ends and take care at all times to prevent foreign materials from entering any pipe.
7. All risers and runouts in finished parts of building shall be run concealed, unless otherwise noted.

B. WATER PIPING

1. Water mains unless otherwise noted shall be graded to drain with a minimum grade of one inch in 40 feet.
2. Water runouts shall be taken from the top of the mains, with mains vented at high points. Water runouts taken from top of mains must be vented. Provide valved drains at all low points.
3. All safety relief valves for water relief shall have a discharge pipe turned down to discharge the water at the floor.
4. Provide manual air vents for water piping. Vents shall be provided at all high points of the piping system. Air vent discharge tube shall be turned down to allow discharge to be collected in a bucket or run to floor drain.
5. Each air vent shall be located so that it is accessible for service. Provide access panels where required. Piping shall be pitched to prevent traps or air pocket, except at the vent.

C. STEAM PIPING

1. Steam systems shall be pitched for drainage in direction of flow. Pitches, unless otherwise shown on the drawings, shall be not less than 1" in 8'-0".
 - a) Steam piping shall be pitched away from control valves.
2. Reducers in steam piping shall be eccentric type with the bottom level.
3. Install branch connections to steam mains using 45-degree fittings in main with takeoff out top of main. Use of 90-degree tee fittings is permissible where 45-degree fittings are impractical. Where length of branch takeoff is less than 10 feet, pitch branch line down toward mains.
4. Install unions or flanges adjacent to each valve, at final connections of each piece of equipment, and elsewhere as indicated.

5. Install strainers at inlet to pressure regulating valves, steam traps, control valves, and elsewhere as indicated.
6. Provide drip trap assembly at low points, points where condensate may back up in front of control valves and natural drainage points such as ends of mains, bottoms of risers, and ahead of pressure regulators, control valves, isolation valves, pipe bends, and expansion joints. Run condensate lines from traps to nearest condensate receiver. Where condensate lines form a trap, provide vent loop over the trapped section.
 - i. Size drip legs at vertical risers same size as pipe and extend beyond rise. Size drip legs at other locations same diameter as main. In steam mains 6-inch and larger, dirt leg size can be reduced, but to no less than 4-inch. Provide 18-inch long drip leg for steam mains smaller than 6-inch NPS.
 - ii. Install gate valve at drip legs, dirt pockets, and strainer blowdowns to allow removal of dirt and scale.
 - iii. Install steam traps close to drip legs.
 - iv. Install double block and bleed isolation valves upstream of steam traps located inside exterior manholes.
7. A vent pipe shall be installed for all steam safety valves to vent steam which is terminated so as not to create a hazard to personnel. All vent pipes and discharge piping from relief valves and safety valves shall be installed with hangers or supports to prevent pipe weight or strain from being placed on the relief or safety valve. Provide drip elbow with drain line from drip elbow at each steam safety valve.
8. Steam traps shall be provided at all low points of system as shown and detailed on drawings. Trap assembly shall be complete with strainer with blow-off, shut-off, check valve union reducers and globe valve bypass. All trap lines shall be Schedule 80 pipe.
9. Bucket traps shall be provided for all condensate producing equipment or mains and risers requiring return to the condensate of the condensate mains on medium pressure steam lines.

D. PIPING SYSTEM JOINTS

1. Threaded Joints: Thread pipe in accordance with ANSI B2.1; cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint compound, or pipe joint tape (Teflon) where recommended by pipe/fitting manufacturer, on male threads at each joint and tighten joint to leave not more than 3 threads exposed. Interior of pipe shall be reamed or filed so as to remove all burrs or fins. The interior surfaces shall be thoroughly cleaned before erection and blown out through temporary connections after erection.
2. Soldered Joints: Solder copper tube and fitting joints where indicated, in accordance with recognized industry practices. Cut tube ends squarely, ream to full inside diameter, and clean outside of tube ends and inside of fittings. Apply solder flux to joint areas of both tubes and fittings. Insert tube full depth into fitting, and solder in a manner which will draw solder full depth and circumference of joint. Wipe excess solder from joint before it hardens.
3. Insulating (Dielectric) Unions: Comply with manufacturer's instructions for installing unions. Install unions in a manner which will prevent galvanic action and stop corrosion where there is joining of ferrous and non-ferrous piping.
4. Welding:
 - a) Piping may be shop welded and brought to the site for installation.

- b) Qualification: Operators who are to do the welding shall be properly qualified to do satisfactory work as required by Section IX of the ASME Boiler and Pressure Vessel Code. Copies of welder certifications shall be provided to the Owner for all welders on the job. The Designer or Owner reserves the right to require qualifying demonstrations at the mechanical contractor's expense, of any welders assigned to the job.
 - c) Pipe welding shall comply with the provisions of the latest revision of the applicable American National Standard Institute Code. Specifically, piping shall comply and be tested in accordance with standards of ANSI/ASME B31.1, Power Piping.
 - d) Welded Joints: Weld pipe joints in accordance with recognized industry practices. Pipe welding in sizes 4 inches and smaller may be either by the manual metallic arc process or the oxyacetylene welding process, and in sizes larger than 4 inches shall be of the manual metallic arc process with coated electrodes. All welding shall be done in accordance with Chapter V of the latest edition of the ANSI code for pressure piping B31.1 except welding on boiler external piping which shall conform to the provisions of the latest revisions to the applicable section of the ASME Boiler and Pressure Vessel Code.
 - i. Bevel pipe ends at 37.5 degree angle where possible, smooth rough cuts, and clean to remove slag, metal particles and dirt.
 - ii. Install welding rings for butt-welded joints on pipe 8" and larger.
 - iii. Use pipe clamps or tack-weld joints with 1.0" long welds; 4 welds for pipe sizes to 10", 8 welds for pipes sizes up to 20".
 - iv. Build up welds with a stringer-bead pass, followed by a hot pass, followed by a cover or filler pass. Eliminate valleys at center and edges of each weld. Weld by procedures which will ensure elimination of unsound or unfused metal, cracks, oxidations, blow-holes and non-metallic inclusions.
 - v. Do not weld-out piping system imperfections by tack-welding procedures; refabricate to comply with requirements.
 - vi. Install forged branch-connection fittings wherever branch pipe of size smaller than main pipe is indicated, or install regular "T" fitting (at Contractor's option).
 - e) Tee connections in welded piping shall be made with a factory fabricated butt welding tee or with weld-o-let of butt or socket. Tees fabricated from pipe shall not be permitted. Long radius welding ells shall, wherever possible, be used in changing pipe directions of welded pipe lines. Mitered joints shall not be approved.
 - f) Pipe weld will be achieved by full penetration of base, metal, multiple pass.
 - g) The Owner reserves the right to utilize radiographic testing to verify the integrity of any weld(s). If the integrity of any weld(s) are found to be in compliance with ANSI B31.1, the Owner shall pay for the cost of the tests. If any weld(s) are found to be deficient, the Contractor shall be responsible for all costs associated with the testing and repair of welds.
5. Flanged Joints: Match flanges within piping system, and at connections with valves and equipment. Clean flange faces and install gaskets. Tighten bolts to provide uniform compression of gaskets.

E. CONDENSATE DRAINS

- 1. Provide condensate drains on all air handling units, blower coil units, fan coil units and cooling coils. Pipe to nearest floor drain or where indicated on drawings.
- 2. Condensate drain piping shall be installed with trap at the coil connection and shall have a minimum seal depth equal to the respective air handling unit fan static pressure plus one inch.

F. VALVES

- 1. General: Except as otherwise indicated, comply with the following requirements:

- a) Install valves where required for proper operation of piping and equipment, including valves in branch lines where necessary to isolate sections of piping. Valves shall be accessible and separate support shall be provided when necessary.
- b) Install valves with stems in the vertical position where possible, but in no case with stems pointed downward from a horizontal plane.
- c) Insulation: Where insulation is indicated, install extended stem valve, arranged in the proper manner to receive insulation.
- d) Applications Subject to Shocks: Install valves with bodies of metal other than cast-iron where thermal or mechanical shock is indicated or can be expected to occur.
- e) Applications Subject to Corrosion: Do not install bronze valve components in direct contact with steel, unless the bronze and steel are separated by a dielectric insulator. Install bronze valves in steam and condensate service and in other services where corrosion is indicated or can be expected to occur.
- f) Mechanical Actuators: Install mechanical actuators with chain operators where indicated, and where valves 4" and larger are mounted more than 7'-0" above the floor, and where recommended by the valve manufacturer because of valve size, pressure differential, or other operating condition making manual operation difficult.
- g) Selection of Valves: Gate valves or butterfly valves shall be used at all locations where shut-off valves are required unless otherwise indicated. For valves 2" and smaller, ball valves may be used. Gate valves shall not be used for balancing.
- h) Valve Stems: Select and install valves with outside screw and yoke stems, except provide inside screw non-rising stem valves where headroom prevents full opening of OS and Y valves.
- i) Non-Metallic Disc: Limit the selection and installation of valves with non-metallic discs to locations indicated and where foreign material in the piping system can be expected to prevent tight shut off of metal seated valves.
- j) Renewable Seats: Select and install valves with renewable seats, except where frequent usage of the valve is indicated.
- k) Lubricant-Seal: Select and install plug valves with lubricant-seal except where frequent usage is indicated or can be reasonably expected to occur.
- l) Fluid Control: Except as otherwise indicated, install gate, ball, globe, plug and butterfly valves to comply with ANSI B31. Where throttling is indicated or recognized as the principal reason for the valves, install globe or butterfly valves. Install check valves where indicated and where flow reversal is obviously not desirable but can be reasonably expected to occur, including piping at the discharge of pumps. Install silent check valves at the discharge of centrifugal pumps or other locations where necessary to eliminate water hammer occurring from reversal of flow.

G. STEAM TRAP

- 1. Steam Trap Applications:
 - a) Use inverted bucket traps on medium pressure riser drip legs in manholes.
 - b) Use Float and Thermostatic traps on heat exchangers, low pressure flash tanks, humidifiers, and coils.
 - c) Use thermodynamic disc traps on building medium pressure drip legs.
- 2. Install steam traps in accessible locations close to connected equipment. Install gate valve, strainer and union upstream of trap; install union, check valve, test tee/valve, and gate valve downstream from trap.

H. STRAINERS

1. Install strainers at inlet of pumps, at inlets to pressure-reducing valves, temperature-regulating valves, automatic flow control valves, solenoid valves, steam traps, and elsewhere as indicated or as required for proper operation of the system. Install strainers in accordance with manufacturer's instructions and so that screens are easily removable.
2. Install 3/4-inch nipple and ball valve in blowdown connection of strainers 2 inches and larger. Match size of strainer blowoff connection for strainers smaller than 2 inches.

I. WATER TREATMENT CHEMICAL FEEDERS

1. Systems requiring water treatment chemical feeders include:
 - a) heating hot water system.
2. Chilled water and steam treatment feeders and chemicals are provided through the campus distribution system.
3. Water treatment analysis and chemical addition shall be completed by the Owner.

J. FLOW METERING

1. Assemble and install connections, tubing, and accessories between flow measuring elements, flow meters, and flow computers according to manufacturer's written instructions.
2. Install flow meter elements in accessible positions in piping systems.
3. Install flow meters in proper orientation and with proper flow direction based on manufacturer specifications.
4. Install differential-pressure-type flow meter elements, with at least minimum straight lengths of pipe, upstream and downstream from element according to manufacturer's written instructions.
5. Install permanent indicators on walls or brackets in accessible and readable positions.
6. Install connection fittings in accessible locations for attachment to portable indicators.
7. When possible, meters shall be installed five (5) feet or lower above the finished floor.
8. Connections
 - a) Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.
 - b) Connect flow meter-system elements to meters.
 - c) Connect flow meter transmitters to meters.
 - d) Connect thermal-energy meter transmitters to meters.

K. ELECTRICAL EQUIPMENT SPACE

1. Do not run piping through transformer vaults, elevator equipment rooms, and other electrical or electronic equipment spaces and enclosures. Where piping is indicated running through these areas, provide a watertight drain pan to protect electrical equipment.

L. PIPE SLEEVES

1. All pipes installed under this contract passing through walls and partitions of building shall be provided with pipe sleeves which extend 1/4 inch beyond finished surface. Sleeves shall be neatly cemented in position, concentric with the pipes, after they are in final position, with sleeve sized for the insulation thickness specified or as detailed on drawings. Provided clearance between sleeve and pipe or between sleeve and insulation to allow for pipe movement due to expansion and constriction.
2. All pipes passing through floors, except penthouse floors, and equipment rooms above grade, shall have pipe sleeves which project 1/2 inch above the finished floor. In equipment rooms, above ground floors, sleeves shall project at least 6 inches above finished floor and be sealed and caulked to prevent water from leaking into ceiling below.
3. All penetrations through fire rated and smoke rated floors and partitions shall be caulked with an approved fireproof material to form a fire and smoke stop at the floors, and fire or smoke rated partitions. Material shall be installed in accordance with its U.L. rating. Any sleeves provided and not later used shall be sealed with concrete or similar fireproof material. Refer also to plan details.
4. Pipe sleeves passing through floors, interior partitions, ceilings and exterior penetrations above grade shall be standard steel pipe sleeves. Pipe sleeves through non-fire rated interior partitions may be galvanized sheet metal.

M. CLEANING AND FILLING CHILLED WATER AND HOT WATER SYSTEMS

1. The chilled water and hot water piping systems shall be cleaned using Dearborn Aqua-Serve BC-45 cleaner or approved equivalent.
2. Add cleaner to the system at the rate of ten pounds per one hundred gallons; fill, vent, and circulate solution.
3. Temporary filters shall be used during the flush to remove debris loosened by the cleaning process.
4. The supply and return lines shall be tied together on each end and the cleaning solution shall be circulated by temporary cleaning pump until filter checks show the fluid is clean, or twenty-four (24) hours, whichever is longer.
5. All instrumentation, and any system component not compatible with the cleaning process shall be removed before the cleaning agent is applied.
6. The system shall be flushed and circulated with clean water after the cleaning process until the system is free of the cleaning solution, and is in a neutral pH state.
7. remove and clean strainers.
8. Proper disposal of any contaminated fluids shall be the responsibility of the contractor.
9. Refill the system with clean, treated water and purge all air.
10. Clean, fill and test system prior to connection to: domestic water system for hot water system.

N. CLEANING AND FILLING STEAM PIPING SYSTEMS

1. All piping systems or part systems shall be cleaned and flushed prior to testing. All strainers shall be cleaned after the flushing process.
2. The condensate piping systems shall be cleaned using Dearborn Aqua-Serve type BC-45 cleaner or approved equal.

3. A contractor with knowledge and experience in steam blow cleaning shall be contracted to supply a complete package including supervision necessary to perform the work in a timely, safe, and efficient manner.
4. Steam blow procedure and equipment set up must be approved by the designer and the Owner.
5. All steam lines shall be "steam blowed cleaned". Cleaning force ratio shall be a minimum of 1.0. Steam blow shall be repeated at least a minimum of 3 cycles with a cooling period of 48 hours in between each cycle.

O. TESTING

1. All piping shall be leak tested prior to applicable of insulation. Contractor shall repair all leaks immediately using industry standard methods.
2. All piping, except oil and gas piping, shall be tested with water at 150% of operating pressure and not less than 150 psig pressure. During test the piping shall be isolated from equipment and ends capped. Pressure shall be provided by means of a test pump and maintained for at least 24 hours. All piping to be concealed shall be tested before concealing or covering.
3. Final test shall consist of subjecting the piping and equipment to steam and water tests, duplicating as far as possible the normal operating conditions under which the piping systems shall function. During the application of the final test, proper provisions shall be made to remove all air and to expose all joints to the service under which they will operate. Under the final test all joints shall be made absolutely tight, the piping shall expand or contract freely on the supports and shall maintain good alignment throughout.
4. The Contractor shall maintain a test log consisting of piping section tested, building name, date, time, test pressure, results of test, and tester's initials. This log shall be turned over to Engineer as part of project acceptance submittal.

P. NON DESTRUCTIVE TESTING OF EXTERIOR STEAM PIPING IN TUNNELS

1. All welds in the steam and steam condensate distribution system shall be inspected and tested by non-destructive examination.
2. Inspections and tests shall be performed by an American Welding Society Certified Welding Inspector (AWS-CWI).
3. All butt welds shall be tested by means of radiography. The criterion for pass/fail of these tests shall be as defined in ANSI/ASME B31.1.
4. All socket welds shall be tested by means of dye penetrate or magnetic particle analysis. The criterion for pass/fail of these tests shall be as defined in ANSI/ASME B31.1.
5. Where radiography cannot be used to test a weld due to site restrictions, the weld may be visually inspected by the AWS-CWI provided that all the following conditions are met.
 - a) The University Facility Engineering Representative (UFER) and Engineer shall agree that a radiographic test cannot be reasonably achieved.
 - b) The pipe joint fit up shall be inspected prior to welding by the AWS-CWI.
 - c) All welding passes shall be inspected by the AWS-CWI including the root pass, hot pass, and all fill and cover passes.

END OF SECTION 23 10 00

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SECTION 23 10 10 UNDERGROUND STEAM SYSTEMS

PART 1. GENERAL

- A. Provide concrete conduit, trenching, backfilling, and installation of underground steam systems in accordance with these specifications and other specification sections and contract documents.
- B. DESCRIPTION
 - 1. The requirements of this section apply to the piping systems shown on the drawings, specified in this section and in other related sections.
- C. RELATED SECTIONS
 - 1. Refer to Section 23 10 00 HVAC Piping, Valves and Accessories for piping and valves.
 - 2. Refer to Section 31 50 00 Excavation Support and Protection.

PART 2. PRODUCTS

- A. PIPING MATERIALS
 - 1. Refer to Specification Section 23 1000, HVAC Piping, Valves and Accessories.
- B. UNDERGROUND CONDUIT SYSTEM.
 - 1. All steam and condensate lines shall be enclosed in a continuous concrete conduit system between manholes. The conduit system has the following general appearance. The pre-cast concrete covers may also have an arched shape. The tunnel system shall be installed with 36" minimum cover, with an emphasis on going no deeper than necessary.
 - 2. Foundation:
 - a) The conduit foundation shall consist of a continuous cast-in-place monolithic concrete foundation slab with appropriate expansion joints. The foundation will be poured with concrete having a 28- day minimum compressive strength of 4000 psi. Structural reinforcement shall be designed per the loading requirements by a licensed structural engineer, but in no case shall be less than 6 x 6 - W2 x W2.9 welded wire fabric (6 gage). The structural re-enforcing steel shall meet the requirements in the steel reinforcement section of this document. The foundation shall have a sloped floor and center drain allowing for proper drainage to the downstream manhole of any tramp water in the conduit system. The center drain shall have a minimum dimension of 1" depth by 4" width. The foundation shall be keyed or notched on either side to accept the precast covers ensuring proper alignment, and preventing lateral motion during backfill.
 - b) Slab surfaces shall be screeded straight and to proper grades and pitched uniformly to drainage points. The foundation slab and drain shall extend through building and manhole walls unless noted on the drawings. The openings to the manhole from the conduit system shall be sealed off with 4" thick block insulation to prevent air from drafting down the conduit system. The conduit center drains shall not be blocked off from the manhole. Other methods of removable insulation will be considered.

3. Pre-cast Covers.
 - a) The pre-cast concrete covers in the conduit system shall not be used as a means of piping restraint or support in any manner. At expansion loops and elbows, conduit shall be sized to allow for expansion and contraction without damaging the insulation, piping, or conduit structure.
 - b) The pre-cast covers shall be manufactured by an industrial/commercial manufacturer who has been manufacturing the style cover selected for a minimum of five (5) years. The manufacturer must provide a minimum of five (5) reference projects where this cover has been used. The covers shall be cast with inside clearance dimensions as shown on the drawings. Suppliers of precast tunnel covers must furnish calculations to the Designer to verify structural adequacy for design loading.
 - c) The pre-cast covers shall be designed with interlocking ends such that the covers joined together in a method similar to tongue-and-groove or lap-joint.
 - d) The concrete used in the covers shall have the minimum 28 day compressive strength as required by the licensed structural engineer, but shall not be less than 4000 psi in any case. The conduit system shall be designed to withstand all of the following loading conditions.
 - (1) HS-20 highway loads at 2 feet of cover, and
 - (2) Soil loading assuming a soil density of 100 lbm/cuft., at the installed depth of cover, or at 10 feet of cover, whichever is greater.
 - e) Structural reinforcement shall be designed per the loading requirements by a licensed structural engineer, but in no case shall be less than 6 x 6 - W2 x W2.9 welded wire fabric (6 gage). The structural re-enforcing steel shall meet the requirements in the steel reinforcement section of this document.
4. Sealants
 - a) Waterproofing sealant shall be used at all joints between foundation slab and pre-cast concrete covers, and at joints between adjacent pre-cast concrete cover sections. The sealants shall be butyl resin or one part polyurethane. The polyurethane sealants shall be equal to SikaSwell S as manufactured by Sika. The butyl resin sealants shall be equal to ConSeal as manufactured by Concrete Sealants Inc.
 - b) The sealant shall be installed so as to provide full coverage of all concrete joint contact surfaces per the manufacturers recommendations. Place sealant on parts to be joined prior to final positioning of the pre-cast structures.
5. Waterproofing mastic
 - a) A heavy coat of non-asphalt, rubber/resin based mastic for underground use shall be applied a minimum of 12 inches wide to all joints after the joint is made. The mastic shall be equal to Sandell Special Nuflex Mastic as manufactured by Sandell Manufacturing Co., Inc.
6. Waterproofing Membrane
 - a) A waterproofing membrane shall be installed over the entire conduit system. The membrane shall be polyvinyl chloride. The membrane shall have a nominal thickness of 20 mils, and have a minimum tensile strength of 2300 psi.
 - b) The membrane shall be wide enough to drape over the conduit structure and lap over the foundation on both sides in one piece. The membrane shall be extended axially along the conduit system from a large roll so as to minimize the number of joints in the membrane.

- c) The PVC membrane jacket shall be overlapped a minimum of 12 inches and sealed with a nonasphalt resin based sealant at membrane joints to produce a waterproof seal. The waterproofing membrane shall be adhered to the concrete joints and to itself at overlaps. The entire conduit system shall be made waterproof. All manufacturer's installation recommendations shall be followed.
- 7. Waterproofing Backfill Protection
 - a) The waterproofing membrane shall be protected from backfill by a layer of non-woven polypropylene. The polypropylene protective layer shall have an approximate weight of ½ lb. per square yard. The polypropylene covering shall be equal to Terratex non-woven geotextile No. 8 as manufactured by Webtec, Inc. At wrap joints the materials shall overlap a minimum of 12 inches. The wrap joints shall not be coincident with waterproofing membrane joints. All manufacture's installation recommendations shall be followed.

PART 3. EXECUTION

A. EXCAVATION

- 1. The Contractor is responsible for all demolition, excavation, surveying, grading, dewatering, bedding and backfilling required to install direct buried conduits.
- 2. Where the native soil condition is determined to be poor provide excavation below subgrade (EBS) and undercut backfill material to underside of steam pits, box conduit or tunnels mud slab.
- 3. Work shall be made and erected square, plumb, straight and true, smooth, with accurately fitted joints and intersections. Work shall be reinforced and anchored in place.
- 4. Contractor shall be responsible for location and levels of work of this Section, this contractor shall assist others in properly locating equipment and pipe systems.

B. BEDDING AND UTILITY COVER

- 1. Coordinate material installation in accordance with the applicable requirements of Division 33 Sections for trenching, dewatering, .
- 2. Provide bedding from excavation to bottom of direct buried conduits a minimum of 6".
- 3. Provide utility cover to 12" above top of direct buried conduits and/or box conduits.

C. PIPING SUPPORTS, ANCHORS, AND GUIDES

- 1. All piping shall be supported with devices which permit the pipe to expand thermally without wear to the pipe. Slide type supports, or roller type supports may be used. When rollers are used, piping saddles matching or exceeding the insulation depth shall be used. When slides are used, a Teflon slide surface shall be integral to the slide design. All means of pipe supports shall be secured in position. Anchor and guide supports shall be cast into the base slab when it is poured. Supports providing only vertical support may be secured by stainless anchor bolts rather than cast in place.

2. All supporting and restraining devices must be selected as part of the system stress analysis. The devices shall be suitable to sustain the static and dynamic loads of the system as defined in the ASME B31.1 Power Piping Code.
3. No anchoring systems which use insulation as a means of piping restraint or support shall be allowed. Anchors shall be welded to piping. Saddles shall be tack welded to the piping. Guides structure shall be welded to the piping. All wear shall occur between saddles and roller, or between guides and substrate, with no wear at the piping.
4. All structural embedments and anchor bolts penetrating the concrete structures shall be stainless steel. An example would be a simple channel support where a horizontal channel is welded to two 3" pipes embedded into the concrete to create a flat support structure for an anchor, guide, support, etc.
 - a) The pipes embedded in the concrete would be 304L stainless steel. The channel iron cross member would be carbon steel.
 - b) Only the material penetrating the concrete needs to be stainless. In the case of 304L stainless pipe welded to carbon steel channel, SS309 filler material would be used to make the dissimilar metal weld.
 - c) Carbon steel shall not be used within 2 inches of the floor of manholes or pipe conduits.
5. For piping systems in conduits with expansion loops or Ells, the piping anchors, at a minimum, shall consist of a structural steel channel welded to the pipe. The structural channel shall have a length equal the 2x the nominal diameter of the pipe, and a width equal to ½ the nominal diameter of the pipe. For example, a 12 inch pipe will have a channel that is fully welded along the pipe axis at the contact lines not less than 24 inches, and 6 inches between the welds. This channel is then welded to the substrate to create an anchor, or is riding on the Teflon surface to create a slide, etc. The channel could be an "H" beam, for a more heavy-duty application.
6. Hangers or supports shall be installed within two (2) feet of each change of direction, in any plane. Protect insulated steam and steam condensate piping at support points with saddles or extended slides welded to the pipe.
7. Hangers and supports shall be as manufactured by Fee & Mason, Grinnell, Modern, B-Line or an approved equal.

D. ROUTING

1. The Contractor shall coordinate the routing of all steam and steam condensate piping with other contractors prior to installation.
2. Furnish and install valves as required to allow for complete system venting and drain down.
3. Grade piping and piping conduit systems not less than 1/8th inch per foot in the direction indicated on the drawings.
4. Proper standoff shall be provided to protect other utilities from damage from construction, maintenance, or operating conditions. Consideration shall be given to potential damage to other utilities from high temperatures near steam lines.

5. Standoff from electrical and telecom utilities or systems shall be a minimum of three feet. When adequate standoff cannot be achieved, any portion of a duct bank within three (3) feet of steam conduit in any direction shall be insulated with two (2) inches thick cellular glass on the three sides closest to the steam line, until at a point not closer than three (3) feet.
6. Standoff from chilled water lines shall be a minimum of five (five) feet. When adequate standoff between chilled water and steam lines and the chilled water lines cannot be achieved, the chilled water lines shall be insulated with a minimum of two (2) inches cellular glass insulation.
7. Piping shall have a locating wire and warning tape installed meeting the following requirements:
 - a) Direct bury a bright yellow plastic warning tape buried 12 inches below grade, directly above the center of the steam conduit structure. The tape shall read “WARNING STEAM – WARNING STEAM – WARNING STEAM”.
 - (1) Along with the warning tape 12” above the steam conduit direct bury a locating wire. The wire shall be equivalent to Annixter #6Q-1202-05 (bright Yellow), direct burial 2 conductor, 12 gage stranded copper. The wire shall penetrate the manholes through a one inch PVC sleeve, and be coiled on a hook inside of the manholes. The sleeve shall be sealed with a high temperature silicone sealant around the wire. The wire shall not continue through manholes, but shall be broken inside of each manhole. The wire shall be clearly labeled on the hooks inside of the manholes to say “Trace Wire”

END OF SECTION 23 10 10

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SECTION 23 10 20 UNDERGROUND CHILLED WATER SYSTEMS

PART 1. GENERAL

- A. Provide trenching, backfilling, and installation of underground chilled water systems in accordance with these specifications and other specification sections and contract documents.
- B. DESCRIPTION
 - 1. The requirements of this section apply to the piping systems shown on the drawings, specified in this section and in other related sections.
- C. RELATED SECTIONS
 - 1. Refer to Section 23 10 00 HVAC Piping, Valves and Accessories for piping and valves.
 - 2. Refer to Section 31 50 00 Excavation Support and Protection.

PART 2. PRODUCTS

- A. PIPING MATERIALS
 - 1. Refer to Specification Section 23 1000, HVAC Piping, Valves and Accessories.
- B. AIR VENTS
 - 1. Automatic Air Vents. Val Matic Model 38 or approved equal by Dezurik, Pratt or equivalent. Maximum working pressure 300 psi, compound lever type, 1" inlet, ½" outlet, stainless steel trim and float, cast iron body and cover.
 - 2. Manual Air Vents. 1" bronze body, heavy duty, 2 piece ball valve. Class 600 WOG, threaded or soldered ends, solid stainless steel; ball and stem not chrome plated; full port.
- C. DIRECT BURIED VALVES
 - 1. Valves to be designed for direct buried application shall conform to latest revision of AWWA C504 in addition to the requirements listed below.
 - 2. Valves shall be rated for AWWA C504 Class 150B. Valves are to be bubble-tight at the rated pressure in either direction. They shall be suitable for throttling service and operation after long periods of inactivity. Valves must be hydrostatic, and leak tested in accordance with AWWA C504.
 - 3. Ductile iron body ASTM A536, restrained mechanical joint (AWWA C111/ANSI 21.11) ends. Valves shall be furnished complete with all required MJ joint accessories (bolts, nuts, gaskets and glands).
 - 4. Valve discs shall be constructed of cast iron ASTM A126, Class B, or ductile iron ASTM A536. Disc shall have ASTM A276-Type 316 continuous stainless-steel seating edge to mate with valve seat.
 - 5. Valve shaft to be corrosion resistant, ASTM A276-Type 304; ASTM A276-Type 316; ASTM A564 Grade 65-45-12 or approved equal.

6. Resilient seat shall be natural rubber (BUNA-N). Seat shall be bonded or mechanically retained in the valve body only. The seat shall be capable of mechanical adjustment and/or replacement in the field.
7. Valve assembly shall be furnished with a non-adjustable, factory set, thrust-bearing, and centered to the valve disc at all times. Shaft bearings shall be contained in the integral hubs of the valve body, be self-lubricated sleeve type and be sealed in place with self-adjusting packing.
8. Valves to be complete with grease packed buried service gear operator in compliance with latest revision of AWWA C504. Actuator shall have adjustable open and closed mechanical position stops that can withstand input torque of 450 ft-lbs. Orient valve operator to the outside of the trench or pipe (see Appendix D). Operator shall include shaft extensions to within one foot of finished grade, centering disc(s) located on shaft extensions, and all required soil pipes. Refer to drawings for length of shaft extensions and soil pipes.
1. Approved Manufacturers: DeZurik, Pratt, Valmatic or approved equal.

D. Valve Boxes

1. Valve boxes shall be 2 – piece cast iron, screw type, 5.25” shaft with heavy-duty highway H20 lid marked “CHILLED WATER” or “CHW”.
2. Valve boxes to be coated with coal tar for direct buried service application.

E. Vent Valve Boxes

1. Vent valve boxes shall be 2-piece cast iron, 12-inch diameter box with a cover with a highway H20 rating. Boxes shall be located directly above the installed corporation stop. Mark cover as “CHILLER WATER” or “CHW”.

PART 3. EXECUTION

A. EXCAVATION

1. The Contractor is responsible for all demolition, excavation, surveying, grading, dewatering, bedding and backfilling required to install direct buried conduits.
2. Where the native soil condition is determined to be poor provide excavation below subgrade (EBS) and undercut backfill material to underside of steam pits, box conduit or tunnels mud slab.
3. Work shall be made and erected square, plumb, straight and true, smooth, with accurately fitted joints and intersections. Work shall be reinforced and anchored in place.
4. Contractor shall be responsible for location and levels of work of this Section, this contractor shall assist others in properly locating equipment and pipe systems.
5. Refer also to Specification Section 31 50 00 Excavation Support and Protection.

B. BEDDING AND UTILITY COVER

1. Coordinate material installation in accordance with the applicable requirements of Division 33 Sections for trenching, dewatering, and shoring.
2. Excavate to bottom of pipe bedding. Undercut the trench bottom (4" in stable soils, 6" in rock or wet trenches and 8" in unstable soil) and replace the undercut material with crushed stone chips in the bottom of the pipe trench. Finish bottoms of excavations to true, level surface.
3. Bed piping and cover up to a point 4" inches above the top of the pipe with thoroughly compacted sand or pea gravel. Take care during bedding, compaction and backfill not to disturb or damage piping. Backfill above the bedding in lawn areas shall be thoroughly compacted excavated material free of large stones, organic, perishable, and frozen materials. Backfill above the bedding under existing and future utilities, paving, sidewalks, curbs, roads and buildings shall be granular materials, pit run sand, gravel, or crushed stone, free from large stones, organic, perishable, and frozen materials.

C. AIR VENTS

1. Run water mains level or pitch in the direction as shown. Install manual air vents at all high points where air may collect.

D. VALVE BOXES:

1. Provide buried service actuator for underground valves with worm gear operator. Valve box bell section shall sit on a stabilizer, BFVA from Adaptor Inc, Bingham & Taylor Buffalo box or approved equal.
2. Valve shall open by turning operating nut counter clockwise.
3. Valve boxes shall have removeable debris cap.
4. Valve boxes shall have a minimum 3" metal (non-corrosive) Identification tag set flush in the the concrete around the valve box or forged into the cover. The tag shall identify the service, i.e. CHW or CHILLED WATER and pipe size. Letters shall be minimum 1" high.
5. Valve box stabilizers shall be set to ensure no material can migrate from backfilling around the valve nut.

E. THRUST BLOCKING:

1. Securely block and wedge all bends, caps, plugs, and tees, for piping systems 4" and larger, to solid undisturbed earth with approved precast or cast-in-place concrete thrust blocks.

F. ROUTING

1. Lay all pipes to line and grade shown on the plans with bell ends up hill. Lay with minimum 3 feet of cover where there is no grade given for the chilled water main on the plan sheets. Keep ends of the water lines sealed at all times to prevent the entrance of animals or foreign materials.

2. Where two (2) pipes are laid in the same trench, maintain a minimum spacing of 12” between pipes and fittings.
3. Mechanically compact bedding and backfill to prevent settlement.
4. Do not leave more than 100 feet of trench open without backfill above the bedding at any time. Backfill all trenches completely, or provide safety barrier fencing at the end of each work day.
5. Restore the surface of all disturbed areas to a like condition of the surface prior to the work. Level off all waste disposal areas and clean up all areas used for the storage of materials or the temporary deposit of excavated earth. Remove all surplus material, tools and equipment.
6. The Contractor shall coordinate the routing of all chilled water piping with other contractors prior to installation.
7. Furnish and install valves and vents as required to allow for complete system venting and drain down.
8. Proper separation shall be provided to protect other utilities from damage from construction, maintenance, or operating conditions.
9. Piping shall have a warning tape installed meeting the following requirements:
 - a) Direct bury a bright blue plastic warning tape buried 12 inches below grade, centered over the piping. The tape shall read “WARNING CHILLED WATER – WARNING CHILLED WATER – WARNING CHILLED WATER”.

END OF SECTION 23 10 20

SECTION 23 25 00 – HVAC INSULATION

PART 1 - GENERAL

A. DESCRIPTION

1. General provisions and other mechanical systems are specified in other Sections of Division 23.
2. This Section covers thermal insulation for equipment, ductwork and piping specified in Division 23.

B. QUALITY ASSURANCE

1. Conform to the North Carolina State Building Code, Mechanical and Energy Conservation Codes 2018.
2. Materials shall be applied subject to their temperature limits. Methods of application of insulating materials or finishes not specified in detail herein shall be in accordance with the particular manufacturer's published recommendations.
3. Insulation shall be applied by experienced workers regularly employed for this type of work.

C. RATINGS

1. Insulation and accessories, unless specifically excepted herein, shall have a maximum composite flame spread rating of 25 and a maximum smoke developed rating of 50. Materials that are factory-applied shall be tested as assembled. Materials which are field-applied may be tested individually.
2. Flame spread and smoke developed ratings shall be in accordance with ASTM E84. Products or their shipping cartons shall bear a label indicating flame spread and smoke developed ratings.
3. Treatment of pipe jackets and duct facings to impart flame and smoke safety shall be permanent. The use of water-soluble treatments is prohibited.
4. Vapor barriers shall have a maximum permance of 0.05 perm

PART 2 - PRODUCTS

D. MATERIALS

1. Fiberglass Pipe, Duct and Equipment Insulation:
 - a) Maximum K-value for preformed pipe insulation: 0.23 Btu·in/hr·ft²·°F at 75°F.
 - b) Maximum K-value for blanket and board insulation: 0.28 Btu·in/hr·ft²·°F at 75°F.
 - c) Manufacturer: CertainTeed, Johns Manville, Knauf, or Owens Corning.
2. Preformed Fittings:
 - a) Equal thickness and composition to adjacent pipe insulation.

- b) Premolded Fitting, Valve, and Flange Covers - PVC, 15 mils thick. Provide 2-layer precut insulation inserts matched to pipe insulation, vapor barrier and required mastic adhesives and tapes.
 - c) Manufacturer: Hamfab, Manville, Performance Insulation Fabricators, or Quality-Fit.
- 3. Flexible Elastomeric Sheet, Tubing and Tape:
 - a) Closed-cell.
 - b) Maximum K-value: 0.27 Btu-in/hr-ft²-°F at 75°F.
 - c) Manufacturer: Armacell AP Armaflex, Kavco, or RUBATEX.
- 4. Calcium Silicate: Calcium silicate block and pipe insulation shall be asbestos-free, chloride inhibited insulation conforming to ASTM C533 and all latest addenda, furnished with standard canvas jacket as required. K factor shall not exceed 0.38 at 100 degrees F.
- 5. Pre-formed Cellular Glass: Cellular glass pipe insulation shall be closed cell expanded glass insulation with no binders or fillers conforming to ASTM C552 and all latest addenda, furnished with all service jackets with self-sealing laps as required. K factor shall not exceed 0.32 at 75 degrees F.

E. FACINGS AND JACKETS

- 1. General service facing and jacketing shall be a laminate of aluminum foil, glass reinforcing and finished white kraft paper having a perm of not more than 0.02 and a puncture resistant of 50 beech puncture units. Where used as an underlayment, jacketing shall consist of foil, glass scrim and plain fire resistant kraft.
- 2. Glass cloth shall be pre-sized closely woven glass fiber fabric weighing not less than 8 oz. per square yard.
- 3. Fitting Jackets:
 - a) PVC, 15 mil thick,.
 - b) Manufacturer: Foster Sealfas/Speedline, Johns Manville Zeston 2000, Owens Corning, or Starr Davis.
- 4. Glass insulation covers shall be one-piece factory premolded PVC covers with factory precut insulation inserts.
- 5. Aluminum jacketing shall be manufactured from aluminum alloy 0.016 inch thick and have a factory lined vapor barrier. Jacket may be 3/16 inch corrugated, embossed, or smooth. Accessories including edge-safe strapping, seals, fasteners, aluminum fitting jackets, adhesives, etc., shall be compatible with jacketing and shall be furnished by the same manufacturer furnishing jacketing.

F. REMOVABLE JACKETS FOR STEAM

- 1. For Box Type Jackets:
 - a) High-temperature insulation blanket formed of silica Aerogel and reinforced with a non-woven, glass-fiber batting.
 - b) Insulation must be hydrophobic
 - c) Estimation of Maximum Use Temperature 1200°F (650°C)
- 2. For Non Box Type Jackets:
 - a) Fiberglass mat with no chemical binders, type HP5 needled fiber. 1" @ 5LB/CF. Maximum Use Temperature 1000°F (538°C).
- 3. All insulation materials shall be Non-Asbestos
- 4. Jacket Dry Location:
 - a) Silicone Fiberglass Composite Jacketing, 17 oz/sq. yd. minimum

- b) Estimation of Maximum Use Temperature 450°F (232°C)
- 5. Jacket Wet Location (Steam Vaults/Pits):
 - a) All PTFE (Pure Teflon)- LFP 2110 13.5 oz/sq. yd. minimum
 - b) Estimation of Maximum Use Temperature 600°F (315°C)
- 6. Thread:
 - a) Kevlar
 - b) Begins to decompose at about 800 degrees (426 degrees C).
 - c) Does not melt
 - d) Diameter- .0114 inches
 - e) Break Point – 35LBS
- 7. Construction:
 - a) Sewn with lock stitch at a minimum of 4 to 6 stitches per inch. Jackets shall be sewn using specified thread. The thread must be able to withstand the skin temperatures without degradation.
 - b) Hog rings, staples and wire are not an acceptable methods of closure.
 - c) No raw cut jacket edges shall be exposed after install.
 - d) Jackets shall be fastened using hook and loop (Velcro) straps and D-rings.

G. ACCESSORIES

- 1. Adhesives and Mastics:
 - a) All adhesives, sealers, and vapor barrier coatings, shall be compatible with the materials to which they are applied, and shall not corrode, soften or attack such materials in either the wet or dry state. All sealants shall be UL approved and labeled.
 - b) Manufacturer: Armacell, Childers, Epolux, Foster, Marathon, Pittsburg Corning PC 88, Pittsburg Corning Pittcote 300 (interior) or 404 (exterior), or Vimasco.
- 2. Coal Tar:
 - a) Self-priming, cold-applied type.
 - b) Manufacturer: Koppers Bitumastic 50.
- 3. Tape: pressure sensitive, foil-scrim-kraft backed.
- 4. Lacing wire shall be 18 gauge soft annealed copper clad steel.
- 5. Wire mesh shall be No. 18 wire, woven to one inch hexagonal mash, galvanized after weaving.
- 6. Glass fiber reinforcing mesh shall be white 20 x 20 weave glass mesh with resin binder.
- 7. Impaling anchors shall be stud welded copper plated pins with zinc coated retaining clips.
- 8. Corner bead shall be 26 gauge, small nose type with 2 inch to 3 inch expanded metal flanges galvanized after fabrication.
- 9. Reinforcing corner angles shall be heavy duty roll-on corner bead with two inch aluminum strips adhered to 2-1/4" paper flanges.

10. Finishing cement shall be asbestos-free, hydraulic-setting cement consisting of spun mineral fiber and inert hydraulic-setting binders. Cement shall be quick setting without shrinkage cracks and with hard surface finishing characteristics.
11. Insulated Pipe Supports - Protection shields or pre-insulated pipe supports shall be provided on all pipe hangers bearing insulated pipes. On pre-insulated pipe supports, apply 3-inch wide vapor barrier tape or band over all butt joints. Refer to Section 15112 - Pipe Hangers, Support and Anchors.

PART 3 - EXECUTION

A. GENERAL

1. Surfaces to be insulated shall be clean, dry, and free of foreign material, rust, scale and dirt when insulation is applied. Perform pressure and leakage tests and submit results required by other Sections before applying insulation.
2. Where existing insulation is damaged due to the new work, repair damage to match existing work or replace damaged portion with insulation specified for new work.
3. Do not insulate over sight glasses, visual level or flow indicators, nameplates or ASME stamps. Bevel and seal insulation around these items.
4. When equipment with insulation requires periodic opening for maintenance, repair, or cleaning, install insulation in such a manner that it can be easily removed and replaced without damage to insulation or vapor barrier. Alternatively, provide removable insulation jackets which are attached with snaps, Velcro, or other means.

B. INSULATION OF PIPING AND DUCTWORK IN MECHANICAL ROOMS AND EQUIPMENT PLATFORMS

1. All exposed mechanical piping and ductwork in equipment rooms, equipment platforms, storage areas and areas without ceilings shall be finished with 8 oz. canvas glue sized for painting.
2. Labels with flow arrows shall be installed on all piping.

C. INSULATION FOR HOT PIPE

1. Insulate the following pipe with mineral fiber pipe insulation or calcium silicate of the thickness indicated, and white all service jacket with self-sealing lap.

Insulation Thickness, Inches						
Heating System	Fluid Operating Temperature Range, °F	Pipe Size Thru 1"	Pipe Size 1.25" – 1.5"	Pipe Size 2" – 4"	Pipe Size 5" & 6"	Pipe Size 8" and above
Hot Water	Thru 200	1.5	1.5	2.0	N/A	N/A
Steam	LPS and MPS	1.5	2.0	3.0	N/A	N/A
Steam Cond		1.5	2.5	2.5	N/A	N/A
Steam Vent (under 7 ft AFF elevation)		1.0	1.0	1.5	N/A	N/A
Arch Tunnel Steam and Pumped Condensate		N/A	3.0	3.0	N/A	N/A
Arch Tunnel drip trap medium pressure return to flash tank		1.0; 2.0 inside manhole	N/A	N/A	N/A	N/A

2. Steam and condensate piping buried in tunnels shall be insulated with calcium silicate with 30 mil PVC or aluminum jacket.
3. Install insulation with jacket drawn tight and side laps and end joint butt strips secured. End joint butt strips shall be minimum 3" wide and of material identical to jacket
4. Piping, valves, flanges, fittings, unions, strainers, steam traps, and other appurtenances shall be insulated with preformed or mitered fiberglass fittings. Wire fittings in place and cover with a smoothing coat of insulating cement. Cover fittings, valves, and flanges with premolded PVC covers.
5. Valves 2" and larger and all steam traps shall have insulation applied so that it can be removed and re-installed without damaging the insulation or shall have manufactured, removable insulating jackets.
6. Insulated Pipe Supports – Galvanized sheet metal protection shields or pre-insulated pipe supports shall be provided on all pipe hangers bearing insulated pipes. On pre-insulated pipe supports, apply 3-inch wide vapor barrier tape or band over all butt joints.
7. Insulation on piping systems shall not be applied until the systems have been tested and released for insulation application.

D. COLD PIPE INSULATION THICKNESS

1. For cold water make-up and condensate drain piping
2. Insulate with fiberglass pipe insulation, vapor barrier, and white all-service jacket or flexible elastomeric insulation.
3. Insulations shall be 1/2" thick for pipe up to 1.5" diameter and 3/4" thick for pipe 2" diameter and larger.

E. CHILLED WATER PIPE INSULATION THICKNESS

1. Insulate chilled water supply and return piping with preformed cellular glass pipe insulation, and all service jacket with self sealing lap.

2. Insulation shall be 1 ½" thick for pipe up to 1 ½" diameter and 2" thick for pipe up to 4" diameter.
 - a. Outdoor, direct buried piping locations shall be uninsulated.

F. INSULATION FOR DUCT SYSTEMS

2. Insulate the supply air duct systems with flexible, fiberglass insulation, 2" thick, with foil-scrim-kraft facing:
 - a. Overlap edges 3" and secure 12" on center with copper-clad, stainless steel or galvanized steel wire.
 - b. Seal joints, breaks, and punctures with tape.
 - c. On ducts over 3' wide, insulation shall be secured to the underside with mechanical fasteners maximum 18" on center each way.
3. Insulation of ductwork in mechanical rooms and utility corridors.
 - a. Rigid insulation shall be installed on ductwork installed in mechanical rooms. Minimum 1.5" thick for outside air duct; 2" thick for supply air duct.
 - b. Secure with welded pins or clips set in adhesive 18" on center each way with 2 rows per panel minimum.
 - c. Seal joints and clips with tape.
 - d. Finish insulation with minimum 8 oz. canvas, set in white lagging adhesive.

G. INSTALLATION

1. Insulation shall be clean and dry during installation and during application of any finish.
2. Install insulation materials with smooth and even surfaces, jackets drawn tight and cemented down smoothly at longitudinal and end laps. Do not use scrap pieces of insulation where a full length section will fit.
3. Install insulation, jackets and coatings continuous through openings and sleeves in nonrated construction. For penetrations of fire- or smoke-rated construction, insulation shall be butted tightly against the fire stop specified in Division 07.
4. Banding wires shall have the twisted terminals turned down toward the insulation without damaging the vapor barrier.
5. Install layered insulation with layer joints staggered. Wire inner layer 9" on center; apply outer layer and finish as specified herein.
6. Finish open ends of pipe insulation as specified herein for fittings.
7. Provide rigid inserts at each insulation protector location for piping 1.5" and larger.
8. Fill hollow steel pipe covering protection saddles with fiberglass insulation.
9. Standing seams and projections in ductwork or casings shall have insulation applied so that at least 0.25" of insulation will cover such projections.
10. Lined Ductwork:
 - a) Lined ductwork is not permitted for new ductwork insulation.
11. Insulation and vapor barrier shall be continuous around and under standoff brackets used for mounting balancing and control devices on ductwork.
12. Diffuser backs shall be insulated the same as the supplying ductwork.
13. Perimeter of reheat coil frames shall be insulated the same as the supplying ductwork.
14. Supply air valves shall be factory insulated.

END OF SECTION 23 25 00

SECTION 23 60 00 – HVAC EQUIPMENT

PART 1. GENERAL

A. DESCRIPTION

1. Refer to the General and Supplementary Conditions and Division 00 and 01 for special requirements and conditions which apply to all Sections of Division 23.

B. QUALITY ASSURANCE

1. Conform to the North Carolina State Building Code: Mechanical and Energy Conservation Codes-2018, and NFPA 90A.

C. RELATED SECTIONS

1. Refer to Section 23 09 01, BAS Basic Materials, Interface Devices, and Sensors for Air Valves.
2. Refer to Section 23 00 50, HVAC Motors, Starters and Variable Speed Drives.
3. Building Automation System commissioning is specified in Section 23 08 01. This Section includes responsibilities and obligations in support of the commissioning process specified therein.

PART 2. PRODUCTS

A. TERMINAL UNITS

1. Casings:
 - a) Minimum 22 gauge galvanized steel.
 - b) Acoustical lining: minimum 0.75" thick, fiber-free, closed cell, foam insulation. Lining shall meet erosion test method described in UL 181-1996 and shall have a flame spread rating of not more than 25 and a smoke developed rating of not more than 50 in accordance with NFPA 90A.
 - c) Access doors: sealed, flush type with cam-locks for access to internal parts for service or maintenance.
 - d) Enclosure: removable type for control components..
 - e) Casing leakage rate of less than 3% at 4" wg.
 - f) Inlet velocity shall not exceed 2200 fpm.
2. Control Motors:
 - a) Factory installed on units by unit manufacturer.
 - b) Coordinated with automatic control system manufacturer. Refer to Section 23 09 00 through 23 09 93 BAS Specifications.
 - c) Airflow sensors: averaging multipoint type, with taps for field calibration, minimum $\pm 5\%$ accuracy with 90° elbow at inlet.

3. Volume Regulators:
 - a) Factory preset: minimum and maximum air quantity. Air volumes and unit size shall be indicated on the regulator.
 - b) Gauge taps and calibrated means of adjustment to permit field adjustment of air quantities without unit disassembly.
 - c) Pressure independent, capable of maintaining constant volume, $\pm 5\%$, up to 4" wg inlet air pressure.
 - d) Factory mounted.
 - e) Removable
4. Heating Coils: As specified below.
 - a) Hot water control valves as specified in 23 90 01 BAS Basic Materials, Interface Devices, and Sensors.

B. COILS

1. General:
 - a) Coils shall be provided with copper tubes, and nonferrous fins with belled collars mechanically bonded to the tubes.
 - b) Supply and return connections shall be on the same end.
 - c) Performance shall be in accordance with AHRI 410-2001 (with Addendum).
 - d) Minimum working pressure rating shall be equal to that specified herein for the piping system in which the coil is installed. Coils shall be tested at a minimum pressure of 315 psig.
2. Refer to additional requirements for coils in air handlers, below.

C. FAN COIL UNITS

1. Horizontal concealed and finished cabinet type, with accessories as indicated on the Drawings. Install cabinet style where exposed to view.
2. Complete with coils, galvanized steel chassis, insulated casing, insulated (or non-corroding) stainless steel primary and secondary drain pans, filters, manual air vent, disconnect switch, and one or more centrifugal fans.
3. Condensate overflow switch shall be sense overflow from the primary drain pan or moisture in the secondary drain pan and will turn off the unit. A dry contact output shall be provided for interface to the building automation system.
4. Unit shall be furnished with a disconnect switch and inline fusing to protect electrical components. The disconnect switch shall be operable from the outside of the cabinet.
5. Control valves shall be capable of full closure against a 75 psig head.
6. Cooling coils: chilled water type, as specified in Paragraph B, Coils. Coil casings and supports shall be stainless steel.

7. Filters: throw away type, 2" pleated, MERV 8 rating. Filter access shall be from side.
8. Motors: Supply fans shall be driven by NEMA Premium Efficiency motors. All motors shall have integral thermal overload protection with a maximum ambient operating temperature of 40°C. Motor wires shall include a quick-disconnect motor plug, permanent split capacitor type, with 3-speed windings.
9. Manufacturer: Daikin, JCI/York, Climatemaster, Envirotec, McQuay, or Trane.

D. FANS - GENERAL

1. All fans shall be of the type and size listed and shall be a standard product of the manufacturer. Fans to be mounted outdoors shall have weatherproof motor and drive cover. Fans as scheduled to have airfoil blading shall not be changed to backwardly inclined or forward curved blading. All wheel sizes and outlets shall be in accordance with the Standards of Air Movement and Control Association International, Inc. (AMCA), and fans shall bear AMCA seal.
2. All fans shall be furnished with vibration isolators, back draft shutters, access doors, bird screen, disconnect switches, dampers and discharge cowls as applicable. Belt guards shall be provided on all units with belts.
3. Provide with each fan a motor drive suitable to meet conditions scheduled. Each motor shall be sized to operate non-overloading, and be 1,750 RPM, open type, or as scheduled.
4. Drives shall be rated for 150% of required horsepower.
5. Belt drive motors shall be provided with an adjustable slide base to be used in conjunction with the drive to adjust belt tension and allow for adjustments to be made in drive speed. The drive shall be of the multi-V belt type designed for 150% of the motor rating. Drive sheaves shall be adjustable speed type so fan speed can be easily changed.
 - a) Sheaves shall be replaced with fixed sheaves after final air balance.
 - b) Provide a spare set of fan belts for each fan.
6. Provide wall or roof cap for toilet exhaust fans as applicable. Vent cap shall be minimum 24 ga. steel with epoxy coating and bird screen. Finish color shall be selected to be similar to roof. Vent cap shall be intended for sloped roof, similar to Broan 634M.

E. PUMPS

1. End-suction, split-case back pull-out type, bronze-fitted, flexible-coupled, with bronze-sleeved or stainless steel shafts, mechanical seals designed for the pump service with ceramic stationary seats, bronze casing and impeller wear rings, shaft and coupling guard, and one-piece bronze impellers of non-overloading type so motor nameplate rating shall not be exceeded at any point on the pump curve up to 125% of the flow indicated on the Drawings. Impellers shall be statically, dynamically, and hydraulically balanced. Casings shall have drilled and tapped vent and drain holes and air vent cocks. Bleed valves and gauge ports shall be installed at accessible locations.

- a) Each pump and motor shall be mounted on a common base of welded steel construction with grout holes.
 - b) Pumps shall be designed for a working pressure of 175 psig and a maximum fluid temperature of 240°F.
 - c) Bearings: ball type, grease lubricated, with fittings, designed for in-service lubrication or sealed for life, rated for a L₁₀ life of 50000 hours at the maximum load scheduled on the Drawings.
 - d) Motors: as specified in Section 23 0010, HVAC General.
 - e) Impeller diameter shall not exceed 92% of volute cutwater diameter for single-volute design and 92% for double-volute design.
 - f) For process chilled water applications: stainless steel drain pan, 16 gauge minimum with a 1" drain coupling.
 - g) Manufacturer: Armstrong, Aurora, Bell & Gossett, PACO, Patterson, or Taco.
2. Inline centrifugal close-coupled back pull-out type, bronze-fitted, with bronze-sleeved or stainless steel shafts, mechanical seals designed for the pump service, bronze casing wear rings, and one-piece bronze impellers of the nonoverloading type so motor nameplate rating will not be exceeded at any point on the pump curve up to 125% of the flow indicated on the Drawings. Impellers shall be statically, dynamically, and hydraulically balanced. Casings shall have drilled and tapped vent and drain holes. Bleed valves and gauge ports shall be installed at accessible locations.
- a) Pumps shall be designed for a working pressure of 125 psig and a maximum fluid temperature of 250°F.
 - b) Motors: as specified in Section 23 0010, HVAC General.
 - c) Impeller diameter shall not exceed 92% of volute cutwater diameter.
 - d) Manufacturer: Armstrong, Bell & Gossett, PACO, Patterson, or Taco.

F. CUSTOM AIR HANDLING UNITS

1. GENERAL – Provide custom-fabricated air handling units with capacity as indicated on the schedule. The units consist of components as shown on drawings, including but not limited to fan and motor assemblies, all necessary dampers, filters, drain pans, wiring, steam and water coils, humidifier, UV disinfection lights, service lights, controls and other accessories as outlined in the schedule, enclosed in a single or multiple-piece casing. Units shall have overall dimensions as indicated and fit into the space available with adequate clearance for service as determined by the Engineer. Tags and decals to aid in service or indicate caution areas shall be provided. Electrical wiring diagrams and installation, operation and maintenance (IOM) manuals shall be attached to the control panel access doors within each unit.
- a) Units shall be wired for single point power connection by the manufacturer for each of the following: the fan section, the service lights, and the UV disinfection lights. Components shall be UL or ETL listed.

2. UNIT BASE – Unit perimeter base shall be completely welded and constructed from 6" structural steel or aluminum, and shall accommodate concrete pad installation as shown on drawings (Note: bolted or riveted bases are not acceptable). Floor support junctions shall be located at 14" increments (maximum) or less, in order to provide floor rigidity and support as required for internal components. Steel base frame is to be painted for long term corrosion resistance. All major components shall be supported by the base without sagging or pulsating.
 - a) Provide recessed floor drains piped under the air handling unit floor and extend through the base of the unit with threaded, capped terminations. Floor drains shall be provided in each air handling unit section that does not have a drain pan. Each section will have a 2" lip on the perimeter to form a watertight pan. Floor seams shall be continuously welded to maintain a water tight seal.
3. RIGGING PROVISION – Multiple Piece Units: Units shipped in multiple sections shall be engineered for field assembly. The unit section base frame shall include lifting lugs located at the corner of the unit (and along the sides as required by design) and sized to allow rigging and handling of the units. Rigging shall be performed using all lifting lugs at all time, and in strict accordance with the instructions provided within the installation, operation and maintenance (IOM) manual. Peripheral lifting lugs shall be removed after rigging, however bolts shall be set back in place after lug removal. Lifting lugs located along a section side corresponding to a unit section split shall be removed without bolts being set back in place afterwards. Units shall be provided with all necessary gaskets, caulking, hardware and instruction for assembly on site by installing contractor.
4. UNIT CASING –
 - a) Unit wall and roof rigid frame shall consist of one of the following:
 - (1) 16 ga. galvanized formed steel corner posts and 16 ga. G90 galvanized formed steel (1" x 2") intermediate frame posts, providing stable construction allowing for removal of any panel without affecting unit structural integrity. Units without framed type of construction are not acceptable. Exterior casing panels shall be attached to the gasketed (1" x 2") steel frame with corrosion resistant fasteners. Unit panels shall be made of 18 ga. galvanized steel outer liners and 22 ga. galvanized steel inner liners.
 - (2) The exterior casing shall be constructed of .040" embossed aluminum. Exterior walls shall be flush with no external standing flanges. The interior lining shall be a solid lining of a minimum of .040" smooth aluminum.
 - b) The cooling coil section interior lining shall be 20-gauge type 304 stainless steel. The humidifier section interior lining shall be 20-gauge tyoe 304 stainless steel or 0.040" smooth aluminum.
 - c) Air handling unit casing shall be of the "no-through- metal" design. Casing shall incorporate insulating thermal breaks using a phenolic resin coating so that, when fully assembled, there is no path of continuous unbroken metal-to-metal conduction from inner to outer surfaces.
 - d) Provide necessary support to limit casing deflection to L/200 of the narrowest panel dimension. If panels cannot meet this deflection, additional internal reinforcing is required.

- e) All panel seams shall be caulked and sealed for an airtight unit. Leakage rates shall be less than 1/2% at 125% of design static pressure or 10" W.C. whichever is greater. Leakage rate below 50 cfm will not be required.
- 5. DOUBLE WALL CONSTRUCTION – Units shall entirely be made of double wall construction. Single wall construction with coated insulation is not acceptable. Exposed insulation edges in the air stream are not acceptable. Floors shall be 12 gauge stainless steel treadplate or 3/16" aluminum treadplate, capable of supporting 500 lbs. Provide sleeves through casing wall for piping, wiring and controls.
- 6. INSULATION – Unit wall, floor and roof panels shall be insulated with minimum 3" thick, R13, polyurethane. All insulation edges shall be encapsulated within the panels. All perforated sections shall have insulation with black acrylic coating.
- 7. FANS - Fans shall be plenum type airfoil fans, tested in accordance ANSI/AMC 210-2007. Fans shall be statically and dynamically balanced throughout the complete speed range. Bearings shall be selected for L10 bearing life of 100,000 hours and provided with extended lube lines.
 - a) Motors and drives are as specified in Section 230050.
 - b) Fans shall have inlet backdraft dampers.
 - c) Fans shall have protective enclosures within the AHU casing.
 - d) Fans with motors 15HP or larger shall have a structural monorail incorporated into the fan housing to assist removal.
 - e) Fans with motors 5 HP and larger shall have lifting lugs incorporated into the fan housing to assist removal.
- 8. ACCESS DOORS – Full size access door(s) allowing for periodic maintenance and inspections shall be provided for all serviceable components as shown on the plans. Minimum dimensions shall be 24" wide unless indicated otherwise on plans or schedules. Removable panels are not acceptable except for fan sections which house fans larger than the door opening. Doors shall be solid double wall insulated construction. Insulation shall be the same as unit panels. Both the inner and outer liners shall be made of the same material as unit cabinet outer liner construction. The door hinge assembly shall be die cast zinc with stainless steel pivot mechanism, completely adjustable. Hinges shall allow doors to open at 180° with no shear effect on the hinge side of the perimeter gasket. The doorframe shall be extruded aluminum with a built in thermal break barrier and full perimeter gasket. The door gasketing shall employ a double seal comprising of an adhesive neoprene compressible foam gasket on the outer door panel and an "automotive style" neoprene bulb gasket fixed onto the inner door frame for out-swing doors, "rippled" foam for in-swing doors. There shall be a minimum of two heavy duty metal handles per door.
 - a) All doors shall be provided with an 8" x 8" dual thermal pane safety glass window. Windows through which UV disinfection lights are visible shall incorporate UV filter.
 - b) Door handles shall be operable from both inside and outside of the unit.
 - c) On all access doors where moving parts could cause injury, an ETL, UL 1995, and OSHA approved tool operated safety latch shall be provided.
 - d) Unit shall be single side access.

9. CONDENSATE / DRAIN PANS – Drain pans for cooling coil shall be fabricated from 16 gauge type 304 stainless steel. All drain connections shall be piped and trapped (in field, by Others) separately for proper drainage. Drain pans shall be sloped at a minimum of 1.5% with a threaded drain pipe connection ending through the side of structural base frame. Drain pans shall extend a minimum of 4” upstream and 30” downstream of cooling coil sections to prevent wetting of plenums. All drain pan corners shall be welded.
 - a) Chilled water coil drain pan shall have a stainless steel grate installed over the entire pan. Grate shall be raised above bottom of pan with fixed or adjustable legs. Top of grate shall be level with top of pan.
10. COILS – General Information (applicable to Steam or Hydronic Coils) – Acceptable coils shall have AHRI Standard 410 certification and bear the AHRI symbol. Coils shall be submerged in water and tested to a minimum dry air / nitrogen pressure of 300 psig standard copper tube coils. Coils shall display a tag with the inspector's identification as proof of testing. Tubes shall have a nominal thickness of 0.035" [0.5mm] unless otherwise specified. Fins shall be made of 0.0095" [0.2mm] thick aluminum unless otherwise specified. Tubing, return bends and headers shall be made of seamless UNS 12200 copper meeting ASTM B75 and ASTM B251 Standards. Coil return headers shall be equipped with factory-installed air vent connections placed at the highest point available on the face of the header.
 - a) Casings, supports, and endplates shall be made of stainless steel. Double flanged casings on the top and bottom of finned height shall be provided to allow for coil stacking. Piping, control valve and valve operator shall be supplied and installed by others.
 - b) Unit piping shall extend 3” beyond the edge of the casing.
 - c) Coils shall be designed to withstand 250 psig maximum operating pressure and a maximum water temperature of 300°F [149°C] for standard duty copper tube coils. Standard construction fluid MPT connections shall be made from red brass meeting ASTM B43 Standard or Schedule-40 steel pipe as a minimum.
 - d) Coils shall be maximum size to fill unit casing except that steam coil height shall be adjusted to allow steam condensate to drain from coil with no motive steam pressure.
 - e) All Coils in Air Handling Units:
 - (1) Shall completely fill the unit casing except where noted otherwise.
 - (2) Shall have aluminum fins, mechanically bonded to copper tubes.
 - (3) Shall have copper headers.
 - (4) Maximum air velocity of 500 feet per minute, unless noted otherwise.
 - (5) Minimum 0.035" wall thickness.
 - (6) Minimum 0.0095" fin thickness.
 - (7) Minimum 5/8” tube size.
 - (8) Shall not be overlapped.
 - (9) Shall be individually removable without removing other coils.
 - f) Cooling Coils in Air Handling Units:

- (1) Maximum air velocity of 420 feet per minute.
 - (2) Maximum of 8 rows at 10 fins per inch
 - (3) Designed for counterflow of water to air.
 - (4) Provide intermediate drain pans on all stacked cooling coils. The intermediate pan shall drain to the main drain pan through a copper downspout.
 - (5) Selected for water velocity of 4 to 6 feet per second at design conditions
- g) Heating Coils in Air Handling Units:
 - (1) Designed for parallel flow of water to air.
- 11. FILTERS - Provide filters of the type indicated on the schedule. Factory fabricated filter sections shall be of the same construction and finish as the unit. Outside air inlets shall be equipped with galvanized steel racks that permit filter slide out removal (side access). Side service filter sections shall include hinged access doors. Internal blank-offs shall be provided by the air unit manufacturer as required to prevent air bypass around the filters.
 - a) The filters shall be listed as Class II under UL Standard 900. Filters shall be tested per ASHRAE Standard 52-76.
 - b) The following shall be installed upstream of all AHU components:
 - (1) Pre-filter units shall be equipped, to a minimum, with 2" thick, 30% efficient (MERV 7) medium efficiency pleated filters. The effective media shall not be less than 4.6 square feet of media per 1.0 square foot of filter face area, and shall contain not less than 15 pleats per linear foot. Initial resistance at 500 fpm approach shall not exceed 0.28" wg
 - (2) High efficiency pre-filter. High Efficiency Rigid Filters – Filters shall be 12" deep high performance, pleated, totally rigid and totally disposable type with MERV rating of 13. Each filter shall consist of high density glass fiber media, media support grid, contour stabilizers and enclosing frame. Filter media shall be laminated to a non-woven synthetic backing to form a lofted filter blanket. The metal grid shall be bonded to the filter media to eliminate the possibility of media oscillation and media pull-away. The metal grid shall be formed in such a manner that it effects a tapered radial pleat design. The grid shall be designed to support the media both vertically and horizontally. Contour stabilizers shall be permanently installed on both entering air and exit air sides of the filter media pack to ensure that the tapered radial pleat configuration is maintained throughout the life of the filter. The filter shall be capable of withstanding a 10" wg pressure drop without noticeable distortion of the media pack. The enclosing frame shall be constructed of galvanized steel. It shall be constructed and assembled in such a manner that a rigid and durable enclosure for the filter pack is affected. The periphery of the filter pack shall be continuously bonded to the inside of the enclosing frame, thus eliminating the possibility of air bypass. The enclosing frame shall be equipped with protective diagonal support members on both the entering air and air exit sides of the filters.

- c) Final filters. High Efficiency Rigid Filters shall be installed downstream of fan(s) – Filters shall be 12" deep high performance, pleated, totally rigid and totally disposable type with MERV rating of 13. Each filter shall consist of high density glass fiber media, media support grid, contour stabilizers and enclosing frame. Filter media shall be laminated to a non-woven synthetic backing to form a lofted filter blanket. The metal grid shall be bonded to the filter media to eliminate the possibility of media oscillation and media pull-away. The metal grid shall be formed in such a manner that it effects a tapered radial pleat design. The grid shall be designed to support the media both vertically and horizontally. Contour stabilizers shall be permanently installed on both entering air and exit air sides of the filter media pack to ensure that the tapered radial pleat configuration is maintained throughout the life of the filter. The filter shall be capable of withstanding a 10" wg pressure drop without noticeable distortion of the media pack. The enclosing frame shall be constructed of galvanized steel. It shall be constructed and assembled in such a manner that a rigid and durable enclosure for the filter pack is affected. The periphery of the filter pack shall be continuously bonded to the inside of the enclosing frame, thus eliminating the possibility of air bypass. The enclosing frame shall be equipped with protective diagonal support members on both the entering air and air exit sides of the filters.
- d) The filters shall be as manufactured by Farr, Purolator, Flanders, Camfil, AAF or equal. Filters shall be in compliance with ANSI/UL 900 – Test Performance of Air Filters. Filter air velocity shall not exceed 500 fpm through each filter bank.

12. GAUGES

- a) Each Filter bank, chilled water coil, and fan section shall be furnished with: Magnehelic gauge with a 4 3/4" OD white static pressure dial with black figures and zero pointer adjustment. Pre-filters and final filters shall be considered separate filter banks. Gauges shall be piped in copper tubing and mounted to the AHU exterior. Gauges shall be piped with minimum 10 psig rated 3-way on-off-vent valves on each of the low pressure and high pressure gauge inlets.
 - (1) Filter banks shall be monitored by the BAS.
- b) Accuracy shall be +/- 2% of full scale and shall be selected for the differential pressure operating point at 50% of full range. Filter gauges shall have a full range of 0-2" w.g.

13. DAMPERS

- a) Unit shall be equipped with all necessary dampers required for the system as shown on the mechanical drawings. Dampers shall be designed for operating temperatures between -40° and 212°F. Air leakage through a 48" x 48" damper shall not exceed 10.3 cfm/sq. ft. against 4 in. w.g. differential static pressure at standard air condition. Standard air leakage data to be rated in accordance with AMCA certified rating program. Damper actuators shall be provided by the controls sub-contractor. Flat or formed metal blades are not acceptable.

- b) Damper construction shall be as follows: damper frame shall be of extruded aluminum or galvanized steel; damper blades shall be of extruded aluminum; dampers shall be of opposed blade type or parallel blades where indicated; damper blade ends shall be sealed with neoprene edge seals with bottom and top blade wiper seals. Outside air dampers shall be opposed blade motorized and fan discharge air dampers (for multi-fan installations) shall be of parallel blade gravity backdraft type. For other dampers, see manufacturer's recommendations.

14. AHU ELECTRICAL POWER AND CONTROLS

- a) All wiring and electrical connections shall be of copper wires, copper bus bars, and copper fittings throughout. Power supply terminals shall be identified. The maximum temperature of terminals shall not exceed 167°F (75°C) when the equipment is tested in accordance with its rating.
- b) All high voltage wiring conduit shall consist of Liquidtight flexible metal conduit for wet locations.
- c) When unit section splits are present, low voltage wiring shall be split using quick connectors for quick and easy field installation. Additionally, for each set of quick connector, the male branch in one unit section and the corresponding female branch in the next unit section shall be identified with the use of a colour code or numbered labels. At each high voltage line split, a junction box shall be provided in one of the sections; the wiring in the section where the junction box is located and the matching wiring in the next section shall be identified with the use of a colour code or numbered labels.
- d) The unit shall feature a mounted permanent nameplate displaying at a minimum the manufacturer, serial number, model number, date of manufacture, and current and voltage readings..
- e) A flow schematic with sensor and component identification and location, interlocks, sequence of operation and factory set-points shall be included with submittals.
- f) A wiring schematic and a bill of materials shall be completed in ladder/logic format, with component labeling according to line numbers, once a release for production has been received. The wiring schematic, bill of materials and flow schematic shall be submitted prior to unit shipment and included within the units control compartment.
- g) EMCS Control Systems – Shall be provided and install by the mechanical contractors.
- h) Each unit section shall be equipped with wet location service lights with gasketed polycarbonate housing, impact resistant polycarbonate lens, and instantaneous start down to 0°F. Mounting brackets shall be stainless steel. Lights shall be wired to a main switch for a separate 120 volt power supply. Lights shall be fluorescent or LED type.
- i) VFD cable to variable speed fan motors shall be 3-phase, 3 ground, copper tape spiral shield, galvanized steel interlocked Armor cable. To ensure system reliability, the cable shall be terminated in connector designed exclusively for ASD/VFD cable.

15. UV DISINFECTION (See Add Alternate No 13)
 - a) UV disinfection lights shall be installed 12" downstream of cooling coils. Lights shall cover the entire cross section of the internal casing. Bulbs shall be installed a maximum of 12" on center. Each rack shall be provided with a power control center in a NEMA 1 enclosure mounted on the exterior of the air handler. Units shall have water resistant seals and housing shall be constructed of stainless steel and aluminum. Install a safety interlock switch adjacent to the indicator lights. Lights shall turn off automatically when there is no airflow or when the plenum door is opened. Bulbs shall have an output of 3,070 microwatts/cm² at a wavelength of 254 nanometers at a distance of 6" from the bulb. Bulbs shall have an effective life of 10,000 hours and be designed to operate at 600 fpm. System shall be Lumalier AR series disinfection system or equivalent by Xenex, American Ultraviolet, UV Resources, or JCI/York.
 - (1) Bulbs shall be non-proprietary, available from multiple manufacturers. Submittal shall include a minimum of three alternate bulb manufacturers with cross-referenced model numbers.
 - (2) Ballasts shall have a minimum 5 year warranty.
 - (3) Install minimum 6"x6" safety warning label on each side of access door.
 - (4) Controller shall be installed on the exterior of the unit.
16. FLOW MONITORING SYSTEM - Each fan shall be supplied with a complete flow measuring system, utilizing a piezometer flow ring. The flow measuring system shall measure differential pressure through the fan inlet cone. The flow measuring station shall not obstruct the inlet of the fan and shall have no effect on fan performance (flow or static) or sound power levels. A surface mounted differential pressure transducer, located on the unit exterior, shall provide a visual display and shall provide a 4-20 ma output control signal for use in the BAS as specified elsewhere. The manufacturer shall provide the flow coefficient to the BAS subcontractor for use in calculating fan cfm. Airflow measurement shall be accurate to +/-5% over a range of 40-100% of full flow.
17. STEAM INJECTION HUMIDIFIER PANEL - Steam injection humidifier panel shall be designed for a maximum non-wetting absorption distance of 8". The panel shall consist of a steam supply header, condensate collection header and vertical steam dispersion tubes spaced evenly across the air handler casing. Steam dispersion tubes shall be insulated. Headers and dispersion tubes shall be type 316 stainless steel. Insulating jacket shall have a minimum R-value of 0.56 Btu/hr °F and shall be approved for use in plenums, meeting UL 723 and ASTM E84 smoke and flame spread ratings. Panel shall be installed in the air handler by the air handler manufacturer and connect to exterior steam and condensate piping through pipe sleeves. Condensate shall be trapped and returned to boiler plant. Humidifier shall be Dri-steam ULTRA-SORB LV series. Products with equivalent performance by Nortec or Armstrong shall be considered.
18. MANUFACTURER - Custom air handlers and energy recovery units shall be by Buffalo, Air Enterprises, Environmental Air Systems, Engineered Air, Climatecraft, or Ventrol.

G. CONDENSATE RETURN UNITS

1. Vertical duplex type, with inlet strainer and 2 vertical pumps. Factory test complete unit and furnish certified test report including NPSH characteristics.
2. Receivers: close-grained cast iron or welded steel, equipped with pump suction isolation valves, site glass, and lifting lugs.
3. Pumps: centrifugal type, permanently aligned and flange mounted for vertical operation. Pumps shall be bronze-fitted with bronze centrifugal impeller, stainless steel shaft, and mechanical seals designed for 250°F operation at scheduled pressures. Pumps shall be close-coupled type.
4. Motors: as specified in Section 23 0010, HVAC General, except vertical, 3500 rpm type. Motors shall be "off the shelf" type with NEMA standard shaft.
5. Control Panel:
 - a) Factory wired between pumps and float switches, for single external electrical connection.
 - b) Provide fused, control-power transformer if voltage exceeds 230 V ac.
 - c) NEMA 250, Type 1 enclosure with hinged door and grounding lug, mounted on pump.
 - d) Motor controller for each pump.
 - e) Electrical pump alternator to operate pumps in lead-lag sequence and allow both pumps to operate on receiver high level.
 - f) Momentary-contact "TEST" push button on cover for each pump.
 - g) Numbered terminal strip.
 - h) Disconnect switch.
6. Manufacturer: Armstrong, Bell & Gossett, Spirax Sarco, Spence, Shipco, Peerless, Weil, or Weinman.

H. SHELL AND TUBE HEAT EXCHANGER

1. Heat exchanger shall be a packaged assembly of tank, heat exchanger coils, and specialties, tested at specified conditions, and certified for performance and safety as a complete unit. Components requiring service and/or maintenance shall be accessible.
 - a) Provide with vacuum breaker and mounting saddles. Support saddles shall have a foot mount with provision for anchoring support.
2. Shell and tube heat exchangers: shall be carbon steel with cast iron bonnet head, and steel mounting saddles or support brackets. Removable tube bundle shall consist of 0.75" od, 0.049" wall thickness copper tubes expanded into steel tube sheets. Baffles shall be provided maximum 12" oc for spacing of tubes. Each unit shall be designed, constructed, certified, and stamped in accordance with ANSI/ASME BPV-VIII-1-1998 for 125 psig working pressure for the shell and 125 psig working pressure for the tubes. Water velocity shall be maximum 6 fps, and minimum 3 fps.

- a) Manufacturer: Armstrong, Bell & Gossett, or Taco.
- 3. Expansion tanks: as specified in Section 23 1000, Piping, Valves and Accessories.
- 4. Inline air separators: as specified in Section 23 1000, Piping, Valves and Accessories for chemical shot feeders.
- 5. Pressure gauges and thermometers: as specified in Section 23 1000, Piping, Valves and Accessories.

PART 3. EXECUTION

A. TERMINAL UNITS

- 1. Install terminal units with manufacturer's recommended upstream duct conditions for operation of velocity sensors and volume controls, and required clearances for control panels, coils, and other components.

B. FAN COIL UNITS

- 1. Valve assemblies shall be installed external to the unit cabinet, for ease of maintenance.
- 2. Condensate drain shall be piped full size, minimum 1-1/4" DWV copper, to nearest floor drain. Insulate condensate drain per HVAC insulation specifications.
- 3. An overflow switch installed in the secondary drain pan shall shut the unit off and send a dry contact alarm signal to the building automation system.
- 4. Install filters and provide one extra set. Do not run unit without filters.
- 5. Maintain recommended clear area to allow for maintenance of components and removal of filter.

C. FANS

- 1. Fans shall be handled and installed as indicated on the drawings and as per manufacturer's recommendations.
- 2. Lubricate bearings on fans as per manufacturer's recommendations. Ensure wheels rotate freely without binding.
- 3. Ensure ductwork and fan casing is free of dirt or foreign material.
- 4. Ensure electrical connections are properly made and fan disconnects are properly located.
- 5. Ensure inlet and discharge duct geometry is properly installed.
- 6. Starting:

- a) Follow manufacturer's recommendations.
 - b) Check fan and motor for correct rotation.
7. Post-Starting:
- a) Check isolation and flexible connections.
 - b) Check radiated and discharge sound power levels.
 - c) Determine speed, airflow rates, static pressure and record on fan curve.
8. Pre-Acceptance:
- a) Re-lubricate all bearings.
 - b) Perform measurements of discharge, inlet and radiated sound power levels after entire system is balanced and adjusted.

D. PUMPS

- 1. Provide 24" minimum clearance on the sides and ends of base-mounted pumps and motors to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.
- 2. Furnish an extra set of mechanical seals for each pump and submit receipt acknowledging same.
- 3. Provide base elbow supports for horizontal connections to base-mounted pumps.
- 4. Install back pull-out type pumps with space and accommodations for back pull-out per the manufacturer's recommendations.
- 5. Support pumps and piping separately so piping is not supported by pumps.
- 6. Install thermometers and pressure gages.
- 7. Equipment Mounting: Install base mounted pumps on cast-in-place concrete equipment bases.
 - a) Coordinate sizes and locations of concrete bases with actual equipment provided.
- 8. Contractor shall employ a technician certified by the selected pump manufacturer to field align flexible coupled pumps after the base has been grouted, the pipe/pump alignment check and flushing and cleaning procedures have been completed. Pump and motor alignment for each flexible-coupled pump shall be verified to be ± 0.002 " parallel vertical and horizontal and 0.005" angular per radius-inch horizontal and vertical. Submit a written statement verifying completion and tolerance of alignment.

E. AIR HANDLING UNITS

1. Start-up Service: Provide certified factory-authorized and trained start-up service for purposes of installation inspection, initial equipment settings, energization and adjustment. Start-up shall be provided for each AHU by a factory authorized service center. A certified start-up form shall be filled out for each AHU with a copy provided to the commissioning agent, engineer, and owner.
2. Provide flexible connections between fans and unit casings or external duct connections if fan discharge is at the casing wall. Support connections and ductwork independent of the air handling unit.
3. Provide air tight grommets for all casing penetrations such as gage probe connections, electrical conduit for power and control wiring, control air tubing, grease tubing, etc. Extend all such connections from inside the air-handling unit to an accessible location.
4. Pipe condensate drains, humidifier pan drain and humidifier drains. Provide traps as indicated on the plans.
5. Leak testing
 - a) The owners representative shall have the option to witness factory leak testing after fabrication. The unit shall be tested for conformance with the leakage requirements of the specifications. The cost of the testing shall be borne by the contractor.
 - b) Leak testing shall be performed by measuring the airflow pumped into (or out of) the unit at the cabinet design operating pressure. All inlet and discharge openings shall be sealed along with the air seal at the supply fan to isolate the high and low side of the unit until the specified leakage rating pressures are achieved. Airflow measurements shall be performed in compliance with AMCA standard 210. The testing shall be witnessed by the Owner's Representative. A detailed report, including all data and test methods shall be submitted.
6. Pre-Starting:
 - a) Compare specified and shop drawings data to installed data including:
 - (1) Make/model/size
 - (2) Fan wheel size
 - (3) Nameplate flow, static pressure
 - (4) Motor size, speed, efficiency, type, and voltage
 - (5) Heating coil, cooling coil
 - (6) Mixing baffles
 - (7) Return, exhaust and outside air motorized dampers, operation and size
 - (8) Filters
 - (9) Vibration isolation, flexible connections and seismic restraints (internal and external)
 - (10) Special features – access doors, liners, inlet vanes, labels, lights.
 - (11) Ensure variable speed drive is operational
 - b) Confirm that gaskets between shipping splits are installed without kinks or folds and are installed evenly across all mating sections.

- c) Lubricate bearings on fans as per manufacturer's recommendations. Ensure fan wheel rotates smoothly without binding. Adjust belts to proper alignment and tension.
- d) Vacuum out air system plenums and ductwork.
- e) Ensure temporary filters are installed. Under no circumstances run systems without filters installed.
- f) Ensure all balancing and fire/smoke dampers are open and ductwork is complete. For VAV systems, ensure that at least 60 percent of terminal units are open.
- g) Ensure minimum position specified for terminal units are properly set.
- h) Ensure all coils are in operation.
- i) On parallel fan systems, ensure backdraft dampers are installed.
- j) Ensure electrical connections are completed and system disconnects are within visual access of unit.
- k) Ensure controls are operational.
- l) Ensure inlet and discharge duct geometry are properly installed.

7. Starting:

- (1) Follow manufacturer's recommendations.
- (2) Check fan and motor for correct rotation.

8. Post-Starting:

- a) Check vibration isolation and seismic restraints.
- b) Check radiated and discharge acoustics at design conditions.
- c) Run for one hour and check filters and coils.
- d) Determine fan speed, airflow rates, static pressure and record on fan curve.
- e) Balance water flow across water coils and ensure water treatment is operational.

9. Pre-Acceptance:

- a) Replace temporary filters with permanent filters.
- b) Vacuum heating coil and cooling coils.
- c) Re-lubricate all bearings.
- d) Perform acoustical measurements of discharge plus radiated levels at operating conditions after entire system is operational.
- e) Check belts for tension and wear.

F. CONDENSATE RETURN UNITS

- 1. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.
- 2. Support pumps and piping separately so piping is not supported by pumps.

3. Install thermometers and pressure gages.
4. Equipment Mounting: Install pumps on cast-in-place concrete equipment bases.
 - a) Coordinate sizes and locations of concrete bases with actual equipment provided.
5. Piping Connections
 - a) Where installing piping adjacent to machine, allow space for service and maintenance.
 - b) Pipe drain to nearest floor drain for overflow and drain piping connections.
 - c) Install full-size vent piping to outdoors, terminating in 180-degree elbow at point above highest steam system connection or as indicated.

G. SHELL-AND-TUBE HEAT-EXCHANGER INSTALLATION

1. Equipment Mounting: Install heat exchangers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases specified in Section 033000, Cast-in-Place Concrete.
 - a) Coordinate sizes and locations of concrete bases with actual equipment provided.
2. Install heat exchangers on saddle supports.
3. Heat-Exchanger Supports: Use factory-fabricated steel cradles and supports specifically designed for each heat exchanger.

H. STARTUP SERVICE FOR MECHANICAL EQUIPMENT

1. Engage a factory-authorized service representative to perform startup service.
2. Complete installation and startup checks according to manufacturer's written instructions.
3. Clean strainers.
4. Set factory installed controls.
5. Set controls for automatic start, stop, and alarm operation.
6. Set float switches and overflow alarms to operate at proper levels.
7. Set balancing valves for specified flow.
8. Check motors for proper rotation.
9. Equipment shall not be operated without strainers and filters in place.

I. ELECTRICAL CONNECTIONS

1. Ensure that equipment is wired properly with rotation in directions indicated and intended for proper performance.
2. Provide positive electrical equipment and motor grounding.
3. Electrical work shall comply with Division 26 specifications.

END OF SECTION 23 60 00

SECTION 23 70 00 – AIR DISTRIBUTION

PART 1. GENERAL

A. RELATED SECTIONS

1. Refer to Section 23 00 95 - HVAC Test-Adjust-Balance.
2. Refer to Section 23 09 01 BAS Basic Materials, Interface Devices, and Sensors for air valves and control dampers installed in duct systems.
3. Refer to Section 23 60 00 HVAC Equipment for terminal boxes and reheat coils installed in duct systems.
4. Refer to Section 23 60 00 HVAC Equipment for air handling units.

B. QUALITY ASSURANCE

1. Construct all ductwork in accordance with referenced SMACNA "HVAC Duct Construction Standards, Metal and Flexible", Second Edition, 1995, unless higher standards are specified herein. Ductwork pressure classifications shall be in accordance with referenced SMACNA standards, except as otherwise specified. Rectangular ductwork shall meet functional criteria defined in Section VII of the First Edition, 1985, of SMACNA's duct construction manual.
2. All ductwork shall be free from pulsation, chatter, vibration and objectionable noise. If any of these defects appear, correct by removing and replacing, or reinforcing at no cost to the Owner.
3. An independent Test and Balancing Contractor shall test and balance the systems in accordance with Section 23 00 95.
4. Duct leakage shall not exceed 3% of delivered volume.
5. Flexible ducts, including insulation and sealants, shall conform to the requirements of NFPA 90A and UL Standard 181 for Class 1 ducts.
6. ARI Compliance: Test and rate air outlets and inlets in accordance with ARI 650 "Standard for Air Outlets and Inlets:
7. ASHRAE Compliance: Test and rate air outlets and inlets in accordance with ASHRAE 70 "Method of Testing for Rating the Air Flow Performance of Outlets and Inlets".

C. CODES

1. NFPA Compliance: Comply with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems" and NFPA 90B "Standard for the Installation of Warm Air Heating and Air Conditioning Systems.
2. U.L. 181: Factory-Made Air Ducts and Air Duct Connectors.

PART 2. PRODUCTS

A. SHEET METAL -GENERAL REQUIREMENTS

1. Provide all metal ductwork as indicated on the drawings. Ducts, unless otherwise specified shall be constructed entirely of G90 grade galvanized steel sheets. Where duct liner is indicated or specified, sizes shown are for the inside of the lining.
2. All sheet metal work shall be performed by trained mechanics, experienced in this type of work and shall be installed in a neat, workmanlike, and substantial manner.
3. Flexible connections shall be installed at all connections between ductwork and fans, except on packaged units where internal isolation is provided. Each unit shall be heavy glass fabric, forming a flexible air-tight bellows joint.
4. Provide access panels or doors in ceilings or walls and access doors in ductwork as required for access to items of equipment mounted inside the ducts.
5. All duct joint sealing compounds, glues, mastics and adhesives used on duct construction shall be "Fire Safe" and be UL approved and labeled.

B. STAINLESS STEEL DUCTWORK

1. Ducts shall be minimum 18 gauge, type 316L stainless steel of welded construction.
2. All manual, automatic and fire/smoke dampers (including blades and frames); turning vanes; fittings; and accessories located in the ducts shall be the same material as the ductwork.

C. PREINSULATED FLEXIBLE DUCTWORK

1. Flexible ductwork shall consist of CPE liner duct permanently bonded to a coated corrosion resistant spring steel helix insulated with a minimum of 1 inch thick fiberglass insulation covered with an outer vapor barrier of glass fiber reinforced foil laminate.
2. Insulation shall have a thermal conductivity (k) no greater than .25 at 75 degrees F.
3. Duct for high velocity systems shall have a working pressure of not less than 10 inches of water gage and a maximum operating temperature of not less than 250 degrees F.
4. Duct for low velocity systems shall have a working pressure of not less than 5" inches of water gage and a minimum operating temperature of not less than 250 degrees F.
5. Liner shall be dark gray or black.
6. Provide galvanized spring steel clamps of the wrap around screw lock type for each duct connection.

D. VOLUME CONTROL DAMPERS (MANUAL)

1. Provide manual multiblade opposed blade type control dampers of the size as shown on the drawings. Single blade dampers may be used up to 8" x 8". Each damper shall be fitted with locking quadrant with cast alloy body and stand-off for fixed manual setting for insulated and non-insulated work.

2. Construction of stainless steel dampers shall be similar to steel dampers except material shall be stainless steel.
3. Dampers shall be dieformed of heavy gauge steel, pivoted on the longitudinal axis in molded synthetic bearings encased in a heavy gauge zinc coated steel frame. All damper axels shall be 1/2" plated steel square or hex. Blades shall be constructed of not less than 16 gauge galvanized steel, mounted in steel channel frames not less than 2 inches in width, adequately braced. Damper blades shall be no larger than 6 inches wide.
4. For round duct dampers up to 14" diameter, body shall be minimum 24 gauge galvanized steel. Damper blade shall be minimum 22 gauge up to 8" diameter and 20 gauge up to 14" diameter. Provide minimum 3/8" square rod and low leak bushing. For insulated ducts provide 2" stand-off and locking regulator.
5. Damper linkage shall be suitable for the pressures involved. Dampers shall be mounted securely to duct, casing or in walls as required. Dampers in ductwork shall have position indicator to indicate relative position and open and closed position shall be clearly marked.
6. For all ducts less than 18" wide or less than 10" deep, provide Durodyne Hex Nut type dial regulator, code number SRHS 388 for non-insulated duct and a Durodyne dial regulator, code number SRST-2" for insulated duct, to be used with shop fabricated, 16 gauge blade, SRST-2" mounted in steel channel frame.

E. ACCESS DOORS AND PANELS

1. Unless indicated otherwise, doors shall be square, shall be large enough for inspection and maintenance of duct mounted equipment, and shall be no smaller than 10" x 10".
2. Construction: Construct of same or greater gage as ductwork served, provide insulated doors for insulated ductwork. Provide flush frames for uninsulated ductwork, extended frames for externally insulated duct. Provide one side hinged, other side with one handle-type latch for doors 12" high and smaller, 2 handle-type latches for larger doors. Provide continuous, neoprene gaskets around perimeter of doors. Access door materials shall match duct.
3. Doors and panels shall be Milcor, Ventfab or American Warming as approved by the Architect/Engineer.

F. DIFFUSERS AND GRILLES

1. Registers, grilles and diffusers for supply, return, and exhaust air shall be provided as indicated and scheduled on the plans. Units shall be selected for quiet operation with draftless distribution and shall be provided with baffles, dampers, etc., necessary to accomplish this. Units which are noisy in the opinion of the Architect-Engineer, shall be removed and replaced with acceptable ones. Units shall also be furnished with gaskets at edges to prevent leakage.
 - a) The interior portions of wall grilles and registers, including connecting duct, which are exposed to view, shall be painted flat black. Interior portion of ceiling diffusers shall be of the same color as the diffusers and accessories shall be flat black.
 - b) Diffuser backs shall be insulated the same as the connecting ductwork.

G. THERMOMETERS

1. Provide 3-1/2 inch, solid liquid filled dial thermometers with scale having white background, black embossed figures and markings and glass window with adjustable angle bracket mounting, flanged connection and coiled bulb.
2. Range - 30 degrees F to 130 degrees F.

PART 3. EXECUTION

A. DUCT CONSTRUCTION FOR LOW VELOCITY DUCTS

1. All rectangular and round duct handling low pressure and low velocity air shall be constructed of galvanized sheet metal. Low velocity duct construction shall be used for ducts downstream of terminal boxes and air valves. No ducts shall be less than 24 gauge.
2. All square bends or elbows shall be fitted with turning vanes.
3. As a minimum, install the following number of vanes:

Duct Width (inches)	# of Vanes
9	2
14	3
19	4
60	5
4. Crossbreak sheet metal in accordance with Figure 1-8 of SMACNA HVAC Duct Construction Standards.
5. For split fittings, the split shall be proportional to the air flow.
6. Transitions, offsets, and construction for obstructions shall follow SMACNA Figures 2-9 and 2-10 except that sides shall slope a maximum of 15 degrees.
7. Ductwork shall be sealed at all transverse and longitudinal seams in accordance with SMACNA Table 5-2 for "Seal Class B".
8. Branch take-offs to diffusers may be "spin-in" fittings. Spin-in fittings shall be equipped with balancing dampers unless diffusers are supplied with volume control dampers.
9. No 3 or 5 piece adjustable type ells shall be used. No snap-lock joints shall be used.
10. All radius bends or elbows shall have a centerline radius equal to 1-1/2 times the duct width. Radius bends or elbows shall be utilized unless they won't fit, in which case square bend or elbows with turning vanes may be used.
11. Formed on flanges will be constructed as SMACNA T-25 flanges. Formed on flanges are not allowed beyond 42" wide ductwork, or above 2" w.g.

B. DUCT CONSTRUCTION FOR HIGH VELOCITY DUCTWORK

1. All rectangular ducts handling high velocity or medium pressure air shall be constructed of galvanized steel sheet metal. Ductwork upstream of terminal boxes and all exhaust duct shall be constructed to high velocity duct standards. Supply ductwork downstream of terminal boxes or air valves may be constructed in accordance with low velocity duct standards.

2. Duct reinforcement and gauge shall be in accordance with SMACNA pressure class 4" W.G..
3. Transverse joints shall be reinforced double "S" slip, or Ductmate Duct Connection System. Formed on flanges will not be accepted. Longitudinal joints shall be Pittsburgh lock, grooved seam, double corner seam, or approved equivalent.
4. All high velocity ducts must have all seams, joints and connections sealed with sealing compound of an approved type. Sealing compound to be liquid sealer or bead type sealer as required to meet the special conditions.
5. Shop procedure for sealing ducts shall be as follows in accordance with SMACNA seal class "A":
 - a) Before fittings and joints are assembled, duct sealer shall be applied to rivets, grooved seams and tap-off collars. On the internal side of the metal Pittsburgh lock, pocket shall be flooded with sealing compound using pump type oil can, and the duct assembled.
 - b) Duct sealer of an approved type shall be brushed around reinforcing rod washers, corners, rivets, notches and tap-off collars after duct is assembled. A double "S" slip or other approved type connector shall be installed on the air leaving side of the duct and fastened in-place, using metal screws on 6 inch centers. Sealing compound shall be brushed into connecting lap and corner on joints and all seams of "S" slip or approved type connector.
 - c) Coat inside of connecting lap of "S" slip and duct surface with sealing compound. Where possible sealing shall be done on inside of the ductwork.
6. Field procedure for sealing joints shall be as follows:
 - a) Sealing compound shall be spread on the inside of the double "S" slip or connector and the joints of duct assembled. Immediately after joints are assembled, holes shall be drilled through the "S" slip and metal screws inserted on 6 inch centers. Sealer shall be applied over the screw head.
 - b) After 24 hours, a second coat of sealing compound shall be spread over the joints and allowed to dry for 24 hours before testing.
7. All branch take-off taps to terminal boxes shall be conical fitting, 45° round wye, 45° rectangular wye, or 6" minimum 45° entry tee unless indicated otherwise on plans.
8. All radius bends and elbows shall have a center line radius equal to 1-1/2 the width of the duct. All square bends and elbows shall be provided with hollow turning vanes. These vanes shall be made of 20 gauge galvanized metal up to 18 inches in length.
9. As a minimum, install the following number of vanes:

DUCT WIDTH (INCHES)	# OF VANES
9	2
14	3
19	4
60	5
10. Crossbreak sheet metal in accordance with Figure 1-8 of SMACNA HVAC Duct Construction Standards.
11. For split fittings, the split shall be proportional to the air flow.

12. Transitions, offsets, and construction for obstructions shall follow SMACNA Figures 2-7 and 2-8 except that sides shall slope a maximum of 15 degrees.

C. STAINLESS STEEL DUCTWORK

1. All exhaust ductwork shall be stainless steel.
2. Make changes in direction with long radius bends. When constructing duct transformations do not exceed 15 degree taper. Elbows shall be smooth radius and a centerline radius of 1.5 times the duct diameter.
3. Ducts shall be sloped to drain back to hoods and equipment.
4. For welded construction, all seams and joints shall be externally welded liquid tight using the Tungsten Inert Gas (TIG) process, with thoriated tungsten electrodes or added filler equivalent to Type 304 stainless steel to match the material of the ductwork.
5. Welding inside an occupied building requires advance notice to the University's environmental health officer and use of a portable welding fume eliminator.

D. DUCT HANGERS AND SUPPORTS

1. Support horizontal ducts with hangers of size and spacing as indicated in SMACNA Duct Construction Standards.
2. Attachment to structure shall be as specified in Section 23 00 10 HVAC General Requirements.
3. Do not support ductwork from furring, hung ceilings, metal pan roof or from another duct or pipe.
4. Do not use perforated band iron.
5. Horizontal Duct Supports:
 - a) Install hangers at each change in direction of duct.
 - b) Strap hangers:
 - (1) Extend strap down both sides of ducts.
 - (2) Turn under bottom two inches minimum. Provide a minimum of 2 screws per side.
 - (3) Screw hangers to bottom, upper and lower sides of ducts at 12 inches on center maximum.
 - (4) Seal all screw penetrations of ductwork.
 - c) Angle hangers:
 - (1) Support rectangular fume, vapor, and cage washing ducts on angle hangers. Do not penetrate duct with fasteners.
 - d) Support circular fume, vapor, and cage washing exhaust ducts with shop-rolled flat bar bands around duct.
 - (1) Bands shall be 16-gauge by 1-inch steel minimum, hot dipped galvanized or prime coated after fabrication.
 - (2) Fasten top to hanger rod and bolt bottom of bands.

6. Support ductwork at each change in direction.
7. Where vertical ducts penetrate floor openings, provide two horizontal galvanized steel angle supports attached to the long side of the duct and anchored to the floor with expansion bolts. Extend angles 3 inches beyond edge of opening. Provide the following angle sizes:

DUCT SIZE (INCHES)	ANGLE SIZE (INCHES)
Thru 36	1 1/4 x 1 1/4 x 1/8
37 thru 59	2 x 2 x 3/16
60 and larger	3 x 3 x 3/8
8. In all cases where duct sleeves are roughed through walls, floors, or ceilings, they shall be blocked and braced to prevent sagging or crushing occurring during construction.
9. Duct openings through exposed walls of equipment rooms shall be fitted with sheet metal collars to make a neat closure between opening and sleeve.
10. Support insulated ducts on the inside of the insulation.

E. FLEXIBLE DUCT INSTALLATION

1. Utilize high pressure flexible duct, maximum length of 2 feet, for connections from medium or high pressure duct systems to terminal boxes and air valves.
2. Flexible duct lengths on low pressure systems shall not exceed 6 feet.
3. Stretch new duct when removing it from cartons where it may have been shipped in a compressed state.
4. Use the minimum length of flexible duct required to make the specific connection unless specifically noted otherwise on the drawings.
5. Avoid sharp bends. Use a minimum side bend radius equal to 1/2 the inside diameter of the duct.
6. Support horizontal duct runs for a maximum sag of 4 inches per 10 feet. Use 3/4 inch or wider galvanized strap hanger material.
7. Allow the flexible duct to extend straight away from connectors for a few inches prior to initiating all bends.
8. Make all connections of flexible duct to rigid duct or terminals as follows:
 - a) Apply Foster's 30-02 sealant to the inside of the flexible duct to a depth of 3 inches.
 - b) Slide the flexible duct over the connector and wrap with minimum of two revolutions of reinforced foil duct tape starting about 2 inches back from end of flexible duct and sealing overlap with last wrap.
 - c) Place a clamp over the taped end and secure firmly.

F. DUCT ACCESS DOORS

1. Install duct access doors to open against system air pressure, with latches operable from either side, except outside only where duct is too small for person to enter. Install access doors in the bottom of the duct unless they are inaccessible in this location. Label access doors in accordance with Section 23 00 10.
2. Provide where indicated, duct access doors of size indicated. Provide access doors, whether indicated or not, for all duct mounted fire dampers or fire/smoke dampers and for visual access to all automatic dampers. Additionally, install access doors at inlet to air flow measuring stations, smoke detectors, static pressure sensors, and all other locations where equipment is installed in ductwork. Install duct access doors upstream and downstream of all reheat coils and duct-mounted humidifiers.

G. DIFFUSERS AND GRILLES

1. Locate ceiling air diffusers, registers, and grilles, as indicated on general construction "Reflected Ceiling Plans". Unless otherwise indicated, locate units in center of acoustical ceiling modules.
2. All of the above devices, such as diffusers and grilles shall be securely attached to ductwork and sealed to walls and ceilings with sponge rubber gaskets.
3. Diffuser backs shall be insulated the same as the ductwork to which it is attached.

H. THERMOMETERS

1. Thermometer in duct systems shall be provided in each discharge air side of cooling and heating coils of air handling units.

END OF SECTION 23 70 00

SECTION 26 0000 - ELECTRICAL GENERAL REQUIREMENTS

PART 1. GENERAL

A. RELATED DOCUMENTS

1. The drawings, general provisions of the Contract, including General and Supplementary Conditions, Division 01 of the Specifications, and General Requirements, apply to the work specified in Division 26, Division 27 and Division 28.
2. The requirements of Section 26 0000 govern the work specified in all other sections of Division 26, 27 and 28.
3. Cutting and Patching: Refer to Division 02 Sections.
4. Concrete: Refer to Division 03 Sections.
5. Firestopping and Sealants: Refer to Division 07 Sections.
6. Painting: Refer to Division 09 Sections.

B. DESCRIPTION OF WORK

1. Animal Research Facility: The building contains a National Institutes of Health (NIH) defined area which is an Animal Research Facility (ARF) area. This area requires particular construction materials and installation which differ considerably from normal construction. Observe and comply with all ARF area requirements of construction carefully.
2. The work includes furnishing all labor, materials, equipment and services required for the complete installation of the electrical systems indicated. The systems shall be installed complete and ready for use.
3. Where the term “provide” is used on the drawings and in the specifications, it is intended to be defined as “furnish and install in place”.

C. CONTRACT DOCUMENTS

1. The drawings are diagrammatic and are not intended to include every detail of construction, materials, circuitry, equipment, or exact routing of circuitry. Take actual field measurements at the job site in lieu of scaling the drawings.
2. Review the Contract Documents and coordinate all work with all other trades as necessary to provide equipment manufacturer’s recommended clearances, to provide equipment operation such that it is not detrimental to other equipment, and to avoid conflicts and interference. Coordinate fuse, disconnect, breaker, and wiring requirements with other trades and provide items required to suit final installed particular equipment provided by other trades.

3. In case of conflict between codes, reference standards, drawings, specifications, and other Contract Documents, the most stringent requirements shall govern. Any conflicts shall be brought to the attention of the Designer for clarification and direction prior to ordering or providing materials or labor. The Contractor shall issue a Request For Information to the Designer in order to clarify the intent of the documents. The Contractor shall bid the most stringent requirements.
4. Locations indicated for switches, outlets, equipment, and other devices indicated, are approximate and shall be field verified with the Owner's representative.

D. SUBSTITUTIONS

1. Where substitution of other than specified equipment is made and such change requires changes in the electrical power supply (wire, conduit, circuit breakers, starters, etc.), the contractor installing substituted equipment shall include in his bid the cost for the electrical changes required.

E. RENOVATION WORK

1. With regards to existing electrical work and existing installations in renovation work where the existing is to remain, the requirements of these specifications and drawings within the Construction Documents shall apply to that work with the exception of the requirement to replace the existing materials to meet the material or 'Products' requirements of the specifications. Work that is to remain shall be secured, supported, labeled, boxes shall be provided with covers, conduit and wiring shall be terminated accordingly, and work shall be made to meet all other specification 'Execution' requirements. Where existing work is altered, that portion of the work shall meet the full requirements of the Contract Documents.

F. CODES AND REGULATIONS

1. Installation shall comply with all laws applying to electrical installation. The work shall be in accordance with the latest edition of the following codes and all local governing codes, ordinances and regulations, and with the regulations of the serving utility companies, as a minimum:
 - a) NFPA 70 - National Electrical Code (NEC), 2020 Edition
 - b) NFPA 72 - National Fire Alarm Code, 2013 Edition
 - c) NFPA 101 - Life Safety Code, 2015 Edition
 - d) NFPA 110 – Standard for Emergency and Standby Power Systems, 2013 Edition
 - e) North Carolina Building Code (NCBC), 2018 Edition
 - f) Occupational Safety and Health Act of North Carolina (OSHANC)
 - g) Code of Federal Regulations (CFR) 1910.269
 - h) NFPA 99 - Health Care Facilities
2. Where requirements of the contract documents are in excess of the above code requirements, the contract documents shall govern. Where the above Codes and Regulations conflict with the contract documents the more stringent of the two criteria shall prevail.

G. QUALITY ASSURANCE

1. Electrical and mechanical equipment, and installations, including but not limited to wire, cable, raceway, boxes, fittings, lighting controls, transformers, switchboards, panels, motor control centers, busway, wiring devices, cover plates, safety/disconnect switches, circuit breakers, starters, automatic transfer switches, lightning protection, surge protection devices and light fixtures, shall be acceptable to the authority having jurisdiction, and shall be listed and labeled (per National Electrical Code) for its use and installation by a third party listing agency. Electrical and mechanical equipment shall comply with standards of CSA International, Underwriter's Laboratories, Inc., ITS-ETL and/or other approved third party listing agencies accredited by the North Carolina Building Code Council and acceptable to the authority having jurisdiction.
 - a) Third party listing agencies accredited by the North Carolina Building Code Council can be found at the following website or can be obtained by contacting the North Carolina Department of Insurance:

http://www.ncdoi.com/osfm/Engineering_and_Codes/Documents/Code_Enforcement_Resources/ElectricalMechanicalEquipmentLabeling.pdf

2. The electrical system components, equipment, installation and completed system shall conform to the standards, guidelines and recommendations of the following:
 - a) AEIC (American Association of Edison Illuminating Companies)
 - b) ANSI (American National Standards Institute)
 - c) ASTM (American Society for Testing and Materials)
 - d) ASHRAE/IES (90.1 energy conservation code)
 - e) BOCA (Building Officials Code Administrators)
 - f) Federal Specifications (FS) as indicated
 - g) ICEA (Insulated Cable Engineers Association)
 - h) ICC (International Code Council)
 - i) ICBO (International Conference of Building Officials)
 - j) IEEE (Institute of Electrical and Electronic Engineers)
 - k) Illuminating Engineering Society of North America (IESNA)
 - l) NCCM (N.C. Construction Manual w/G.S. as listed)
 - m) NECA (National Electrical Contractor Association)
 - n) NEMA (National Electrical Manufacturers Association)
 - o) NESC (National Electrical Safety Code)
 - p) NFPA (National Fire Protection Association)
 - q) NEIS (National Electrical Installation Standards)
 - r) U.L. (Underwriters' Laboratories Inc.)
 - s) OSHA (Occupational Safety and Health Administration)
 - t) SBCCI (Southern Building Code Congress International)
 - u) TCLP (Toxicity Characteristic Leaching Procedure)

3. Where requirements of the contract documents are in excess of the above code requirements, the contract documents shall govern. Where the above standards, guidelines and recommendations conflict with the contract documents the more stringent of the two criteria shall prevail.
4. Provide only new materials and equipment listed and labeled for the use intended by CSA International, Underwriter's Laboratories, Inc., ITS-ETL and/or other approved third party listing agencies accredited by the North Carolina Building Code Council and approved by the authority having jurisdiction. All equipment, including packaged multiple item equipment, shall be third party listed, approved and labeled as such by an agency or party acceptable to the city, state, North Carolina Dept. of Insurance (NCDoI) and/or local authority having jurisdiction. Where multiple pieces of equipment and/or components are installed in a common enclosure or as a single assembly, the entire assembly shall be listed and labeled as an assembly.
 - a) Where modifications to existing equipment occur which were not within the parameters of the factory labeling certification, that equipment shall be recertified by a third party agency as noted above for the adaptation or modification as if it were new equipment. U.L. provides for 'Field Evaluation Services' for unlabeled equipment or major modifications to existing labeled equipment, and it provides for 'Field Inspection Services' for minor modifications to existing labeled equipment.
 - b) Where the addition of modules or units within existing equipment, or minor modifications are made to existing equipment which are within the specific parameters of the factory labeling certification (ie – adding a breaker or other unit/module in a space listed for the addition of such in the original certification), the equipment may not require certification. Coordinate with the original manufacturer, and the particular listing and labeling certification from the factory.

H. PERMITS

1. General: Provide all required permits.

I. PRODUCT DELIVERY, STORAGE, HANDLING AND PROTECTION

1. Deliver equipment, components, accessories and materials in factory packaged water-resistant type containers or protect from the weather by other means approved by the Designer.
2. Handle products carefully to avoid damage to component and to finish. Do not install damaged materials. Replace damaged materials with new materials and remove from project site.
3. Provide and maintain at all times a protective cover of not less than 0.004" thick polyethylene sheeting or a similar approved material for covering all items of equipment immediately after the equipment has been set in place or if in a place of storage at the construction site. This covering shall be maintained to prevent the accumulation of dirt, dust or other foreign materials on the equipment and to prevent fouling of working parts during construction.

4. During and after installation all panels, cabinets, enclosures and other equipment (power, control, etc.) shall be kept closed and latched to prevent inadvertent ingress of water, dust, pests, rodents or other environmental items.

J. EXCAVATION AND BACKFILL

1. Normal excavation and backfill for installation of electrical work shall be provided under this Division. Heavy, hydraulic-operated equipment shall not be used for backfill, or for excavation immediately adjacent to structures.
2. If rock is encountered during normal excavation, notify the Designer immediately.

K. WARRANTIES

1. Warrant all materials, equipment, and workmanship shown or implied by these documents to be free of defects for a period of minimum one year. All warranties shall begin at date of Owner final acceptance. If within the stated warranty period after the Owner's acceptance date any work or equipment is found to be defective, correct it promptly at no cost to the Owner.
2. Equipment requiring warranties beyond one year are as follows:
 - a) Surge protection devices shall be warranted for minimum ten years and where so indicated shall be warranted for greater.
 - b) Lighting controls, dimmers, occupancy sensor and other lighting control components shall be warranted for five years.
 - c) Indoor LED light fixtures, drivers and modules shall be warranted for five years.
 - d) Exterior LED light fixtures, drivers and modules shall be warranted for five years.
 - e) Battery powered exit light units and battery powered emergency egress fixture units shall be warranted for three years with an additional two years pro-rated warranty on the battery.
3. Manufacturer's warranties and a letter stating the contractor's warranty of products and work shall be included in the submittal of Operation and Maintenance Manuals.

L. SUBMITTALS

1. Submit submittals in accordance with Conditions of Contract.
2. Provide submittals for wire and cable (including VFD cable), raceway, grounding items, boxes/fittings, electrical power equipment, surge protection devices, wiring devices and plates, light fixtures, lighting controls, and fire detection and alarm equipment. Submittals shall clearly state all options and accessories. See particular specifications sections for detailed submittal requirements.
 - a) Fire alarm submittals and shop drawings shall include a floor plan showing system devices and conduit size/routing. Submittal shall include box sizes and requirements. Floor plan in DWG format can be provided at the request of the Contractor.

- b) Power equipment, including but not limited to panelboards, breakers, disconnects and fuses, shall clearly indicate AIC rating and bus material.
- 3. Product Data: Product data includes manufacturer's standard catalog data, installation instructions and recommendations, drawings, certifications and other detailed information describing the material and product specified.
 - a) Indicate any deviations from the specified item.
- 4. Shop Drawings: Shop drawings include specific information not found in manufacturer's standard product data. Information shall include dimensions of products and equipment, charts and graphs, floor plans, and other descriptive information required to completely identify the item specified.
 - a) Indicate any deviations from the specified item.
- 5. Phenolic Labels: The exact layout and text to be placed on phenolic labels shall be submitted for review prior to label installation.
- 6. Maintenance Data: Submit maintenance data and parts list for each item and accessory; including "trouble-shooting" maintenance manual.
- 7. Record Documents: Refer to Division 1. As a minimum, the contractor shall mark up one of his copies of the Construction Document drawings in red indicating any variances in installation from the drawings, exact locations with dimensions of conduits capped below grade, locations of telecom pull boxes not exposed and visible from the floor, and locations of empty and/or spare conduit terminations and their associated pull boxes. The contractor shall turn over this set of mark-ups to the Designer at the completion of the project.

M. PROTECTION OF ELECTRICAL EQUIPMENT

- 1. Protect electrical equipment from the weather, in particular, dripping or splashing water, at all times during shipment, storage and construction. Comply with manufacturer's recommendations with regard to storage and protection. Should any apparatus be subjected to possible injury by water, thoroughly dry and test in accordance with manufacturer's instructions and recommendations. The cost of testing shall be at the expense of the Contractor. Test equipment required shall be provided by the Contractor.
- 2. Inspect all electrical equipment and materials prior to installation. Damaged equipment and materials shall not be installed or placed in service until the Owner has been notified and a response received from the Owner regarding the disposition of the equipment or materials.

N. WORKING CLEARANCES

- 1. Working clearances around equipment requiring electrical service shall comply with Code and manufacturer's requirements.

2. The electrical contractor shall field verify location of all new proposed and existing equipment and shall coordinate location of all new electrical equipment with other trades, and shall install electrical equipment (including conduit) such that it does not interfere with the other equipment manufacturer's recommended service and working clearance. Typical for all mechanical, plumbing, sprinkler and other trades' equipment including but not limited to required clearance at terminal unit controllers and valves.

PART 2. PRODUCTS

A. GENERAL

1. All materials and equipment shall be new and shall be listed by the Underwriter's Laboratories, Inc., for the use intended when a standard for such material and use exists.
2. All products and materials shall comply with all applicable standards and publications of NEMA, ANSI, ASTM, IEEE, AEIC, ICEA or other publications referenced.
3. All equipment of a particular kind such as wiring devices and panelboards, and all lighting fixtures of the same category, shall be the product of the same manufacturer.
4. All electrical equipment terminations including but not limited to disconnects, starters, breakers, devices and lugs, shall be rated 75 degrees C. Where existing equipment is incurred or equipment provided by others is provided which has less than 75 degrees C termination rating, the contractor shall provide wiring sizes to comply with the NEC for a lower temperature termination rating.
5. Equipment and products furnished and installed shall be that as specified and shall be the width, depth and height to fit within the space as indicated on the drawings and plans. It is the responsibility of the contractor to coordinate equipment and products to be installed with existing conditions, with the space provided for the equipment as shown on drawings, and with other equipment installed by other contractors or other installers in order to ensure equipment will fit in the space and all required clearances will be provided.

B. EQUIPMENT IDENTIFICATION AND LABELING

1. Provide arc-flash hazard warning label on all electrical equipment, new and existing, including switchboards, panelboards, industrial control panels and motor control centers, which is shown on the drawings. All existing equipment as mentioned in which work is performed shall be labeled. Label shall be standard industry type to warn of potential electric arc flash hazard. Label shall meet the requirement of NEC for arc-flash hazard warning.

2. **Nameplates:** Nameplates shall be installed on all disconnects, safety switches, transfer switches, double throw switches, panelboards, transformers, switchboards, breakers in switchboards, motor control centers and other electrical equipment installed on the project. Nameplate shall indicate equipment name, where equipment is fed from ("Fed From ____"), what equipment is being served (for disconnects, starters, etc.), voltage and phase. Nameplates shall be engraved, laminated phenolic with color surface and letters as indicated. Plates up to 8 square inches shall not be less than 1/16" thick material; plates larger than 8 square inches shall not be less than 1/8" thick. Letters shall be 1/2" high where the size of the label allows or as high as possible otherwise, and clearly legible and shall not touch each other. Where there is existing equipment in the project area, and where there is equipment outside the project area that is used for branch or feeder circuitry associated with the project, and that equipment does not have a label, provide a label on such equipment as if it were new.
3. **Nameplates for Equipment Furnished by Others:** Where a starter, VFD or other equipment is provided by the mechanical or plumbing contractor, or others, and a feeder or branch circuit is provided to serve such equipment, furnish a label as indicated above to the other contractor or supplier for installation on such equipment.
4. **Junction, Pull and Outlet Boxes:** All junction, pull and outlet boxes shall be painted per the color scheme below, and shall be labeled indicating the panel or equipment source and the circuit number.
5. **Letter Style:** Condensed Gothic, 1/2" minimum height or as high as label allows where physical constraint limits text height.
6. **Attachment:** Nameplates on interior of building shall be attached with self-tapping stainless steel screws with screw sharp filed smooth or protected, or rivets. Nameplates on exterior shall be attached with two-part epoxy.
7. **Color:**
 - a) Blue (dark blue) with white letters: 120/208V Equipment
 - b) Black with white letters: 277/480V Equipment
 - c) Bright Red with white letters: Fire Alarm Equipment
 - d) Dark Red (Burgundy) with white letters: Security Equipment
 - e) Orange with white letters: Telephone Equipment
 - f) Cyan (light blue) with white letters: BAS/Controls Equipment
 - g) Yellow with black letters: Lighting Control Equipment

C. CONDUIT AND EQUIPMENT SUPPORTS

1. **Channel:** Provide channel mounting system and associated appurtenances and fittings to install equipment and raceway as required. Channel mounted in finished spaces (areas other than mechanical or electrical rooms) shall have ends filed and sanded to remove burrs and sharp edges. Indoor dry areas shall have a system with standard zinc finish. Outdoor areas, damp locations and wet locations shall have a system with hot dipped galvanized finish. Channel system shall be Eaton/B-Line or approved equal by Kindorf or Caddy.

PART 3. EXECUTION

A. INSTALLATION - GENERAL

1. Install materials and equipment in accordance with manufacturer's instructions and recommendations. Where equipment is located about, near or adjacent to other trades' equipment, coordinate with the respective trade and/or the manufacturer, determine any required working clearance for the other trades' equipment, and locate equipment accordingly. Care shall be used in the erection of equipment and material to avoid causing damage. Repair of damaged equipment shall be made at no additional expense to the Owner.
2. Compliance with the latest edition of the National Electrical Code, the North Carolina State Building Code, local codes and requirements, and these specifications shall be the absolute minimum standard of acceptance. The regulations of the local utility shall govern service connections and metering provisions.
3. All enclosures and raceway installed on the exterior or interior of exterior building wall shall be mounted on strut or "clamp-backs" spaced a minimum of 1/4" off wall surface.

B. PLACING EQUIPMENT IN SERVICE

1. Equipment requiring electrical service shall not be energized or placed in service until all interested parties have been notified and are present or have waived their right to be present. Where equipment to be placed in service involves service or connection from another contractor or the Owner, the Contractor shall notify the Owner in writing when the equipment will be ready. The Owner shall be notified as far in advance as possible, of the date the various items of equipment will be complete.

C. INSPECTIONS

1. The North Carolina, Department of Administration, State Construction Office (SCO) is the authority having jurisdiction (AHJ) for the electrical inspections on this project. It is the responsibility of the electrical contractor to notify the electrical inspectors in the SCO to schedule the required below grade work, in-wall rough-in, above ceiling, and final inspections, as applicable. No work shall be covered up until after the inspection has been completed and approved by an authorized SCO inspector. All scheduling of electrical inspections with the State Construction Office (SCO) electrical inspector shall be Monday thru Friday unless specifically exempted and approved by SCO.
2. It is the responsibility of the electrical contractor to notify the electrical utility company, to schedule inspection and approval of all primary and secondary service electrical conduit and duct banks prior to pouring concrete or covering. No work shall be covered up until after the inspection has been completed and approved.
3. Conduit and Box Sealing Inspection: The Designer shall inspect sealing of all wire and cable in conduit (including wire and cable installed by others), and the sealing of flush/recessed box perimeter at the finished surface when this work is complete. The Contractor shall complete all wire and cable sealing, and all box perimeter sealing such that the Designer can perform one inspection for all sealing.

D. RENOVATION AND WORK AT EXISTING BUILDINGS

1. Visit the site of the project and become thoroughly familiar with all existing field conditions. Verify every aspect of the proposed work as described or implied by the contract documents. The Contractor shall receive no compensation or reimbursement for the additional expenses he incurs due to his failure or neglect to coordinate between and make a thorough investigation of the contract documents, site, and existing field conditions.
2. Cut and patch any curb and gutter, concrete and asphalt paving as required for installation of equipment. Rework and patch finishes, surfaces, bases, and site work to match existing installation. Rework all grades and site work, and replant vegetation to match previous conditions and existing finishes.
3. Where existing conditions are found which do not match the original installation of equipment, such as incompatible equipment installed on equipment, the Contractor shall correct the installation to the greatest extent possible and provide the proper compatible equipment. Where existing conditions are found to be unsecure, unattached or not supported properly, the Contractor shall secure, attach and/or support the equipment properly based on the latest edition of the applicable codes and standards. Where boxes, devices, outlets or enclosures are found which do not have proper covers, the Contractor shall provide the appropriate cover.
4. Modifications or adaptations of panels or other equipment shall be as recommended by the manufacturer for the modification or adaptation performed. The end result shall be similar to the original product or installation, except where other requirements dictate the product be brought to a higher standard such as rework in a control panel may require recertification and relabeling by a third party listing agency.
5. Locate and protect existing underground, under slab, in slab and other building and site utilities during construction. Contractor shall utilize equipment and techniques such as, but not limited to, circuit tracing, ground penetrating radar and x-ray to locate utilities prior to cutting concrete, digging or other work.

E. OPENINGS AND SLEEVES FOR ELECTRICAL WORK

1. Provide openings through walls, partitions, floors and roofs as required for the installation of electrical work.
2. Comply with Division 7 Sections and the NCBC regarding protection of openings in fire rated and smoke tight construction. Firestop, draftstop, smokestop and/or protect the annular space around or the penetration of all penetrations through walls, partitions, floors, ceilings, roofs and assemblies in accordance with the requirements of the National Electrical Code, UL listing requirements and the applicable building codes. Refer to the drawings to determine rated walls, ceilings, roof, floor and other rated assemblies, and verify construction ratings and provide penetration assemblies suitable for particular construction.
3. Where a wall, ceiling or floor is not rated all penetrations through such construction shall be as small as feasible and shall be patched with similar building material/finish as close as possible to penetration and then sealed around penetration with firestop caulk/sealant with minimum 1 hour 'F-rating'.

4. Provide sleeves for electrical work passing through walls, partitions, floors and roofs.
 - a) Where conduits pass through exterior or waterproofed roof, floor or walls, design of sleeves shall be such that waterproofing can be flashed into and around the sleeves. Make all such penetrations waterproof.
 - b) Sleeves in concrete and masonry walls, concrete floors and roofs shall be of standard weight steel pipe, finished with smooth edges. Sleeves for walls and partitions other than masonry, concrete and suspended ceilings shall be 22 gauge galvanized steel.
 - c) Floor sleeves shall extend 3 inches above the finished floor unless otherwise indicated. Space between the floor sleeve and passing conduit shall be sealed with approved materials.
 - d) Sleeves for telephone cable shall be rigid steel conduit nipples extending 3 inches above floors and below ceilings and both ends terminated with conduit bushings.

F. SEALING IN ANIMAL RESEARCH FACILITY (ARF) AREAS

1. All electrical boxes, enclosures, devices and equipment in the defined ARF area shall be sealed to the wall or ceiling surface with the specified sealant. Items shall be sealed where in contact with the wall or ceiling surface, and where equipment mounted to the wall or ceiling surface creates a gap of 5/16" or less between the item and the wall or ceiling surface. Equipment intentionally mounted spaced off the wall or ceiling to meet NEC code requirements for an indoor wet location or as noted otherwise spaced off the surface on the drawings shall not be sealed.

G. SUPPORTS FOR CONDUIT AND EQUIPMENT

1. Support conduit from structural members and not from metal deck and slab assemblies.
2. Provide additional support for devices, fixtures, equipment and feeders where the building construction is not suitable for direct mounting.
3. Support lighting fixtures and other equipment from structural members.
4. Threaded rods and other supporting members shall be cut to within 1/2" of bolt, channel or equipment bottom such that it is not a hazard.
5. Boxes, conduit straps/clamps and other equipment mounted to the wall in finished spaces shall utilize bolts or screws which are removable for mounting in lieu of studs or other means.
6. "S" shaped spike type hammer-in anchors are prohibited.

H. PHASE ROTATION

1. Check phase rotation of new feeder and/or distribution systems to ensure proper operation of motorized equipment.

I. PAINTING

1. The Electrical Contractor shall coordinate with the General Contractor and ensure walls and ceilings have an application of the final finish applied to the wall or ceiling prior to installation of surface mounted equipment such as surface boxes, raceway, panels, cabinet or other equipment prior to the installation of such electrical equipment.

J. SPARE PARTS

1. Spare parts shall be provided as indicated in particular specification sections for devices, cover plates, lighting controls, fuses, LED lighting drivers, LED lighting modules, lamps and fire alarm devices.
2. An itemized list of spare parts inventory shall be provided which indicates total components installed on the project as basis for per cent of spare parts provided which shall meet the required number of spare parts.

K. FINAL INSPECTION AND TESTING

1. The work shall be thoroughly tested in the presence of the Designer and the Owner's representative to demonstrate that the entire system is in proper working order and in accordance with the contract documents. Operate all motor driven equipment as nearly as possible under operating conditions for a sufficient length of time to demonstrate correct alignment, wiring capacity, speed and satisfactory operation. All main switches and circuit breakers shall be operated, but not necessarily at full load. During final inspection, furnish the test instruments and qualified personnel to perform complete testing.
2. Costs of tests, including expenses incident to retest occasioned by defects and failures of the equipment to meet the requirements specified shall be paid by the Electrical Contractor.

END OF SECTION 26 0000

SECTION 26 0100 - OPERATION AND MAINTENANCE MANUAL

PART 1. GENERAL

A. DESCRIPTION

1. Provide a separate Operation and Maintenance Manual for each item of electrical equipment and product specified in Division 26, 27 and 28, and shown on drawings, complete as specified herein.
2. See Division 01 of the Specifications for Operation and Maintenance Manual requirements.
3. Submit minimum three copies of Operation and Maintenance Manuals unless otherwise indicated or specified.

PART 2. PRODUCTS

A. OPERATION AND MAINTENANCE MANUALS

1. Manual shall be a hardback three ring loose-leaf binder with reinforced holes in sheets and drawings neatly folded and not extending beyond the edge of the binder. Label cover and spine of binder.
2. Provide printed, labeled dividers for each section with the following information in its respective divided section.
 - a) Project Info: Title sheet with job name, and the names, addresses and phone numbers of the Contractor, all Subcontractors and Suppliers.
 - b) Index: Index of contents.
 - c) Acknowledgement: A signed copy of acknowledgment of instruction to the Owner or the Owner's authorized representative for all electrical systems provided.
 - d) O & M-(Name of Equipment): Printed instructions for the Owner's personnel describing how to operate, service and maintain each piece of equipment, including recommended preventative maintenance, manuals of sequential operation, and controller and diagnostic information. Provide a separate divided section for each group of equipment similar to division of equipment as indicated in the specifications divisions.
 - e) Submittal-(Name of Equipment): Approved shop drawings, submittal data, and parts and maintenance booklet for each item of material and equipment furnished under Division 26, 27 and 29. Final drawings shall include all dimensions. Provide a separate divided section for each group of equipment similar to division of equipment as indicated in the specifications divisions.
 - f) Provide manufacturer's instructions for operation, setup/settings and adjustment of all equipment including but not limited to electronic breakers, dimmers, and occupancy sensors.

- g) Warranty: Guarantees and warranties including extended guarantees and warranties. Manufacturer's warranties and a letter stating the contractor's warranty of products and work shall be included.
- h) Record Documents: Record documents of electrical and control diagrams.
- i) Testing Records: All test documentation required by 'Testing and Start-Up' specification section shall be included in the Operation and Maintenance Manual for future use by Owner.
- j) Inspections: Copies of final inspection certificates.

PART 3. EXECUTION - NOT USED

END OF SECTION 26 0100

SECTION 26 0126- TESTING AND START-UP

PART 1. GENERAL

A. DESCRIPTION

1. Furnish, install and maintain all tools, instruments, material, test equipment, test connections and power. Furnish all personnel including supervision and "stand-by" labor required for the testing, setting and adjusting of all electrical systems and component parts including putting the above into operation.
2. Tests shall be made with proper regard for the protection of equipment and personnel.
3. After equipment has been tested, checked for operation and accepted by the Designer, equipment shall be protected from subsequent testing of other equipment and systems.
4. Record and document all test values of equipment, giving both "as-found" and "as-left" conditions. All tests shall be completely documented stating time of day, date, temperature, conditions and all pertinent test information. Provide a copy of all documented test records to Designer at time of testing and in Operations and Maintenance Manual.
5. The witnessing of any test by the Designer does not relieve the Contractor of warranties for material, equipment, and workmanship, as specified in the General Conditions.
6. Current transformers not used shall be short-circuited at the respective terminal boards to eliminate a hazardous condition.
7. Control circuits shall be checked for conformance with the wiring diagrams furnished by the Designer and manufacturers.
8. Upon completion of the installation and at such time as designated by the Designer, field test shall be made on all equipment, devices, materials and systems in accordance with the manufacturer's recommendations, testing standards of the Institute of Electrical and Electronic Engineers and the American National Standards Institute. All equipment shall be operated and/or cycled ON/OFF to demonstrate operability of equipment. Preparations and coordination with other trades shall be made such that all equipment can be operated and/or cycled ON/OFF.
9. Tests shall be conducted in the presence of the Designer for the purpose of demonstrating the equipment or systems' operation and compliance with specifications. In general, all electrical and mechanical tests shall demonstrate to the Designer that the entire installation is functioning properly and that all equipment and circuits, including power, control, instrumentation, relaying and communication, will function properly and as specified.

B. SUBMITTALS

1. Equipment Test Values: Three certified copies of start-up and test data shall be

submitted to the Designer for review and approval.

2. Motors: The Contractor shall provide to the Designer prior to project final approval a spreadsheet/matrix listing all motors installed or existing motors served by new distribution circuitry or equipment. The document shall list the name of the equipment in which the motor is installed, the motor horsepower, and the motor or equipment full load amps (FLA), minimum circuit ampacity (MCA), and maximum overcurrent protection (MOCP) as indicated on the motor/equipment label. The document shall include the installed overload protection device ratings or settings, including any overcurrent adjustable settings and thermal protector type and ratings.
3. Notify the Designer in writing minimum seven days prior to final inspection certifying that all insulation resistance tests have been performed and include meg readings for each panel.

PART 2. PART 2 - PRODUCTS
NOT USED

PART 3. PART 3 - EXECUTION

A. SPECIFIC TESTS

1. All receptacles shall be tested for proper polarity and wiring configuration.
2. All ground fault interrupting devices and equipment shall be tested for proper operation.
3. All lighting fixtures, switches, lighting control systems, dimmers, occupancy sensors and associated lighting system components shall be tested for proper operation. The contractor shall ensure that all occupancy sensors are setup according to the drawings and specifications, and according to the manufacturer's recommendations for the operation required.
4. All circuit breakers, disconnect switches, automatic transfer switches and other operable electrical equipment shall be manually operated to ensure proper operation.
5. Insulation Resistance Tests: The following tests shall be made on all electrical equipment as indicated, using a self-contained instrument such as the direct indicating ohmmeter of the generator type, or cable insulation tester such as manufactured by James G. Biddle Company, or approved equal. Insulation tester shall have voltage range of 250V/500V, and insulation resistance ohm measurement range from 0 to 1,000 megohms (1 gigohms). The tests shall be performed in accordance with the procedure recommended by the test equipment manufacturer, and the conductor manufacturer. Submit meter specifications and catalog data with test data.
 - a) Feeder Conductor Insulation Resistance Test:
 - (1) PERFORM THIS TEST BEFORE MAKING CONNECTIONS.
 - (2) Feeder Definition: All circuit conductors between the service equipment, the source of a separately derived system or other power

supply source and the final branch-circuit overcurrent device.

- (3) Tests shall be performed on all new feeders, and existing feeders which are intercepted and/or extended. Before making terminal connections of each feeder conductor, an insulation resistance test of each conductor shall be made and recorded for official record purposes. Each conductor of multi-conductor feeder cable shall be tested individually to each other and to a grounded/bonded portion of the raceway or enclosure. Each conductor of a feeder with multiple single conductors installed in the same conduit or raceway shall be tested individually to each other and to a grounded/bonded portion of the raceway or enclosure. If the values of resistance obtained do not meet the specified minimum requirements, further tests shall be made to isolate and replace or correct the poor insulation. If the insulation resistance cannot be raised to meet minimum requirements, the entire conductor/cable involved shall be replaced and new cable installed and tested.
- (4) The following test voltages shall be applied for one minute for electrical systems rated up to 600V, except where otherwise specified herein or as recommended by the manufacturer of test equipment.

Conductor Size (AWG)	Test Voltage (DC)	Minimum Resistance Reading
#6 and smaller	500 volts	1,000,000 ohms
#4 and larger	500 volts	250,000 ohms

b) Neutral to Equipment Ground Insulation Resistance Test:

- (1) After connection of all devices, fixtures and other equipment to each panel, disconnect the neutral feeder from the neutral bar in the panel and perform an insulation resistance test between neutral bar and the grounded enclosure. The reading shall be minimum 250,000 ohms. If resistance value does not meet minimum, further tests shall be made by disconnecting branch circuit neutral conductors from the neutral bar and testing separately to isolate the low readings and the situation shall be corrected, reconnected and retested until minimum 250,000 ohms resistance from neutral bar to grounded enclosure can be achieved.
6. The electrical grounding electrode system shall be tested for resistance and shall yield a resistance of 5 ohms or less at the service entrance equipment. If the specified resistance is not met, provide additional ground rods in length and quantity interconnected to yield the specified amount.
 1. Isolate Power System: The isolated power system shall be tested by the system manufacturer or an approved manufacturer representative according to the NFPA-99 Health Care Facilities Code. The line isolation monitor (LIM) circuit shall be tested after installation, and prior to being placed in service, by successively grounding each line of the energized distribution system through a resistor whose value is $200 \times V$

(ohms), where V equals measured line voltage. The visual and audible alarms shall be activated.

2. Miscellaneous Tests:

- a) Wiring: All control circuits shall be checked for shorts and continuity, and conformance with the wiring diagrams furnished by the Designer and manufacturers.
- b) Polarity Tests: Continuity and polarity tests shall be made on all current and potential transformers to determine whether the polarity is as required and/or indicated on the drawings, and the circuit is continuous.
- c) Phasing Tests: Phases of all switchgear and power cables shall be identified by stenciling the switchgear and tagging the cables with approved tags so that the phases can be identified for connecting to proper phase sequence.

END OF SECTION 26 0126

SECTION 26 0519 - WIRE AND CABLE

PART 1. GENERAL

A. RELATED DOCUMENTS

1. The requirements of Section 260000 govern the work specified in this section.
2. The requirements of this section applies to all wire and cable, including low voltage, communications and signal wiring. See other sections for further requirements for communications wiring including product and installation information.

B. SUBMITTALS

1. Product Data: Submit manufacturer's technical data for materials specified.

C. DELIVERY, STORAGE AND HANDLING

1. Deliver materials in new standard coils or reels with appropriate identification tag indicating length, size, type, insulation and manufacturer's name.
2. Store materials above the ground and in an area where conditions are clean and dry. Protect materials from damage due to construction traffic.

D. NEMA AND ICEA COMPLIANCE

1. Comply with NEMA and ICEA standards and publications for materials construction and testing where applicable.

PART 2. PRODUCTS

A. MANUFACTURERS

1. Acceptable Manufacturers: Provide products manufactured by one of the following, or equal.
 - a) American
 - b) Aetna
 - c) Southwire
 - d) General Cable

B. MATERIALS

1. Building Wire and Cable: Soft, drawn, 98% conductivity copper.
 - a) Sizes #10 and Smaller: Solid.
 - b) Size #8 and Larger: Class B, Stranded.
 - c) Insulation: Unless otherwise indicated, provide the following:
 - (1) 600 Volts, Dual rated THHN/THWN-2, or XHHW-2.

- (2) Isolated Power Systems: 600V, Type XHHW-2.
- d) Special Types: For special applications such as conductors fed through lighting fixtures insulation shall be in accordance with manufacturers recommendations and as required by code.
- e) Wire Sizes:
 - (1) Sizes: Standard AWG sizes. Minimum size #12 unless otherwise indicated. Maximum size 500MCM unless otherwise indicated. Minimum exterior lighting circuitry shall be #10 with #10 equipment ground.
 - (2) Sizes indicated are the minimum and shall be increased as required due to equipment, load, system supplied, length, voltage drop, adjustment factors due to temperature or any other code requirements. Contractor shall evaluate exact final routing, length and installation of all wiring to determine conditions and temperature of space wiring is routed and shall provide wire sizes to meet code requirements and NEC temperature correction factors.
- 2. Control wiring shall be stranded copper conductors unless noted otherwise. Control wiring shall be minimum #14 unless otherwise indicated.

C. VFD CABLE

- 1. Provide VFD cable where indicated on drawings or as noted herein. Where the VFD is located remote from the motor and motor has a local disconnect switch with electrical interlock to control VFD, the wiring from the VFD to the disconnect and from the disconnect to the motor shall be a VFD cable assembly. The VFD cable assembly shall be a cable constructed specifically for VFD application as follows as a minimum. Cable shall be 600V, UL 44, UL 1277, Type TC, 90 degree C Dry, 75 degree C Wet, Suitable for Class I -Division 2, Restriction of Hazardous Substances (RoHS) Compliant, and UL Direct Burial Listed. Cable shall contain three bare copper grounding conductors and an overall minimum 5 mil uncoated copper tape shield. Cable shall have equipment ground conductor indicated or segmented equivalent. Conductors shall be copper, Class B strand, type XHHW-2 or XHHW-2/RHW-2 or RHH/RHH-2 with cross-linked polyethylene (XLP) insulation and an overall PVC jacket. The cable shall be installed in conduit suitable for shielded cable with maximum bend radius of 12 times cable overall diameter. Cable shall be Belden series '295XXC', or approved equal.

D. CLASS 1 DIMMING CONTROL WIRING

- 1. Class 1 dimming control wiring shall meet the requirements of NEC 725. Cable shall be rated 600V, shielded, minimum 18 gauge and maximum 200'length. Install cable in conduit with power conductors unless noted otherwise. Cable shall be Houston Wire & Cable #HW15201802, or approved equal by Anixter, Belden, or Superior Essex.

E. SPLICING

- 1. Solid Conductors: Ideal 'Wire-Nut' or approved equal by 3M or T&B.

2. Stranded Conductors: Solderless mechanical connectors plus gum rubber or friction tape. UL approved insulating covers may be used in lieu of tape.
3. Insulated Multi-Tap Connector: Insulated multi-tap connectors shall be used where indicated on drawings. Connector shall be Ilsco series 'PBTS-X-4', or approved equal by Erico or Cooper/Eaton.
4. T&B 'Sta-Kon' or other permanent type crimp connectors shall not be used for branch circuit splicing.
5. There shall be no splices in low voltage, communication or signaling wiring unless specifically noted otherwise.

F. ELECTRICALLY CONDUCTIVE TERMINAL COMPOUND

1. Electrically conductive terminal compound shall be suitable for all conductors, terminal and bus connections; shall be a rust and corrosive inhibitor; shall protect, lubricate and enhance conductivity of all conductive surfaces; and shall be UL 913F Listed. Compound shall be Thomas & Betts 'Kopr-Shield' Series 'CP8-TB', or approved equal by Blackburn or Crouse-Hinds.

PART 3. EXECUTION

A. INSTALLATION

1. All terminations, feeders and circuitry connected to equipment shall be torqued per the equipment manufacturer's specification with a calibrated torque tool per NEC 110. Where the equipment manufacturer does not publish or include a specific torque, the contractor shall use published torque values listed in UL Standards, NECA documents or the NEC Tightening Torque Tables (Annex I in 2017 NEC). This includes any work in existing panels, transformers, switchboards, motor control centers or other distribution equipment. When existing panels, transformers, switchboards, motor control centers or other distribution equipment is opened for renovation work, all terminations in the equipment, not only new terminations, shall be torqued. Feeders shall not be energized until terminations have been torqued accordingly.
2. Not more than six current carrying conductors, three phase conductors each on a different phase and three neutral conductors, shall be installed in a single conduit, unless specifically noted otherwise.
3. Branch Circuits: Multi-circuit circuitry which shares a common neutral conductor for multiple phase conductors is not permitted for circuits. All circuitry shall consist of a dedicated neutral for each phase conductor.
4. All power conductors shall be installed in conduit or raceway. Conductors shall be continuous from outlet to outlet, and splicing shall be made only in outlet, junction box, trough or gutter.
5. Branch circuit wire sizes shall be increased to avoid excessive voltage drop as follows:
 - a) Nominal 120 Volt Circuits: Increase one wire size for each 50 feet or portion thereof in excess of 50 feet between the panelboard and the first outlet.

- b) Nominal 277 Volt Circuits: Increase one wire size for each 125 feet or portion thereof in excess of 125 feet between the panelboard and the first outlet.
- 6. Provide detectable underground line warning tape located 6"-8" below finished grade directly above duct bank, conduit or cable at all underground direct burial cables.
- 7. VFD Cable Assembly - Install VFD cable from the load side of the VFD to the motor at locations of VFD installations as indicated on the drawings. VFD cable shall not be spliced. Cable shall be continuous from VFD to disconnect, from disconnect to motor, and/or from VFD to motor. Provide conduit size for particular VFD cable provided per manufacturer's recommendations and the NEC. The cable shall be installed in conduit suitable for shielded cable with maximum bend radius of 12 times cable overall diameter. It is the responsibility of the Contractor to ensure the conduit installed is suitable size and configuration for the specific VFD cable provided.
- 8. Electrically conductive terminal compound: Apply compound to conductors and terminals per manufacturer's instructions at all terminals in panels and other equipment outside, including but not limited to breakers, lugs and bus bars, and to exposed terminals in animal holding rooms such as equipotential plane grounding terminals, connectors and clamps.
- B. TERMINATIONS TO DEVICES
 - 1. All wiring terminated on devices including but not limited to receptacles, switches and occupancy sensors shall be terminated on the devices screw terminal by looping wire around the screw terminal and tightening. Insertion of wire into 'quickwire', 'push-in' or 'backstab' compression connection is not allowed.
- C. PULLING
 - 1. Use only third party listing agency approved pulling lubricant. Use no pulling lubricant on isolated power branch circuits.
 - 2. Mechanical pulling devices shall not be used for sizes #8 and smaller.
- D. TESTING
 - 1. General: Perform tests per Specification Section 'Testing and Startup'.
 - 2. NOTE: Feeder testing shall be performed after installation of wire and prior to termination or connection to terminals. See Specification Section 'Testing and Startup'.
 - 3. Test shall include voltage levels and timed steps as recommended by the cable manufacturer.
 - 4. The testing agency shall be approved by the Designer. The testing shall be performed by experienced qualified personnel familiar with "Megger" testing wire and cable.
 - 5. Notify the Designer at least one week in advance of test date.
- E. ISOLATED POWER PANEL SYSTEM

1. Branch circuit conductors shall be #10 minimum , type XHHW-2 insulation. 120V branch circuit wire shall be orange with one distinctive color other than white, green or gray (for what is normally the grounded conductor), and brown with one distinctive color other than white, green or gray.
2. Wire pulling compound shall not be used during wire installation.

F. IDENTIFICATION

1. Color Coding and Marking: All conductors shall be color coded using integrally pigmented insulation except that colored plastic tape may be utilized for wire sizes #4 and larger.
2. Apply the tape on all exposed lengths of conductors in manholes, boxes, panels, switchboards, motor control centers, pullboxes, spliceboxes, and similar locations using half width overlap spiral wrap.
3. Factory mark all conductors 2'-0" on center maximum indicating conductor material, size, insulation and temperature rating.
4. Color Code: Comply with the following:

<u>Color:</u>	<u>120/208V</u>	<u>277/480V</u>
Phase A	Black	Brown
Phase B	Red	Orange
Phase C	Blue	Yellow
Neutral	White	Natural Gray
Ground	Green	Green
Isolated Ground	Green w/ Yellow Stripe	Green w/ Yellow Stripe

The designation of the color code system, including isolated power system color code, shall be clearly stated on the power riser at the main distribution panel of the building per NEC 210.

END OF SECTION 26 0519

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SECTION 26 0526 - GROUNDING

PART 1. GENERAL

A. RELATED DOCUMENTS

1. The requirements of Section 260000 govern the work specified in this section.

B. DESCRIPTION OF WORK

1. The complete electrical installation shall be grounded and bonded in an approved manner.
2. All power circuitry wiring shall include an insulated equipment grounding conductor sized per the NEC. Where phase conductors are increased in size due to voltage drop, high ambient temperatures, or other reasons the equipment grounding conductor shall be increased proportionately per the NEC. Minimum size shall be #12.

C. SUBMITTALS

1. Product Data: Submit manufacturer's technical data for materials specified.

D. QUALITY ASSURANCE

1. NEC Compliance: Comply with National Electrical Code as applicable to the construction and installation of grounding and bonding.

E. REFERENCES

1. Publications listed below (including amendments, addenda, revisions, etc.) form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only. The bonding and grounding system shall be compliant with the following references.
 - a) Institute of Electrical and Electronics Engineers, Inc. (IEEE): 81-1983 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
 - b) National Fire Protection Association (NFPA): National Electrical Code (NEC)
 - c) Underwriters Laboratories, Inc. (UL): 467 - Grounding and Bonding Equipment

PART 2. PRODUCTS

A. GROUNDING CONDUCTORS

1. Size: Per NEC.

2. Material: 98% conductivity copper.
3. Protection: Conductors shall be installed in conduit.
4. Bonding Conductors and Jumpers: Same requirements.

B. EXOTHERMIC CONNECTIONS

1. Exothermic connections shall be Erico 'Cadweld' or approved equal.

C. GROUND ROD

1. Ground rod shall be copper bonded steel driven ground rod, 3/4" x 10', 80,000 PSI tensile strength; copper plating shall be minimum 13 mil. Ground rod shall be Erico Series '6134', or approved equal by ABB, Eaton or T&B.

D. EXPOSED GROUND BAR

1. Exposed ground bar shall be copper, non-anodized, with 7/16" holes, minimum 1/4" x 2" W x 12" L; with insulators and standoffs. Ground bar shall be Erico 'EGBA', or approved equal by ABB, Eaton or T&B.
2. Exposed ground bar connections shall be two-hole compression type lugs using tin-plated copper or copper alloy bolts and nuts.

E. EQUIPOTENTIAL PLANE GROUND SYSTEM

1. Indoor dry location ground jack shall be a hospital grade, 250V, 30A rated green ground jack as provided for isolated power systems. Ground jack shall be mounted on a stainless steel blank plate. Provide a ring terminal with conductor from the ground jack bolt to the equipotential grounding conductor run through or into the outlet box. Ground jack shall be Square D #SHGJ1R, or approved equal by Bender or Post-Glover.
 - a) Provide six ground cords. Cord shall be highly flexible wire with a heavy duty clip end, 15' long; UL 467 Listed; five year warranty. Cord shall be Schneider #SHGC-15-C, or approved equal.
2. Outdoor or indoor wet location ground terminal shall consist of a copper split bolt/terminal post, pressure plate and nut, stainless steel washers and neoprene sealing washer. Ground terminal shall be mounted on a stainless steel blank plate. Verify exact size and model of ground terminal with conductor size. Ground terminal shall be Burndy #KCKF23, or approved equal.
 - a) Coordinate in field and drawings and provide grounding/bonding conductor per NEC 547 from grounding terminal to all ungrounded metallic equipment being installed in animal Holding Rooms. Bond together all ungrounded metallic equipment in Holding Rooms.

PART 3. EXECUTION

A. INSTALLATION

1. Grounding Electrodes: Provide, bond and interconnect all grounding electrodes per NEC 250 and the drawings. This includes the supplemental ground to underground water main, all building piping systems including gas piping, and the building steel.
2. Bonding: Bond together as it applies to the service or separately derived system as shown on the drawings, where available on the premises, the following:
 - a) Metal underground water pipe.
 - b) Interior cold and hot metal water pipes.
 - c) Building metal frame.
 - d) Driven ground rod(s).
 - e) Steel reinforcing bar encased in concrete footing.
 - f) Ground ring.
3. Grounding Conductors: Per NEC. Connect to service equipment ground bus.
4. Grounding electrode conductors shall be permanently spliced and terminated by exothermic heat welding process except terminations at ground bars.
5. Main Ground Bar and other ground bars external to equipment: The mounting surfaces of the shall be cleaned with an abrasive pad. A copper based antioxidant should be applied prior to installation of mounting lugs.
6. Bushings: Install ground bushings with bonding wire to equipment ground on all conduit feeders entering panelboards. Install ground bushing on all conduit with a grounding electrode conductor.
7. Exothermic Connections: Provide exothermic connections for grounding connections at all underground, and covered or concealed terminations such as terminations to reinforcing steel in foundations or footings, and all structural steel components such as columns or roof structures. Provide exothermic connections to all ground rods.
8. Equipotential Plane Ground System: Provide an equipotential plane ground system per the drawings and NEC 547-Agricultural Buildings. Provide a grounding outlet jack or terminal for the equipotential plane ground system as indicated on the drawings.

B. TESTING

1. Grounding Electrode Conductor (GEC):
 - a) Measure resistance between service equipment ground bus and each grounding electrode, using an Ohmmeter with 1% accuracy, and a single length of additional wire, if necessary.

- b) Measure resistance between both ends of the additional wire used.
 - c) GEC resistance is the difference between 1 and 2 and shall not exceed 3 Ohms.
 - d) Isolate and correct any poor connections as indicated.
2. System Ground Continuity: At selected outlets, measure the ground loop impedance using a ground loop impedance tester.
- a) Ground loop impedance shall not exceed a value in ohms that is the voltage to ground divided by five times the rated current.
 - b) If readings exceed the maximum allowed, isolate and correct the cause of the poor connection. If this can be performed prior to cover-up, the faulty couplings and connections can be readily found and corrected. If the source of high reading cannot be practically corrected, pull a separate ground conductor into the raceway and retest.
 - c) Provide Designer with date and time of testing of ground system in sufficient time to schedule presence of field representative.
 - d) Provide report of testing with clear identification of location and final measurement.

END OF SECTION 26 0526

SECTION 26 0533 - RACEWAY

PART 1. GENERAL

A. RELATED DOCUMENTS

1. The requirements of Section 260000 govern the work specified in this section.

B. DESCRIPTION OF WORK

1. All wire and cable shall be installed in raceway unless noted otherwise. Refer to the appropriate sections for descriptions of partial raceway systems utilizing bare cable or future bare cable above accessible ceilings.

C. SUBMITTALS

1. Product Data: Submit manufacturer's technical data for materials specified.

D. QUALITY ASSURANCE

1. NEC Compliance: Comply with National Electrical Code (NEC) as applicable to construction and installation of electrical raceways.
2. NEMA Compliance: Comply with applicable portions of National Electrical Manufacturers Association standards pertaining to nonmetallic duct and fittings for underground installation.

E. DELIVERY STORAGE AND HANDLING

1. Provide color-coded end-cap thread protectors on exposed threads of threaded metal conduit.
2. Handle raceway, conduit and tubing carefully to prevent bending and end-damage and to avoid scoring finish.
3. Store inside and protect from weather.

PART 2. PRODUCTS

A. MANUFACTURERS

1. Firms regularly engaged in manufacture of electrical raceways of types and capacities required whose products have been in satisfactory use in similar service for not less than 5 years.
2. Raceway fittings shall be products produced by one of the following manufacturers:
 - a) Eaton/Cooper/Crouse Hinds
 - b) Emerson/Appleton/ O-Z Gedney
 - c) Hubbell/Bell/Killark/Raco/Taymac

- d) Thomas & Betts/Steel City
- e) Schneider Electric/Square D

B. MATERIALS AND REFERENCES

1. General: For each electrical raceway system, provide a complete assembly with fittings, including but not necessarily limited to, connectors, nipples, couplings, elbows, expansion fittings, bushings and other components and accessories as needed to form a complete system.
2. Color: Fire alarm raceway shall be red.
3. Rigid Metal Conduit – Steel (RMC): U.L. Safety Std . U.L. 6 and ANSI C80.1.
4. Rigid Metal Conduit – Aluminum (RMC-A): U.L. Safety Std . U.L. 6A and ANSI C80.5 and FS WW-C-540c.
 - a) RMC-A shall be copper-free, 6063 aluminum alloy with T-1 temper, and end caps to protect threads.
5. Intermediate Metal Conduit (IMC): U.L. Safety Std . U.L. 1242 and ANSI C80.6.
6. Rigid Metal Conduit Fittings - Steel: FS WW-F-408.
7. Rigid Metal Conduit Fittings - Aluminum: UL 514B, FS W-F-408, FS A-A 50563.
 - a) All fittings used on RMC-A shall be copper-free aluminum.
 - b) Aluminum fittings shall be Thomas & Betts or approved equal by Eaton, Emerson or Hubbell.
8. Electrical Metallic Tubing (EMT): U.L. Safety Std . U.L. 797 and ANSI C80.3.
9. EMT Fittings: FS W-F-408, types and classes as indicated.
10. Flexible Metal Conduit (FMC): FS WW-C-566 Type II zinc coated steel.
 - a) 3/8 inch FMC allowed only with written approval of the Designer.
11. Flexible Metal Conduit - Aluminum (FMC-A): FS WW-C-566C, UL 1, UL 1479, aluminum alloy.
12. Flexible Metal Conduit Fittings: FS W-F-406.
13. Liquidtight Flexible Metal Conduit (LFMC): Provide liquid-tight flexible metal conduit comprised of single strip continuous, flexible interlocked, double-wrapped steel, galvanized inside and outside, forming smooth internal wiring channel with liquidtight jacket of flexible polyvinyl chloride (PVC).
14. Liquidtight Flexible Metal Conduit Fittings: FS W-F-406.
15. Liquidtight Flexible Metal Conduit – Aluminum (LFMC-A):

- a) FS WW-C-566C, UL 1, UL 1479, aluminum alloy, with PVC jacket.
 - b) Anamet Type 'EFL' or approved equal by Allied, or Anaconda.
16. Rigid Polyvinyl Chloride Conduit (PVC): NEMA Standard Publication NO. TC-2. Schedule 40 PVC. Equal to Carlon Type 40 heavy wall PV-Duit.
 17. Underground Line Warning Tape: Tape shall be permanent, bright colored, vinyl tape with magnetic detectable metal strip, not less than 6" wide x 4 mils thick, compounded for permanent direct-burial service, with continuous printed legend indicative of type of underground line below (electrical, telecom, etc.).
 18. Duct Bank Spacers: Duct bank spacers shall be Underground Devices Inc. 'WUNPEECE'.
 19. Mechanical Through-Wall or Through-Floor Conduit Sealing System: O-Z/Gedney 'FSK' or approved equal.
 20. Conduit Thread Compound: Compound shall be a conductive, anti-galling conduit thread lubricant and corrosion inhibitor suitable for application at dissimilar metal connections. Compound shall be Crouse-Hinds #STL, or approved equal by Thomas & Betts or Burndy.
 21. Foam Duct Sealant: Sealant shall be suitable for sealing conductors within raceway. Sealant shall be two-part, closed-cell, expanding foam type caulking, U.L. Recognized, for installation where conductors exit raceway in order to seal out water, rodents and gases. Sealant shall be Polywater 'FST-250' or approved equal.

PART 3. EXECUTION

A. INSTALLATION

1. General: Install raceway, conduit and tubing products as indicated in accordance with manufacturer's written instructions, applicable requirements of NEC and National Electrical Contractors' Association's "Standard of Installation" and in accordance with recognized industry practices to ensure that products serve intended function.
2. RMC shall be steel unless noted otherwise.
3. All raceways shall be EMT except as follows:
 - a) Any location outdoors, in direct contact with earth or underground.
 - b) Indoors in wet or damp location.
 - c) Encased in concrete.
 - d) Where exposed to severe corrosive environment and/or severe physical damage. Schedule 40 PVC may be used where exposed to severe corrosive environment. Schedule 80 PVC shall be used where exposed to severe corrosive environment and severe physical damage.
 - e) In areas where RMC or IMC or other raceway is required by code.

- f) In final connections to motors, dry type transformers, variable frequency drives, and all other rotating or vibrating equipment. Liquidtight flexible metal conduit shall be used for final connection to this equipment. Maximum length of 48".
 - g) 1/2 inch flexible metal conduit shall be used for final connections to lighting fixtures in dry areas. Maximum length of 72" unless noted otherwise.
 - h) Exposed raceway from finished floor up to 8'-0" above finished floor or grade elevation shall be RMC or IMC in mechanical room.
 - i) Where other types of raceway are required by this specification, by the drawings, or by the NEC.
 - j) Conduit installed in concrete, cinderblocks, concrete masonry unit (CMU) walls, brick walls or in concrete filled CMU shall be Schedule 40 PVC. PVC conduit shall transition to EMT or other approved conduit within 18" of penetration out of the above mentioned construction.
 - k) Conduit installed outdoors, underground (in earth or below slab), or on the exterior of the building shall be RMC where noted as such on the drawings..
 - l) Conduit installed on the exterior of the building and exposed to a severe corrosive atmosphere (coastal region) shall be rigid PVC. Provide only where specified on drawings.
 - m) Conduit installed indoors in a wet or damp location shall be RMC or IMC unless noted otherwise. Conduit installed indoors in a wet or damp location shall be installed such that conduit is 1/4" off the wall, ceiling or other finished surface.
 - n) Conduit installed in concrete duct bank shall be Schedule 40 PVC.
 - o) Conduit installed exposed in the designated 'Animal Research Facility' (ARF) area shall be RMC. There shall be no exposed conduit in the ARF area unless requested and approved by the Designer in writing.
- 4. EMT conduit installed below the roof deck shall be installed minimum 1 1/2" from the deck such that screws do not penetrate conduit during reroofing.
 - 5. Conduit mounted on the exterior of the building shall be mounted 1" from the wall.
 - 6. All raceways shall be concealed except as follows:
 - a) In unfinished equipment rooms (Mechanical Rooms and Chases, Electrical Rooms, etc.) conduit leaving or routed to panelboards, disconnects, motor starters, VFDs, mechanical or plumbing equipment or similar surface mount or exposed equipment may be exposed. Conduit serving switches, receptacles, fire alarm devices, telecom devices and other small outlets shall be concealed.
 - b) Where specifically noted as exposed on the drawings.
 - 7. Entire system shall be carefully and neatly installed with exposed work and work above ceiling run parallel or perpendicular to walls, floors and ceilings.
 - 8. Raceway shall be secured and supported by approved manufactured devices. Conduit and wire are not acceptable supports.

9. Raceway shall be securely anchored using appropriate fasteners not more than 8 feet on center and within 3 feet of junction boxes. Use approved type galvanized straps or clamps where raceway is mounted exposed. In finished areas where straps and clamps are used the bolt shall be cut to within 1/4" of the strap, clamp or nut.
10. Conduit installed exposed/surface mounted in finished spaces shall be bent at termination to surface box such that it is mounted tight to finished surface using a one-hole strap unless noted otherwise. Conduit stand-off type clamp, bolt or nut are not permitted in finished spaces unless noted otherwise.
11. Fasteners, including screws and washers, for conduit in wet or damp locations indoors and for any conduit outdoors shall be stainless steel.
12. Where raceway is installed above finished ceilings, use 1/4" threaded rod hangers secured into the structural system above or properly attached to hanger clips, or a channel/trapeze system. Raceways shall not be supported by finished ceiling construction, or from equipment installed by other trades (e.g. sheet metal ductwork, piping, etc.).
13. Risers shall be anchored per NEC, with approved type "U" clamps, or to channel support system that has been secured to the wall.
14. Ends of raceways shall be plugged immediately after installation and shall remain sealed until installation of wires.
15. Complete the installation of electrical raceways before starting installation of cables within raceways.
16. Install pull boxes in all runs having equivalent of four 90 degree bends or in runs more than 100 feet long unless noted otherwise for communications systems. See specification section regarding Electrical Boxes and Fittings.
17. All conduit shall have insulated throat.
18. Fittings and connectors for RMC and IMC shall be galvanized, threaded steel. Connectors and bushings shall be insulated throat type.
19. Terminations of RMC or IMC shall be made with double locknuts and insulating bushings, or in a threaded hub. Thomas and Betts Series 200, or approved equal by Raco or Steel City.
20. Running threads in RMC or IMC will not be permitted.
21. Fittings and connectors for EMT shall be made with steel hexagonal threaded compression type insulated throat connectors. Bushings shall be insulated throat type. EMT fittings in damp location shall be "raintight".
22. Terminations of EMT shall be made with locknuts and insulated, rain-tight, steel hexagonal threaded compression type box connectors, equal to Thomas and Betts, Raco or Steel City. Pot metal, set screw or indented type fittings are not permitted.

23. Minimum size shall be 3/4" unless otherwise noted. The use of 1/2" flexible metal conduit not exceeding 72" in length is permitted for final connection to light fixtures and small equipment. The use of 1/2" EMT conduit for switchlets less than twenty feet in length is permitted.
24. At exposed floor penetrations (i.e., not in walls) provide conduit sleeve through floor and extending 3" above floor. Pack with 1300 degree mineral wool or high temperature grout to make watertight. Where block out has been provided for conduit penetration through floor, frame opening and fill to 3" above floor with high temperature grout to make watertight. The above fireproof requirements are a minimum and this Contract shall include fireproofing of penetrations to meet all code requirements.
25. Provide minimum 200 pound test, conduit measuring type pull tape in all empty conduits.
26. Conduit Thread Compound: Provide conduit thread compound on all conduit threads at the following locations: where dissimilar metals connect (ie-steel conduit and aluminum box), at locations outside, at underground or below slab locations, wash down areas, in finished rooms, and at indoor wet location connections. Compound shall be applied at the aforementioned locations at threaded connections including conduit fittings, conduit hubs, boxes and other connection points. Compound shall completely coat threads at connections.
27. Provide expansion joint fittings at all building expansion joints, where conduit enters a building above grade from the exterior (installed on the interior side of the building), where conduit enters a cold/freezer room/cabinet (installed on the exterior of the room/cabinet), and others areas where required due to thermal expansion/contraction.
28. Spare raceway shall be capped, terminated on a box or terminated such that it is not open.
29. Spare raceway shall be labeled at each end as to the location of the other end. Label shall be a tag wired to the raceway. Writing on the raceway is not sufficient. Label shall read 'To Rm XXX-YYY'. 'YYY' shall indicate 'Above Ceiling', or 'Box in West Wall' or some other defining location of the termination of the spare conduit.
30. Raceways shall not be routed horizontally within concrete floor slabs or within the stone beneath concrete floor slabs.
31. Raceway Installed Underground or Below Concrete Slab on Grade:
 - a) Underground raceway shall be cleaned thoroughly and sealed after cleaning at completion of raceway installation and when existing conduit to be reused has existing wiring removed. Remove all dirt, scale, debris and projections by vacuuming, rodding, scraping, wire brushing and swabbing raceway with hand tools and power equipment designed for the purpose. Use a mandrel 1/2" less in diameter than the conduit. Upon completion of cleaning each end of the raceway shall be plugged to prevent entry of foreign matter. Manhole, handhole and area around conduit termination shall be cleaned of any debris or water removed from the raceway.

- b) Only service entrance raceways or feeders for power, television, telecommunication and/or telephone service to the building, or conduit serving floor boxes shall be installed below slab or grade. All other raceways shall be installed above grade or above floor unless specifically noted otherwise.
 - c) Where raceway is installed below floor or underground the raceway shall be a type and installed in a method approved by the NEC. Raceway shall not be installed in crushed rock or other aggregate below the slab or other locations.
 - d) Where raceway passes through a foundation wall below grade the raceway shall be rigid metal conduit within 5' of each side of the wall. Provide a rigid metal conduit sleeve two trade sizes larger than the raceway within the foundation wall and extending 12" beyond the wall. The raceway shall be centered within the sleeve. Seal the interstitial space between the sleeve and raceway with 3" minimum depth of Foam Duct Sealant.
 - e) Any RMC or IMC installed below grade or in a concrete duct bank shall have a 1/8" minimum coating of "asphaltum" for compliance with NEC for corrosion protection.
 - f) Where underground raceways turn up into enclosures, equipment etc., and up to above grade, the elbow nearest the turn up and stub-up out of slab or grade shall be rigid metal conduit.
 - g) Minimum size conduit installed underground outside building walls shall be 1".
32. Raceway Installed Underground in Duct Bank:
- a) Raceway installed external to the building foundation, except branch circuits, shall be encased in a minimum of 3" concrete on all sides. Encased raceway shall be a type approved by the NEC as suitable for concrete encasement. Minimum cover of raceway shall be 18", except raceway under roadway shall have minimum 24" cover, and circuits greater than 600V shall have minimum 30" cover.
 - (1) Schedule 40 PVC duct with a 3" concrete envelope and 2" separation between ducts shall be used as a duct bank for all work below slabs and underground unless otherwise noted. The contractor may, at his option, use RMC or IMC encased in concrete with a 1/8" minimum coating of "asphaltum" for these conduits.
 - b) Where a concrete encased duct bank extends to a building or manhole there shall be steel reinforcing within the duct bank within 10' of the building or manhole. The steel reinforcing within the duct bank shall be tied to the steel reinforcing in the building foundation wall and/or the manhole wall.
 - c) Where a concrete encased duct bank extends beneath a roadway there shall be steel reinforcing within the duct bank under the roadway and extending within 10' of each side of the roadway.
33. Underground Line Warning Tape: Provide underground line warning tape directly above all duct bank and underground raceway. Tape shall be installed 6" – 8" below grade and shall be continuous along routing of raceway.
34. Duct Bank Spacers: Provide duct bank spacers in all duct bank to properly support and space conduit within the concrete. Spacers shall be securely attached within the form and to the conduit so as to prevent floating.

35. Mechanical Through-Wall or Through-Floor Conduit Sealing System: Where underground conduit enters into the building space, basement or crawl space the conduit penetration through the wall or floor shall be sealed using a mechanical through-wall or through-floor conduit sealing system. Install the sealing system per the manufacturer's installation instruction.
36. Conduit Thread Compound: Provide conduit thread compound on all conduit thread terminations at the following locations: where dissimilar metals connect (ie-steel conduit and aluminum box), at locations outside, at underground or below slab locations, wash down areas, in finished rooms, and at indoor wet locations. Compound shall be applied at the aforementioned locations at threaded connections including conduit fittings, conduit hubs, boxes and other threaded connection points. Compound shall completely coat threads at connections.
37. Foam Duct Sealant: Provide foam duct sealant in conduit at the first conduit termination where conduit comes from underground and is bushed indoors or within equipment and/or terminates to equipment indoors or outdoors, and where conduits terminate to floor boxes installed in a slab on grade. Typical for all underground conduit including but not limited to power, telecom and any other conduit. Install foam duct sealant after all wiring in the conduit has been installed and trained/oriented within the equipment for termination. Install strictly according to manufacturer's recommendations and instructions including using the provided foam damming strips. Where cable/wire is installed by Others (Owner, Telecom Contractor, etc.) coordinate for cable/wire installation and provide sealant after cable/wire installation.

END OF SECTION 26 0533

SECTION 26 0535 - ELECTRICAL BOXES AND FITTINGS

PART 1. GENERAL

A. RELATED DOCUMENTS

1. The requirements of Section 260000 govern the work specified in this section.

B. DESCRIPTION OF WORK

1. The extent of electrical box and electrical fitting work is indicated by drawings, schedules, and the requirements of this section.
2. The types of electrical boxes and fittings required for the project include the following:
 - a) Outlet and Junction Boxes
 - b) Pull Boxes
 - c) Conduit Bodies
 - d) Handholes
3. All boxes shall have a minimum volume of 18 cubic inches.

C. SUBMITTALS

1. Product Data: Submit manufacturer's technical data for all boxes specified.

D. QUALITY ASSURANCE

1. NEC Compliance: Comply with National Electrical Code as applicable to the construction and installation of electrical boxes and fittings.
2. NECA Standard: Comply with applicable portions of the National Electrical Contractors Association's "Standard of Installation."
3. NEMA Compliance: Comply with applicable portions of National Electrical Manufacturers Association standards pertaining to electrical boxes and fittings.
4. ANSI Compliance: Comply with ANSI as applicable to construction and installation of electrical boxes and fittings.

E. COORDINATION OF BOX SIZE FOR SUB-CONTRACTORS AND OTHER CONTRACTORS

1. The contractor shall coordinate with its sub-contractors (fire alarm, telecom, etc.) and other contractors (security, telecom, etc.) and verify the size of the required boxes for the particular devices, fixtures and equipment, and ensure the installed box will accept the device, fixture or equipment being provided. Provide boxes of suitable size and configuration for the specific device being installed. Example – Some fire alarm notification devices require a specific size box and will not fit in some double gang cast boxes.

PART 2. PRODUCTS

A. MANUFACTURERS

1. Manufacturers: Provide products produced by one of the following (for each type of box and fitting):
 - a) Interior Outlet Boxes:
 - (1) Eaton/Cooper/Crouse Hinds
 - (2) Emerson/Appleton/ O-Z Gedney
 - (3) Hubbell/Bell/Killark/Raco/Taymac
 - (4) Thomas & Betts/Steel City
 - b) Weatherproof Outlet Boxes:
 - (1) Eaton/Cooper/Crouse Hinds
 - (2) Emerson/Appleton/ O-Z/Gedney
 - (3) Hubbell/Bell/Killark/Raco/Taymac
 - (4) Legrand/Pass & Seymour
 - (5) Thomas & Betts/Steel City
 - c) Junction and Pull Boxes:
 - (1) Arlington
 - (2) Austin
 - (3) Eaton/Cooper/Crouse Hinds
 - (4) Emerson/Appleton/ O-Z/Gedney
 - (5) Hammond
 - (6) Hubbell/Bell/Killark/Raco/Taymac
 - (7) Thomas & Betts/Steel City
 - d) Conduit Bodies:
 - (1) Eaton/Cooper/Crouse Hinds
 - (2) Emerson/Appleton/ O-Z/Gedney
 - (3) Hubbell/Bell/Killark/Raco/Taymac
 - (4) Thomas & Betts/Steel City

B. MATERIALS WITHIN THE ANIMAL RESEARCH FACILITY (ARF) AREA

1. Boxes which are located in the Animal Research Facility (ARF) area and which penetrate the walls or ceiling of the area shall be cast aluminum boxes with external hubs as follows.

2. Flush/Recess Mounted Outlet Boxes with External Hubs For ARF Areas: Provide corrosion-resistant heavy duty die cast aluminum box with threaded external hubs. Box shall have baked on electrostatic polyester powder paint finish, and minimal and only necessary conduit hubs. Box shall be UL Listed for wet or damp location when provided with appropriate cover and gasketing. Box shall be of the type, shape and size required for the particular installation. Weatherproof outlets for devices shall have a cast metal plate/cover with spring-hinged weatherproof cap suitably configured for each application, including face plate gasket and corrosion proof fasteners. All fasteners for weatherproof boxes shall be Type 302 stainless steel. Boxes for single device (receptacle, switch, etc.) shall be minimum 2.86" wide x 4.63" high x 2.69" deep.
 - a) Product and Manufacturer: Appleton Series 'FD-X-A' (deep), or approved equals by Hubbell, Pass & Seymour, or Crouse-Hinds.
3. Surface Mounted Boxes with External Hubs for ARF Areas: Provide corrosion-resistant heavy duty die cast aluminum box with threaded external hubs. Box shall have external mounting tabs, baked on electrostatic polyester powder paint finish, and minimal and only necessary conduit hubs. Box shall be UL Listed for wet or damp location when provided with appropriate cover and gasketing. Box shall be of the type, shape and size required for the particular installation. Weatherproof outlets shall have a cast metal face plate with spring-hinged waterproof cap suitably configured for each application, including face plate gasket and corrosion proof fasteners. All fasteners for weatherproof boxes shall be Type 302 stainless steel. Boxes for single device (receptacle, switch, etc.) shall be minimum 2.86" wide x 4.63" high x 2.69" deep.
 - a) Product and Manufacturer: Appleton Series 'FD-X-A' (deep), or approved equal by manufacturers listed.
4. Outlet Boxes Located Above Ceiling Space for ARF Areas: Outlet boxes which are located entirely above the ceiling and do not penetrate the ceiling may be 'Interior Outlet Box' as defined elsewhere in this specification section.

C. MATERIALS OUTSIDE THE ANIMAL RESEARCH FACILITY (ARF) AREA

1. Interior Outlet Boxes – Flush/Recessed or Concealed Above Accessible Ceiling: Provide galvanized interior outlet wiring boxes of the type, shape and size, including depth of box, to suit each respective location and installation; constructed with stamped knockouts in back and sides, and with threaded holes and screws for securing box covers or wiring devices. Outlet boxes shall be minimum 4" square x 1 1/2" deep. Lighting outlet boxes where the fixture is mounted on the box may be 4" octagonal by 1-1/2" deep minimum. Wall device boxes shall be 4" square by 1-1/2" deep minimum unless noted otherwise. Outlet boxes served by 1" or 1 1/4" conduit shall be 4 11/16" square x 2 1/8" deep minimum.
2. Masonry Boxes – Masonry boxes shall be galvanized steel, suitable for use in masonry construction and shall be minimum 3 1/2" deep.
3. All boxes shall have a minimum volume of 18 cubic inches.
4. Gangable boxes (assembled in the field) are not allowed. Provide multi-gang boxes (two gang, three gang, etc.) where required.

5. Weatherproof Outlet Boxes or Surface Mounted Boxes in Finished Spaces: Provide corrosion-resistant heavy duty die cast aluminum box with internal hubs, baked on electrostatic polyester powder paint finish, and threaded outlets with minimal and only necessary conduit outlets. Box shall be UL Listed for wet or damp location when provided with appropriate cover and gasket. Box shall be of the type, shape and size required for particular installation with threaded conduit ends. Boxes for devices shall have cast metal face plate with spring-hinged waterproof cap suitably configured for each application, including face plate gasket and corrosion proof fasteners. All fasteners for weatherproof boxes shall be stainless steel. Weatherproof boxes for single device (receptacle, switch, etc.) shall be minimum 2.86" wide x 4.63" high x 2.63" deep.
 - a) Product and Manufacturer: Pass & Seymour Series 'WPB', or approved equal by manufacturers listed.
6. Large Capacity Outlet or Pull Box:
 - a) 4 11/16" square x 3 1/4" deep. Minimum 2) concentric 1", 1 1/4", 2" knockouts. Raco Series '260', or approved equal by manufacturers listed.
 - b) 4 11/16" high x 7 3/4" wide x 3 1/4" deep. Minimum 2) concentric 1", 1 1/4", 2" knockouts. Accepts three gang cover. Raco Series '263', or approved equal by manufacturers listed.
 - c) 6" square x 1 1/2" or 2 1/2" or 3 1/2" deep. Minimum 8) 1 1/4" knockouts and 2) 3/4" knockouts, or blank for customizable knockouts. Provide with blank cover, or one, two or three gang cover by same manufacturer. Garvin Series '6350', or approved equal by manufacturers listed.
7. Large Junction Box for Insulated Multi-Tap Connector Circuit Splices: Provide galvanized steel junction boxes with screw-on cover of the size to suit each respective location and installation with continuous welded seams and screw-on cover. Box shall be NEMA 1, minimum 8" x 8" x 4" deep. Box shall be Austin series 'AB' or approved equal by Hammond or Hubbell.
8. Pull Boxes: Provide galvanized steel junction and pull boxes with screw-on covers of the type and size to suit each respective location and installation with continuous welded seams and equipped with steel nuts, bolts, screws and washers.
9. Large Outdoor Pull Box: Pull box shall be a NEMA 4 single door enclosure with lockable padlock hasp, neoprene gasket, continuous stainless steel hinge pin, all stainless steel hardware and external feet. Box shall be Austin Series 'AB-XXXXXNF', or approved equal by Hubbell/Wiegmann or Hammond.
10. Accessories: Provide outlet box accessories as required for each installation, including mounting brackets, wallboard hangers, extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, barrier plate for separating voltages or communication/power system, compatible with outlet boxes being used and meeting requirements for individual wiring situations.
11. Bushings, Knockout Closures and Locknuts: Provide corrosion-resistant punch-steel box knockout closures, conduit locknuts and malleable iron conduit bushings of the type and size to suit each respective use and installation.
12. Old work type boxes and/or Madison/old work clips are not allowed unless permission is specifically requested by the Contractor and permission granted to use in writing by the Designer.

D. HANDHOLE FOR GROUND ROD

1. Handholes for ground rods shall be polymer concrete of select grade aggregate and a polymer resin system reinforced with fiberglass; shall be open in the bottom and have a minimum wall thickness of 1/2"; and be Teir 22 rated. Cover shall be gasketed, attached to the box with minimum two 3/8" stainless steel hex head bolts and washer, and have a skid resistant surface; and shall have a logo molded into the cover indicating 'GROUND ROD'. Units shall meet or exceed ANSI/SCTE 77 2017.
2. Handhole shall be Oldcastle 'Polymer 910' or approved equal by Armorcast, Hubbell or Jensen.

E. HANDHOLE FOR POWER AND TELECOM WIRING

1. Handhole shall be polymer concrete of select grade aggregate and a polymer resin system reinforced with fiberglass; shall be open in the bottom and have a minimum wall thickness of 1/2"; shall be stackable to accommodate various required depths; and shall have cable racks for support of cables within the box. Cover shall be gasketed, attached to the box with minimum two 3/8" stainless steel hex head bolts and washer, and have a skid resistant surface with a .5 coefficient of friction; have two 1/2" x 4" pull slots; and shall have a logo molded into the cover indicating 'ELECTRIC', 'COMMUNICATION' or other utility as noted on the drawings respective of the contents of the box. Tier rating shall be as indicated on drawings. Units shall be UL Listed and meet or exceed ANSI/SCTE 77 2017, and be clearly factory labeled indicated UL Listing and Tier rating in the box and under the cover.
2. Size and depth of handholes shall be at least the minimum as required by NEC and the depth of conduit. The Contractor shall coordinate with the cables being installed and their associated NEC required bend radius, the conduit being installed and its associated box sizing requirements, and the actual field installation depth of conduit and provide a box suitable for the particular installation.
3. Handholes shall be Hubbell/Quazite Series 'PG' or approved equal by Armorcast, Jensen or Oldcastle.

PART 3. EXECUTION

A. INSTALLATION OF BOXES AND FITTINGS

1. All boxes shall be accessible per the details on the drawings. Boxes above ceilings and at the structure above shall be mounted such that there is no equipment, plumbing, mechanical, electrical or otherwise, installed below the box. Boxes installed above the ceiling shall be mounted within 3' of the ceiling.
2. Animal Research Facility (ARF) Area: Provide boxes as specified for 'ARF Area'. All recessed and surface boxes in ARF areas shall be cast with external hub. See drawings for area designated as 'ARF Area'.
 - a) All devices and/or covers on boxes in ARF areas shall be gasketed, including but not limited to occupancy sensors and fire alarm devices.

- b) Where boxes are recessed in the wall or ceiling provide sealant around box within the opening of the finished surface (wall, ceiling), and provide sealant around cover plate or surface device backplate (occupancy sensor, etc.). Boxes shall be carefully located recessed in wall to ensure cover and gasket contacts box, and such that box does not protrude from wall causing a gap between cover and wall.
 - c) Where boxes are surface mounted directly tight to the finished surface (NOT spaced off wall for wet/damp locations), provide sealant around perimeter of box where box meets finished surface.
- 3. Install electrical boxes and fittings as indicated, and in compliance with NEC requirements, in accordance with the manufacturer's written instructions and with recognized industry practices to ensure that the boxes and fittings serve the intended purposes.
- 4. The following fasteners, screws, bolts, washers and associated hardware used in the building shall be stainless steel:
 - a) Where used for mounting any boxes, clamps and fittings in the 'ARF' area.
 - b) Where used for installation of covers on boxes in the 'ARF' area.
 - c) Where used for mounting weatherproof boxes and fittings.
 - d) Where used for installation of covers on weatherproof boxes.
- 5. Provide knockout closures to cap unused knockout holes where blanks have been removed and plugs for unused threaded hubs.
- 6. Locate boxes and conduit bodies so as to ensure accessibility of electrical wiring.
- 7. The use of conduit bodies shall be limited except where boxes are not applicable. Where conduit bodies are installed on conduit 2" and larger, the conduit body shall be a larger mogul type conduit body.
- 8. Avoid using round boxes where conduit must enter box through side of box which would result in a difficult and insecure connection with a locknut or bushing on the rounded surface.
- 9. Avoid using octagonal boxes unless required by a specific installation.
- 10. Secure boxes rigidly to the substrate upon which they are being mounted or solidly embed boxes in concrete or masonry. Rigidity of outlet box shall not rely on finishing wall structure.
- 11. Provide plaster rings as required for finishing.
- 12. Use a special square masonry box for mounting in exposed masonry walls unless noted otherwise.
- 13. All outlet and device boxes installed in common wall between two rooms shall be offset (not back to back) to limit sound transmission.

14. All outlets and boxes shall be installed in a manner as to comply with the required U. L. rating of the wall, floor, ceiling or other assembly. Provide firestopping and other materials to meet the required penetration rating.
15. Provide spanner bar between studs to locate outlets as shown on drawings. In general, mounting outlets on the nearest stud is not acceptable.
16. Boxes in non-masonry walls shall be supported from the back of the box with metallic bar manufactured for the purpose secured to studs. Conduit and wire are not acceptable means of support.
17. All exposed single or double gang boxes in mechanical or electrical rooms shall be cast aluminum type with internal hub.
18. All boxes shall be accessible. Where existing boxes within the project area are found to be inaccessible or where installation of equipment within the project area causes existing boxes to be inaccessible the boxes shall be relocated such that they are made accessible.
19. Receptacles and telecommunication outlets shown adjacent on plans shall be mounted 8" apart horizontally on center, not necessarily secured to studs for convenience of installation.
20. Boxes in stud walls shall be supported from the back of the box with metallic bar secured to studs. Conduit and wire are not acceptable means of support.
21. Install pull boxes and wire troughs to have front covers accessible. There shall be a minimum of 30" clear in front of the box or wire trough. This distance measured perpendicular to the cover anywhere on the cover.
22. Boxes installed exposed/surface mounted in finished areas shall be die-cast aluminum with internal threaded hubs unless noted otherwise.
23. Handholes: Provide a ground rod in each handhole and ground cable racks and other metal components required to be grounded within handhole.

B. IDENTIFICATION

1. All outlet, junction, and pull boxes and associated covers installed exposed in unfinished areas and above accessible ceilings shall be painted prior to installation.
2. Refer to Section 260000 for color scheme.
3. For power branch circuit and feeder boxes provide identification of circuitry installed in the box. For branch circuits provide the panel and circuit number of the source of the branch circuit which is installed in the electrical box. For feeders provide the panel and circuit number of the source of the feeder and the equipment which the feeder serves. Identification shall be by thermal label maker with white tape and black text. Text shall be 1/2" high. Boxes outside shall have a phenolic label indicating the same.

END OF SECTION 26 0535

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SECTION 26 0583 - ELECTRICAL CONNECTIONS FOR EQUIPMENT

PART 1. GENERAL

A. RELATED DOCUMENTS

1. Refer to Section 260000, Electrical General Requirements

B. DESCRIPTION OF WORK

1. This work includes the electrical connection of all systems equipment and devices specified under other Divisions of this specification (not under Division 26 - Electrical).
2. This work includes the power wiring up to a point consisting of a junction box, outlet, disconnect switch, or other equipment as indicated on the drawings including terminations on the line side of this equipment. Wiring from this point to the mechanical, plumbing or other equipment, up to and including final connections, shall be provided by the respective mechanical or plumbing contractor, or supplier/installer of other equipment.
3. Provide all labor, raceway, conductors, outlets, switches, miscellaneous material, devices and equipment necessary to complete the installation as indicated.

PART 2. PRODUCTS (NOT USED)

PART 3. EXECUTION

A. INSTALLATION

1. All final connections to motors, dry type transformers and other rotating or vibrating equipment shall be made with flexible liquid-tight metal conduit so as to restrict vibration (12" minimum length flex conduit).
2. The electrical contractor shall coordinate with the mechanical and plumbing contractors, and suppliers/installers of other equipment the submittals and other proposed equipment information, site prep guide, utility information and literature. Verify overcurrent requirements, wiring requirements, ground fault requirements and other requirements of the electrical systems serving such equipment prior to the installation of electrical equipment to ensure the electrical systems are adequate for serving the proposed equipment.
3. Fuses shall be provided in the disconnecting means where nameplates rating of equipment to be connected is based on fuses for protection.

END OF SECTION 26 0583

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SECTION 26 0920 - LIGHTING CONTROLS

PART 1. GENERAL

A. SCOPE

1. Lighting controls in the scope of this specification are local controls involving control by occupancy, dimming, daylight, timer, low voltage, and systems for emergency lighting. Note that some devices such as time clocks may be used to control equipment other than lighting.

B. RELATED DOCUMENTS

1. The requirements of Section 260000 govern the work specified in this section.

C. DESCRIPTION OF WORK

1. Provide a complete system of lighting control as shown on drawings and as specified.
2. Any material and/or equipment necessary for the proper operation of the system not specified or described herein shall be deemed part of this specification.

D. SUBMITTALS

1. Product Data: Submit manufacturer's technical data for items specified.

PART 2. PRODUCTS

A. ACCEPTABLE MANUFACTURERS

1. Hubbell
2. Legrand/Pass & Seymour
3. Eaton/Cooper
4. Lutron
5. Tork
6. Wattstopper

B. WALL MOUNT CONTROL DEVICES

1. Color: All wiring devices shall be gray in color except for devices connected on the isolated power system which shall be orange in color.
2. All devices shall have a grounding screw. Devices shall be mounted vertically unless noted otherwise.
3. Timer Switch – 120V or 277V, 800W at 120V, 1200W at 277V, time-out range from 5 minutes to 12 hours, flashed lights at 5 minutes and 1 minute prior to time-out, single pole or three way:

- a) Product and Manufacturer, 120V: Wattstopper 'TS-400', or approved equal by manufacturers listed in the 'Acceptable Manufacturers' section.
- b) Product and Manufacturer, 277V: Wattstopper 'TS-400-U', or approved equal by manufacturers listed in the 'Acceptable Manufacturers' section.

C. LED DIMMER SWITCH

- 1. LED Dimmer Switch – 0-10V Class 1 dimming, 120-277V, single pole or three way, line voltage, adjustable high end and low end light level trim, 8A switching, 50mA sink capacity, power failure memory:
 - a) Product and Manufacturer: Lutron 'DVSTV', or approved equal by manufacturers listed in the 'Acceptable Manufacturers' section.

D. OCCUPANCY SENSOR SWITCHES, WALL MOUNT

- 1. Passive infrared type, single switch/relay - 120/277V, line voltage, 1000W at 120V, 1200W at 277V, single switch/relay, auto or manual on, time delay-5, 10, 15, 20, 25 and 30 minutes, five year warranty:
 - a) Wattstopper PW-301, or approved equal by manufacturers listed in the 'Acceptable Manufacturers' section.
- 2. Passive infrared type, double switch/relay - 120/277V, line voltage, 1000W at 120V, 1200W at 277V, double switch/relay, auto or manual on, time delay-5, 10, 15, 20, 25 and 30 minutes, five year warranty:
 - a) Wattstopper PW-302, or approved equal by manufacturers listed in the 'Acceptable Manufacturers' section.

E. OCCUPANCY SENSOR, CEILING MOUNT

- 1. Passive infrared type - 120/277V, line voltage, 800W at 120V, 1500W at 277V, time delay-5, 10, 15, 20, 25, 30 minutes, sensitivity adjustment, five year warranty, high density lens for up to 500 square feet coverage:
 - a) Wattstopper CI-355-1, or approved equal by manufacturers listed in the 'Acceptable Manufacturers' section.

F. DIMMER/OCCUPANCY/VACANCY SENSOR SWITCH FOR LED

- 1. Passive infrared type, 400 square foot minor motion coverage, 120/277V, line voltage, 0-10V Class 1 dimming, 8A switching, 50mA sink capacity, adjustable for occupancy or vacancy control, high end and low end light level trim, time delay-1, 5, 15, and 30 minutes, five year warranty:
 - a) Lutron #MS-Z101, or approved equal.

G. PLATES AND COVERS – FOR ANIMAL RESEARCH FACILITY (ARF) AREAS

- 1. Provide the indicated weatherproof cover plates for all receptacles, manual only switches, and manual dimmer switches in ARF Areas. See drawings for designated ARF Areas. Do not provide weatherproof covers on wall mount occupancy sensors.

2. Weatherproof Covers for Receptacles and Rectangular Shaped Devices: Cover shall be weatherproof when not in use only. Covers which are weatherproof when-in-use are not allowed. Weatherproof covers shall be heavy duty, commercial grade, cast aluminum, lockable, with an IP44 Suitability Rating.
 - a) For vertical mounted weatherproof ground fault receptacle and other rectangular shaped devices (LED dimmer, etc.) - Product and Manufacturer: Hubbell 'WP26V', or approved equal by manufacturers listed in the 'Acceptable Manufacturers' section.
 - b) For horizontal mounted weatherproof ground fault receptacle and other rectangular shaped devices - Product and Manufacturer: Hubbell 'WP26H', or approved equal by manufacturers listed in the 'Acceptable Manufacturers' section.
3. Weatherproof Plates for Toggle Switches: Cover shall be weatherproof when not in use only. Weatherproof plates for switches shall be heavy duty, cast aluminum, with an IP44 Suitability Rating.
 - a) Product and Manufacturer: For vertical mounted weatherproof device - Hubbell series 'HBL-7420', or approved equal by manufacturers listed in the 'Acceptable Manufacturers' section.
4. In ARF areas as indicated on the drawings which do not require a weatherproof cover provide a jumbo size satin finish, smooth 302 stainless steel cover.

H. PLATES AND COVERS

1. Plates: Device plates shall be standard size satin finish, smooth (not beveled) 302 stainless steel unless noted otherwise. All plates shall look identical except for opening(s), and required size.
2. Device plates on exposed work in finished areas shall be flush with perimeter of box.
3. Weatherproof and exterior mounted devices shall have weatherproof cover plates unless noted otherwise. Weatherproof covers shall be suitable for mounting directly to the box and shall be mounted to a box with four screws. Covers shall not be mounted to device only. In all cases the weatherproof cover shall flip upward for exposure of device.
4. Weatherproof Covers for Receptacles and Rectangular Shaped Devices: Cover shall be weatherproof when not in use only unless required by code to be weatherproof while-in-use. Weatherproof covers shall be heavy duty, commercial grade, cast aluminum, lockable, with an IP44 Suitability Rating.
 - a) For vertical mounted weatherproof ground fault receptacle and other rectangular shaped devices (LED dimmer, etc.) - Product and Manufacturer: Hubbell 'WP26V', or approved equal by manufacturers listed in the 'Acceptable Manufacturers' section.
 - b) For horizontal mounted weatherproof ground fault receptacle and other rectangular shaped devices - Product and Manufacturer: Hubbell 'WP26H', or approved equal by manufacturers listed in the 'Acceptable Manufacturers' section.

5. Weatherproof Plates for Toggle Switches: Cover shall be weatherproof when not in use only. Weatherproof plates for switches shall be heavy duty, cast aluminum, with an IP44 Suitability Rating.
 - a) Product and Manufacturer: For vertical mounted weatherproof device - Hubbell series 'HBL-7420', or approved equal by manufacturers listed in the 'Acceptable Manufacturers' section.

I. PHOTOCELL

1. Photocell shall be rated for 105-305VAC, 1000W, 8A LED. Unit shall be weatherproof, with surge protection, mounted in a stainless steel cover, and be rated for 20,000 cycles with 20 year lifespan, and have a 10 year warranty. Photocell shall be Tork #ZB124WP, or approved equal.

J. TIME CLOCKS

1. Time Clock for Indoor and Outdoor Lighting: Time clock shall be digital, 365/7 day, astronomic type, daylight saving, power backup, manual override; 99 ON/OFF setpoints per week; 120/208-240/277V, 30A general rating. Verify channel and pole configuration as required for lighting circuitry indicated on drawings. Unit shall have removeable memory module for schedule programming. Furnish total of two USB memory module programmers, Tork #USB-MMP. Time clock shall be Tork Series 'DZSXXXBP', or approved equal by ABB, Eaton or Schneider.
 - a) Indoor lighting time clock shall have two channels, SPDT, and shall be Tork #DZS200BP or approved equal.
 - b) Animal water flush time clock shall have two channels, SPDT, and shall be Tork #DZS200BP or approved equal.

PART 3. EXECUTION

A. INSTALLATION

1. Wiring terminations to devices shall be made by looping a bare solid conductor around the screw terminal. Insertion of wire into back "wire holes" is not allowed.
2. Device plate shall be installed with top edge level. Plate shall be installed against wall with no gaps between plate edges and wall, and with face of device flush with plate.
 - a) The electrical contractor is responsible to coordinate, with the General Contractor, the exact location of all mill work, casework and wall mount modular furniture prior to rough-in so that outlet boxes will be properly located.
3. All items of the lighting control system shall be installed in NEMA-1 enclosures unless noted otherwise.
4. Provide operating and maintenance instructions on the system and 2 hours of staff training.

B. IDENTIFICATION

1. Refer to Section 260000 for products.
2. All switches shall be labeled with thermal label maker with clear tape and black text indicating panel and circuit number which serves device.
3. Devices with weatherproof covers shall be labeled with thermal label maker with white tape and black text indicating panel and circuit number which serves device. Label shall be placed inside weatherproof cover on cover portion directly adjacent to device where label can be seen.
4. Receptacles which are switched shall be labeled "Switched" with thermal label maker with clear tape and black text. Label shall be placed to left of receptacle on cover.
5. Device labels shall be printed similar to the following where the panel name and circuit number is appropriate for the particular device:

BA-24

6. Nameplates:
 - a) Refer to Section 260000 for products.
7. Label each enclosure as follows: "Lighting Controls ____"; fill in area served.

C. LIGHTING CONTROLS SETUP

1. All lighting controls, including occupancy sensors, dimmers and network system lighting controls shall be setup as follows:
 - a) Occupancy sensors shall be setup and calibrated to ensure proper operation per the drawings. Sensors shall be adjusted to be activated by minor motion within the space the sensor controls. Sensors shall be adjusted to not be activated by motion outside the space the sensor controls. Sensors shall be adjusted and masked where required per the manufacturer's recommended installation instructions to provide such coverage.
 - b) Ceiling mount occupancy sensors shall be mounted and installed per the manufacturer's installation instructions, including spacing from supply, return or exhaust air outlets/inlets. It is the responsibility of the Contractor to verify final supply, return and exhaust air outlets/inlets and install accordingly.
 - c) Dimmers shall be setup such that the high end light level trim is adjusted to provide footcandles as indicated on the drawings as the maximum light level. This setting shall be made when there is no natural or ambient light which would interfere with this setup. The maximum light level shall be 70 average maintained footcandles unless noted otherwise.
 - d) The Contractor shall coordinate with the Owner and setup all time clocks per the manufacturer's instructions according to a schedule provided by the Owner.

- e) The Contractor shall return to the site 30 days after furnishing and equipment installation, and user occupation by the Owner and make final adjustments to occupancy sensors and time clocks based on the particular use of the spaces and furnishing and equipment layout.

D. SPARE PARTS

- 1. Provide 2% spare lighting control switches, and cover plates of each type installed.
- 2. Provide 10% spare lighting occupancy sensors of each type installed.
- 3. Provide one spare time clock memory module for each lighting time clock.

E. TESTING AND COMMISSIONING

- 1. See Section 26 0126-Testing and Startup, and Section 26 0100-Operations and Maintenance Manuals for testing and commissioning requirements for lighting controls.

END OF SECTION 26 0920

SECTION 26 2416 - PANELBOARDS

PART 1. GENERAL

A. RELATED DOCUMENTS

1. The requirements of Section 260000 govern the work specified in this section.

B. DESCRIPTION OF WORK

1. The extent of panelboard work is indicated by drawings and schedules and the requirements of this section.
2. All work in existing panels shall comply with this section insofar as is applicable to the particular panel and the work in the panel.

C. SUBMITTALS

1. Product Data: Submit manufacturer's technical data indicating application, service, mains, branches, and cabinet description, and include catalog data on work in existing panels.
2. Shop Drawings: Submit schedules complete with dimensions of each panelboard.

D. QUALITY ASSURANCE

1. Minimum Standards: Comply with the following.
 - a) UL 50: Cabinets and Boxes
 - b) UL 57: Panelboards
 - c) UL 489: Branch Circuit and Service Circuit Breakers
 - d) NEMA AB-1: Molded Case Circuit Breakers
 - e) NEMA KS-1: Enclosed Switches
 - f) NEMA PB-1: Panelboards

PART 2. PRODUCTS

A. MANUFACTURERS

1. Product and Manufacturers: Panelboards shall be NQ, NF, or HC (I-Line Series) as manufactured by Square D, or equal as manufactured by Eaton or Siemens.

B. CONSTRUCTION

1. Box:
 - a) Material: Unpainted galvanized code gauge steel.

- b) Size: Minimum 20" wide x 5-3/4" deep with a 4" gutter space on all sides unless noted otherwise. Where feeder cables supplying the mains are carried through box to supply other electrical equipment, or large branch breakers are used, box shall be sized to include this wiring space. This wiring space shall be in addition to the minimum gutter space specified above and the limiting width shall be increased accordingly.
 - c) Size – Main Distribution Panel (indicated by MDP on drawings): Minimum 32" wide x 9-1/2" deep with a minimum 5" gutter space on all sides unless noted otherwise. Where feeder cables supplying the mains are carried through box to supply other electrical equipment, or large branch breakers are used, box shall be sized to include this wiring space. This wiring space shall be in addition to the minimum gutter space specified above and the limiting width shall be increased accordingly.
 - d) Interior mounting studs: At least 4.
 - e) Nameplates and Identification Number: Manufacturer's nameplate and box identification number shall be on box.
- 2. Bussing:
 - a) Material: 98% conductivity copper.
 - b) Tap Arrangement: Phase sequence type, permitting a two or three pole breaker to be installed at any location.
 - c) Plating: All current carrying parts.
 - d) Phase Bussing: Full height of breaker space without reduction.
 - e) Neutral Bussing:
 - (1) Full size, unless otherwise noted.
 - (2) Suitable lug for each outgoing feeder and branch circuit requiring neutral connection.
 - f) Ground Bus: Suitable lug for each outgoing feeder and branch circuit requiring ground connection.
 - g) Bolts: All bolts used to connect current carrying parts together shall be accessible for tightening from the front of the panel.
- 3. Wiring Terminals:
 - a) Feeders (Main Lugs):
 - (1) Compression or set-screw type, bolted to bus.
 - (2) Provide multiple lugs for multiple conductors.
 - (3) Provide special lugs sized as required for circuits(s) noted as "tapped ahead of the main".
- 4. Spaces: Space provisions or spaces for future breakers shall be located at the bottom of the panel and be fully bussed complete with all necessary mounting hardware less the breaker.
- 5. Interior: Factory assembled with switching and protective devices, wire connectors, etc.

- a) Interiors shall be so designed that switching and protective devices can be replaced without disturbing adjacent units and without removing the main bus connectors and shall be so designed that circuits may be changed without machining, drilling or tapping.
 - b) Branch circuit arrangement: Double row construction.
6. Trim:
- a) Trim shall be a hinged door-in-door trim with piano hinge down one side.
 - b) Material: Code gauge steel.
 - c) Flush Panels: 3/4" minimum overlap all around.
 - (1) Provide separate covers for each section of panelboard.
 - d) Surface Panels: Same width and height as box.
 - (1) Mountable by screwdriver without need for special tools.
 - (2) Adjustable indicating trim clamps shall be concealed inside door.
 - e) Doors: Doors shall cover all device handles.
 - f) Hinges: Provide concealed type, 5-knuckle (minimum), steel hinges.
 - g) Auxiliary Fasteners: Units over 48" in height shall have auxiliary fasteners at top and bottom of door in addition to flush latch to provide 3-point fastening.
 - h) Latches: Latches shall be flush, not protruding beyond front of door, spring loaded type.
 - i) Locks: Equip latches with flush, 5-pin cylinder type. Locks shall be keyed alike.
 - j) Finish: Except for box, all exterior and interior steel surfaces shall be properly cleaned and finished with industry standard gray baked enamel paint over a rust-inhibiting phosphatized primer coating approved by the paint manufacturer.

C. CIRCUIT BREAKERS

- 1. Main Breakers:
 - a) Main breakers shall be individually mounted separate from branch breakers.
 - b) Each breaker shall be covered by a metal plate, except for operating handle.
 - c) Connection from the load side to the panel bus shall be bus bar. Insulated wire is not permitted.
 - d) Trip rating shall be clearly indicated upon opening of panel door.
- 2. Branch Breakers:
 - a) Breakers shall be bolt-in type. Plug-in breakers are not allowed.
 - b) Breakers shall be molded case with a thermal-magnetic inverse time-current overload and instantaneous magnetic tripping, unless otherwise shown.
 - c) Breakers shall be quick-make, quick-break, with tripped indication clearly shown by breaker handle taking a position between ON and OFF.

- d) Multi-pole breakers shall have a common internal trip. No handle ties between single pole breakers.
 - e) Breaker contacts shall be 'SWD'-rated for switching duty.
 - f) Breakers shall be arranged as shown in the panel schedule on the drawings. Breaker arrangement “as received from factory” is not accepted unless specialty breakers require a particular orientation or configuration.
 - g) Breaker and circuit number labeling in the panel shall be as shown in the panel schedule on the drawings. Labeling a two pole or three pole breaker or space as a single number is not allowed.
 - h) Trip rating shall be clearly indicated on all breaker handles.
 - i) Breakers with electronic trip functions shall be adjustable in the field.
- 3. Circuit breakers with 225 amp frame or larger shall be electronic trip and provided with adjustable trip settings for long time pickup, long time delay, instantaneous, and, where indicated, ground fault.
 - 4. Ground Fault Circuit Interrupters (GFI): Provide UL Class A (5 milliamp sensitivity) ground fault circuit protection on 120 VAC branch circuits where shown. This protection shall be an integral part of the branch circuit breaker which also provides overload and short circuit protection for branch circuit wiring. Tripping of a branch circuit breaker containing ground fault circuit interruption shall not disturb the feeder circuit to the panelboard. A single pole circuit breaker with integral ground fault circuit interruption shall require no more panelboard branch circuit space than a conventional single pole circuit breaker. Provide separate neutral for circuits on GFI breakers whether indicated on drawings or otherwise.

D. INTERRUPTING CAPACITY

- 1. The minimum amps interrupting capacity (AIC) of the panelboard assembly and all individual breakers and components shall be as indicated on the drawings. Series rating of breakers is not allowed.

E. ISOLATED POWER PANEL

- 1. Provide a complete isolated power panel system with primary main breaker, isolation transformer, branch circuit breakers, internal line isolation monitor, flush mount enclosure, and remote mount line isolation monitor(s) located per the Owner and Designer. System shall be UL Listed for compliance with UL 1047-Standard for Isolated Power Systems Equipment.
- 2. Panel shall have 208V single phase primary-120V secondary, primary breaker, 5kVA hospital grade isolation transformer with Class 180 insulation, electrostatic shield, reference ground bar, and maximum 35db sound level. Panel shall be flush mount, 24” wide, 6” deep and 45” high.
- 3. Branch circuit breakers shall bolt-on 2 pole, 120V, 10k AIR breakers. Panel shall have eight breakers.
- 4. The Contractor shall furnish four (4) 15’ long hospital grade ground cords with heavy duty clip with panel system. Cord shall be Square D #SHGC15C or approved equal by Bender or Eaton.

5. Isolated power panel shall be Square D Class 4800 with remote isolation monitor Square D #IG2000CBMG2 or approved equal by Bender or Eaton.

PART 3. EXECUTION

A. INSTALLATION

1. Panel Circuit Directory:
 - a) Directory shall include name of load as indicated in panel schedule on drawings, and room number(s) for each circuit. Where the load is a motor the motor horsepower shall be included on the directory. Contractor shall verify the installed motor horsepower.
 - b) Print information on furnished card with typewriter or print panel directory on 24 pound white paper with laser printer such that directory fits in allotted space on panel door.
 - c) Identify areas and equipment items served by each breaker. Refer to room numbers assigned by Owner, not Architect's construction drawing numbers.
2. Keys: Collect all keys upon panel delivery. Store on one ring to be kept by project superintendent. Forward to Owner upon substantial completion.
3. Spare Conduit: Provide four 3/4" and two 1" and one 1 1/2" empty conduits for future access to each panelboard. Cap and tag. Terminate all conduit into a box and label cover with name of panel conduit originates.
4. Mounting: Panelboards shall be secured to wall with expansion bolts or to unistrut/channel secured to wall. All panelboards mounted on combustible products, or exterior or below grade walls shall be mounted on channel secured to wall.
5. Wiring and feeders in panel enclosures shall be routed and trained such that they are not against any mounting studs or in any way have the insulation damaged by the mounting studs or other internal hardware.
6. Upon completion of the project and occupation of the space by the Owner, the contractor shall perform a load balance amperage meter test on each new panel to confirm loads are balanced within 10% across all phases. Where loads are not balanced within 10% the contractor shall shift circuits such that phases are more balanced.

B. RENOVATION WORK INVOLVING EXISTING PANELS

1. Work in existing panels shall meet the requirements of this specification section unless the existing panel is of such configuration that it is not possible. Breakers, fittings, mounting accessories and other components installed in existing panels shall be by manufacturer of the panel or compatible with the panel. AIC rating of any equipment installed in an existing panel shall match the highest rated AIC equipment listed on or installed in the panel.

2. Directories shall be updated indicating the same information from the existing directory except that any change in circuitry shall be noted in the panel directory and shall include room numbers. Old directories shall be left in the panel. Indicate the date on the new directory, and mark the old directory 'Not Applicable - Superseded', and the date on the old directory.

C. ISOLATED POWER PANEL SYSTEM

1. Branch circuit conductors shall be #10, type XHHW-2 insulation. 120V branch circuit wire shall be orange (for what is normally the grounded conductor) with one distinctive color other than white, green or gray, and brown with one distinctive color other than white, green or gray. Wire pulling compound shall not be used during wire installation.

D. PANELBOARD IDENTIFICATION

1. See drawings for label detailed description. Refer to Section 260000 for product description.
2. Location of Nameplates:
 - a) Panels: Above door on panel trim.
 - b) Nameplates to read similar to the following where the name, voltage, etc. is appropriate for the particular panel:

PANEL 'BA'
120/208V. 3ø, 4W
FED BY PANEL 'MDP'

END OF SECTION 26 2416

SECTION 26 2726 - WIRING DEVICES AND PLATES

PART 1. GENERAL

A. RELATED DOCUMENTS

1. The requirements of Section 260000 govern the work specified in this section.

B. DESCRIPTION OF WORK

1. The extent of work is defined by the drawings and the requirements of this section.
2. Provide wiring devices compatible with the equipment supplied. Where junction boxes or "non plug-in" connections are indicated on the drawings and the equipment supplied requires a wiring device, provide the appropriate device to service the equipment supplied.

C. SUBMITTALS

1. Product Data: Submit manufacturer's technical data for each item specified.

D. QUALITY ASSURANCE

1. All wiring devices and plates shall be manufactured by the same manufacturer.

PART 2. PRODUCTS

A. ACCEPTABLE MANUFACTURERS

1. Hubbell
2. Legrand/Pass & Seymour
3. Eaton/Cooper
4. Leviton

B. GENERAL

1. The following fasteners, screws, bolts, washers and associated hardware used in the building shall be stainless steel:
 - a) Where used for installation of devices and covers on boxes in the 'ARF' area.
 - b) Where used for installation of devices and covers on weatherproof boxes.

C. WIRING DEVICES

1. Color: All wiring devices shall be gray in color except for devices connected to the isolated power system shall be orange in color.

2. All devices shall have a grounding screw. Devices shall be mounted vertically unless noted otherwise.
3. Devices in locations required by code to be tamper resistant shall be tamper resistant type.
4. Devices in locations required by code to weather resistant shall be weather resistant type.
5. All 15A and 20A, 120V and 250V rated receptacles installed in damp or wet locations, and weatherproof receptacles shall be weather resistant type device.

D. RECEPTACLES

1. Receptacles shall be federal specification grade.
2. General Use Duplex Receptacles, 20 Ampere, 125 Volt, NEMA 5-20R.
 - a) Product and Manufacturer: Hubbell 'HBL5362', or approved equal by Pass and Seymour or Leviton
3. Weatherproof Duplex Receptacles, 20 Ampere, 125 Volt, NEMA 5-20R.
 - a) Product and Manufacturer: Hubbell 'HBL5362-WR', or approved equal by Pass & Seymour or Leviton
4. Self Contained Ground Fault Interrupting (G.F.I.) Duplex Receptacles: 20 Ampere, 125 Volt, NEMA 5-15R, weather resistant, high impact resistant polyester housing.
 - a) Product and Manufacturer: Hubbell 'GF5362SG', or approved equal by Pass & Seymour or Leviton
5. Special Purpose Receptacles: Special purpose receptacles other than those specified above shall be heavy duty specification grade of the NEMA configuration indicated on the drawings, or if not indicated, as required by the serving branch circuit and the equipment to be connected. Coordinate with equipment to be connected and provide NEMA configuration receptacle as required.
6. Twist Lock Receptacle: Device shall have high impact nylon face, glass reinforced thermoplastic base and all brass mounting strap. Devices shall be Hubbell device as listed below or approved equal by Pass & Seymour or Leviton.

E. SWITCHES

1. Switches shall be extra heavy duty industrial grade unless noted otherwise.
2. Single Pole Switches, 20 Ampere, 120/277 Volt.
 - a) Product and Manufacturer: Hubbell 'HBL1221' series, or approved equal by Pass & Seymour or Leviton.
3. Three-way Switches, 20 Ampere, 120/277 Volt.

- a) Product and Manufacturer: Hubbell 'HBL1223' series, or approved equal by Pass & Seymour or Leviton.
- 4. Four-way Switches, 20 Ampere, 120/277 Volt.
 - a) Product and Manufacturer: Hubbell 'HBL1224' series, or approved equal by Pass & Seymour or Leviton.

F. GROUND FAULT CIRCUIT INTERRUPTER/DISCONNECT SWITCH DEVICE

- 1. Device shall be a Class A ground fault circuit interrupter and UL 508 disconnect switch, without a receptacle. Device shall be rated 1 1/2HP and shall have LED indicators. Hubbell #GFBFHP20, OR APPROVED EQUAL BY Leviton or Pass & Seymour.

G. PLATES AND COVERS – FOR WEATHERPROOF OUTLETS IN ANIMAL RESEARCH FACILITY (ARF) AREAS

- 1. Provide the indicated weatherproof cover plates for all receptacles, manual only switches, and manual dimmer switches in ARF Areas unless noted otherwise. See drawings for designated ARF Areas.
- 2. Weatherproof Covers for Receptacles and Rectangular Shaped Devices: Cover shall be weatherproof when not in use only. Covers which are weatherproof when-in-use are not allowed. Weatherproof covers shall be heavy duty, commercial grade, cast aluminum, lockable, with an IP44 Suitability Rating.
 - a) For vertical mounted weatherproof duplex receptacle - Product and Manufacturer: Hubbell series 'WP8V', or approved equal by Pass & Seymour or Leviton.
 - b) For horizontal mounted weatherproof duplex receptacle - Product and Manufacturer: Hubbell series 'WP8H', or approved equal by Pass & Seymour or Leviton.
 - c) For vertical mounted weatherproof ground fault receptacle and other rectangular shaped devices (LED dimmer, etc.) - Product and Manufacturer: Hubbell 'WP26V', or approved equal by Pass & Seymour or Leviton.
 - d) For horizontal mounted weatherproof ground fault receptacle and other rectangular shaped devices - Product and Manufacturer: Hubbell 'WP26H', or approved equal by Pass & Seymour or Leviton.
- 3. Weatherproof Cover for Twist Lock Device While Open (L5-30R): Cover shall be weatherproof when cover is open and device is mated. Cover shall be gray thermoplastic for mounting on FS/FD box, spring loaded polycarbonate cover, IP44 rating, for device with 1.55"-1.58" diameter. Cover shall be suitable for L5-30R receptacle. Cover shall be Hubbell #HBL7425WOA or approved equal by Pass & Seymour or Leviton.
- 4. Weatherproof Plates for Toggle Switches: Cover shall be weatherproof when not in use only. Weatherproof plates for switches shall be heavy duty, cast aluminum, with an IP44 Suitability Rating.

- a) Product and Manufacturer: For vertical mounted weatherproof device - Hubbell series 'HBL-7420', or approved equal by Pass & Seymour or Leviton.
- 5. Weatherproof Cover for Special Purpose Receptacle: Cover shall be weatherproof when not in use only. Covers which are weatherproof when in use are not allowed. Weatherproof plates shall be heavy duty, cast aluminum, with an IP44 Suitability Rating.
 - a) Product and Manufacturer: Hubbell series 'HBL', or approved equal by Pass & Seymour or Leviton. Coordinate exact model type with special receptacle face diameter.
- 6. In ARF areas as indicated on the drawings which do not require a weatherproof cover provide a jumbo size satin finish, smooth 302 stainless steel cover.

H. PLATES AND COVERS

- 1. Plates – In 'ARF' Area: Device plates shall be jumbo size (3.5" W x 5.25" H) where mounted on cast aluminum box, satin finish, smooth (not beveled) 302 stainless steel. All plates shall look identical except for opening(s), and required size.
- 2. Plates – Not In 'ARF' Area: Device plates shall be standard size satin finish, smooth (not beveled) 302 stainless steel. All plates shall look identical except for opening(s), and required size.
- 3. Device plates on exposed work in finished areas shall be flush with perimeter of box.
- 4. Exterior mounted receptacles and other weatherproof receptacles in locations required to have a weatherproof while-in-use cover shall have weatherproof cover plates and shall be listed "raintight while in use".
- 5. Weatherproof covers shall be suitable for mounting directly to the box and shall be mounted to a box with four screws. Covers shall not be mounted to device only. In all cases the weatherproof cover shall flip upward for exposure of device.
- 6. Weatherproof Plates for Toggle Switches: Cover shall be weatherproof when not in use only. Weatherproof plates for switches shall be heavy duty, cast aluminum, with an IP44 Suitability Rating.
 - a) Product and Manufacturer: For vertical mounted weatherproof device - Hubbell series 'HBL-7420', or approved equal by Pass & Seymour or Leviton.
- 7. Weatherproof While-In-Use Cover: Cover shall be extra-duty, cast aluminum, padlockable, with provisions for holding cords, box mounted, NEMA 3R, weatherproof while-in-use cover which meets UL 514D.
 - a) For vertical mounted general use receptacle device - Product and Manufacturer: Hubbell series 'WP8E', or approved equal by Pass & Seymour or Leviton.
 - b) For horizontal mounted general use receptacle device - Product and Manufacturer: Hubbell series 'WP8EH', or approved equal by Pass & Seymour or Leviton.

- c) For vertical mounted ground fault receptacle, and other rectangular shaped devices - Product and Manufacturer: Hubbell series 'WP26E', or approved equal by Pass & Seymour or Leviton.
- d) For horizontal mounted ground fault receptacle, and other rectangular shaped devices - Product and Manufacturer: Hubbell series 'WP26EH', or approved equal by Pass & Seymour or Leviton.

PART 3. EXECUTION

A. INSTALLATION

- 1. Wiring terminations to devices shall be made by looping a bare solid conductor around the screw terminal. Insertion of wire into back "quick make" wire clamp is not allowed.
- 2. All vertically mounted receptacles shall be mounted with the grounding terminal in the up position. Where receptacles are indicated to be mounted horizontally, the device shall be mounted with the neutral terminal in the up position.
- 3. Device plate shall be installed with top edge level. Plate shall be installed against wall with no gaps between plate edges and wall, and with face of device flush with plate.
 - a) The electrical contractor is responsible to coordinate, with the General Contractor, the exact location of all mill work, casework and wall mount modular furniture prior to rough-in so that outlet boxes will be properly located.

B. SPARE PARTS

- 1. Provide 2% spare devices (minimum one) of each type installed.
- 2. Provide 2% spare cover plates (minimum one) of each type installed.

C. IDENTIFICATION

- 1. Refer to Section 26000 for products.
- 2. All receptacles and switches in the project scope area, new and existing, shall be labeled with thermal label maker with clear tape and 1/8" high black text indicating panel and circuit number which serves receptacle.
- 3. Devices with weatherproof covers shall be labeled with thermal label maker with white tape and 1/8" high black text indicating panel and circuit number which serves device. Label shall be placed inside weatherproof cover on cover portion directly adjacent to device where label can be seen.
- 4. Receptacles which are switched shall be labeled "Switched" with thermal label maker with clear tape and black text. Label shall be placed to left of receptacle on cover.
- 5. Device labels shall be printed similar to the following where the panel name and circuit number is appropriate for the particular device:

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6. All wiring devices used to control exhaust fans shall be provided with an engraved nameplate indicating the equipment served.
7. All wiring devices serviced by isolated power panels in addition to being orange shall have an engraved nameplate reading "Isolated Power" and applied with adhesive to the device cover.

END OF SECTION 26 2726

SECTION 26 2816 - SAFETY/DISCONNECT SWITCHES, MANUAL MOTOR SWITCHES, AND FUSES

PART 1. GENERAL

A. RELATED DOCUMENTS

1. The requirements of Section 260000 govern the work specified in this section.

B. DESCRIPTION OF WORK

1. This Section includes disconnects and safety switches as shown as required by codes.

C. SUBMITTALS

1. Product Data: Submit manufacturer's technical data for items specified.

PART 2. PRODUCTS

A. MANUFACTURER

1. Manufacturers:
 - a) General Electric
 - b) Eaton/Cutler-Hammer
 - c) Square D
 - d) Hubbell

B. MATERIALS

1. Safety and Disconnect Switches: Heavy duty, quick-make, quick-break, motor rated, and lockable with defeatable door interlock such that door can be opened while disconnect is in the 'On' position.
2. Single Throw Fusible and Non-Fusible Switches:
 - a) Product and Manufacturer: Square D Class 3110, Type 'H', or approved equal by Eaton or General Electric.
3. Description:
 - a) Where neutral wires are used in the feeder, provide with a solid neutral multi-wire terminal or lug.
 - b) Where ground wires are used in the feeder, provide with a ground multi-wire terminal or lug.
 - c) Provide fused and non-fused type disconnect as indicated.
 - d) Where fused disconnect is shown, provide dual-element fuses unless otherwise noted.

4. Enclosures:
 - a) Indoors: NEMA 1 enclosures unless otherwise indicated.
 - b) Indoors and Outdoors Where Indicated: NEMA 4X Stainless Steel.
 - c) Outdoors: NEMA 3R raintight.
5. Finish:
 - a) NEMA 1 and NEMA 3R: Standard baked gray enamel finish over rust inhibiting phosphate primer.
 - b) NEMA 4X: Type 316 stainless steel.
6. Electrical Interlock Kit:
 - a) Where indicated on the drawings provide an electrical interlock kit in disconnect switch with two NO and two NC contacts. Obtain 120V power source locally or as indicated. Provide control wiring from disconnect to equipment being controlled. Coordinate with controls contractor and equipment being controlled supplier (often a VFD), and provide wiring in the conduit with the feeder for operation/shunting of the equipment by the electrical interlock kit.
 - b) Kit shall be Square D Series 'EIK2', or approved equal by Eaton or General Electric.
7. Accessories: Provide integral fuse pullers for fusible switches.
8. Mounting Hardware: Provide rigid steel (galvanized for exterior use) mounting stands, brackets, plates, hardware and accessories for a complete installation.

C. MANUAL MOTOR STARTER SENTINEL SWITCH

1. Provide manual motor starter switch with thermal overload relay. Switch shall be 120V, 230V or 277V, single pole or double pole, as needed for particular load. Provide device in NEMA 1 general purpose enclosure with handle/guard lock-off, NEMA 3R or NEMA 4 enclosure as required for the particular location or as indicated on drawings. Coordinate with motor load and provide thermal overload units for particular load. Maximum motor size for switch is 1 horsepower. Maximum continuous rating is 16A.
 - a) Product and Manufacturer: Square D Class 2510, Series 'F', or approved equal by Eaton or General Electric.

D. MANUAL MOTOR SATRTING SWITCH

1. Provide manual motor starting switch. Switch shall be rated 600V, double pole or three pole, as needed for particular load. Provide device in NEMA 1 oversized surface enclosure, NEMA 1 general purpose flush enclosure, NEMA 3R or NEMA 4 enclosure as required for the particular location or as indicated on drawings. Maximum motor size for switch is 2HP at 120V, 7 1/2HP at 230V, 10HP at 460V. Maximum continuous rating is 30A at 600V (20A at 600V in NEMA 3R).
 - a) Product and Manufacturer: Square D Class 2510, Series 'K', or approved equal by Eaton or General Electric.

E. MANUAL MOTOR CONTROL/DISCONNECT SWITCH

1. Provide manual motor control/disconnect switch. Switch shall be rated 600V, three pole, 25A, lockable and listed 'Suitable for Motor Disconnect'. Provide device in NEMA 12 metal enclosure. Cover shall be gasketed. Maximum motor size for switch is 5HP at 240V, 10HP at 480V.
 - a) Product and Manufacturer: Square D Class 9421, #9421V2A30 with handle #KCD1YZ and gasket #KZ66, Hubbell #HBL13S33D, or approved equal by Eaton or General Electric.

F. IDENTIFICATION

1. Refer to Section 260000 for product description.
2. All safety and disconnect switches shall have an engraved nameplate indicating the equipment it services.

G. FUSES

1. Provide the following fuse type for the specified circuitry:

<u>Circuit Type</u>	<u>Fuse Type</u>
Service Entrance and Feeders Over 600A	Class L, current limiting, 200K AIC
Service Entrance and Feeders 600A & Less	Class RK1 or J, current limiting, 200K AIC
Motor, Motor Control, Transformer	Class RK5, current limiting, 200K AIC
Individual Equipment with Less Than 50k AIC	Class K5, 50K AIC

PART 3. EXECUTION

A. INSTALLATION

1. Comply with manufacturer's instruction and recommendation.

B. SPARE PARTS

1. Provide six spare fuses of each type and rating used.

END OF SECTION 26 2816

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SECTION 26 4300 – SURGE PROTECTIVE DEVICES

PART 1. GENERAL

A. RELATED DOCUMENTS

1. The requirements of Section 26 0000 govern the work specified in this section.

B. DESCRIPTION OF WORK

1. The extent of surge protective device (SPD) work is indicated by drawings and schedules and the requirements of this section.

C. SUBMITTALS

1. Product Data: Submit manufacturer's technical data indicating application, surge protection, and all electrical characteristics.
2. Shop Drawings: Submit schedules complete with dimensions of each SPD.

D. QUALITY ASSURANCE

1. Minimum Standards: The specified unit shall be designed, manufactured, tested and installed in compliance with the following standards:
 - a) ANSI/IEEE C62.41.1-2002 and C62.45-2002
 - b) ANSI/IEEE C62.1 and C62.11
 - c) Underwriters Laboratories UL 1449 Fourth Edition and UL 1283
 - d) Underwriters Laboratories UL 96A
 - e) Underwriters Laboratories UL 248-1
 - f) The unit shall be UL 1449 Fourth Edition Listed and CUL Approved as a Surge Protective Device and UL 1283 Listed as an Electromagnetic Interference Filter.
2. Provide a product suitable for and installed in coordination with the lightning protection system in order to meet NFPA 780-4.20 – 2014 and UL 96A.

PART 2. PRODUCTS

A. MANUFACTURERS

1. Product and Manufacturers: SPD shall be ABB/Current Technology, or approved equal by Schneider/Square D, Emerson or Eaton.

B. CONSTRUCTION

1. Standard unit shall be supplied in a NEMA 4 metallic enclosure where individually mounted.

2. Where indicated the individually mounted SPD (external to equipment it protects) shall have an internal disconnect with a barrier enclosing the disconnect mechanism and terminals such that there are no exposed energized components when the disconnect is open and the cover is open for maintenance.
3. The unit shall include an engineered solid-state high performance suppression system utilizing arrays of non-linear voltage dependent metal oxide varistors with similar operating characteristics. To maximize current density the device shall contain sufficient thermal mass allowing the device the ability to dissipate large amounts of average power that may be caused from sustained over voltage events and voltage swells as well as repetitive transient impulses.
4. The suppression system components shall optimally share surge currents in a seamless, low-stress manner assuring maximum performance and proven reliability. The suppression system shall not utilize gas tubes, spark gaps, silicon avalanche diodes or other components which might short or crowbar the line, thus leading to interruption of normal power flow to or system upset of connected loads.
5. Under excessive Maximum Continuous Operating Voltage (MCOV) conditions, the device shall be capable of dissipating large amounts of average power that may be caused by overvoltage events and voltage swells as well as repetitive transient impulses. This data shall be published in accordance with NEMA LS-1.
6. The unit shall include a high frequency extended range power filter and shall be UL 1283 listed as an Electromagnetic Interference Filter. The filter shall reduce fast rise-time, high frequency, error-producing transients and electrical line noise to harmless levels, thus eliminating disturbances which may lead to electronic system upset. The filter shall provide minimum noise attenuation as specified.
7. All full magnitude transient current shall be conducted utilizing low-impedance copper bus bar. No plug-in component modules or quick-disconnect terminals shall be used in surge current-carrying paths. If printed circuit boards are utilized in surge current paths, no single trace shall be allowed to conduct more than the proportional current share of the connected SPD component.
8. The unit shall include mechanical or compression lugs for each phase, neutral and ground, if applicable.
9. The product shall be provided with 2 sets of form “C” dry contacts (normally open and normally closed) to facilitate connection to a building management system or other remote monitoring system. The contacts shall be normally open or normally closed and shall change state upon failure of the suppression filter system or power loss in any of the phases.
10. The product shall be provided with an integral monitoring option as specified below:
 - a) The product shall be provided with 2 sets of form “C” dry contacts (normally open and normally closed) to facilitate connection to a building management system or other remote monitoring system. The contacts shall be normally open or normally closed and shall change state upon failure of the suppression system or power loss in any of the phases.

- b) The product shall be provided with a display event counter that makes available the cumulative number of transients the device has been subjected to. The detection circuitry must be current sensing to eliminate erroneous counts that may be produced from stray voltages and noise signals, both conducted and radiated.
 - c) The product shall be provided with an audible alarm that detects and provides notification of single or multiple phase failure of the suppression filter system. The audible alarm shall have a silence switch. The alarm shall have a silence switch as well as a test switch for ensuring positive function and an alarm LED that illuminates when the alarm is disabled.
- 11. Per ANSI/IEEE C62.41 and ANSI/IEEE C62.45, suppression filter systems shall be repetitive surge current capacity tested in every mode without suffering either performance degradation or more than 10% deviation of clamping voltage at the specified surge current.
- 12. In compliance with NEMA LS-1, suppression filter systems shall be single pulse surge current tested in all modes at rated surge currents by an industry-recognized independent test laboratory. Single pulse surge current capacities of 200,000 amps or less are established by single-unit testing of all components within each mode. Due to present industry test equipment limitations, single pulse surge current capacities over 200,000 amps are established via testing of individual components or sub-assemblies within a mode. The test shall include a complete UL1449 Fourth Edition surge test.
- 13. The UL 1449 Fourth Edition listed suppression voltage ratings shall be published, as assigned by Underwriters Laboratories utilizing the UL approved test procedure.
- 14. All EMI-RFI noise rejection or attenuation values shall be in compliance with test and evaluation procedures outlined in NEMA LS-1.

C. OVERCURRENT PROTECTION

- 1. Each suppression element shall be individually fused such that the failure of a single component or the operation of a single fuse element remains isolated and does not render the entire mode, or product, deficient by more 5%.
- 2. For systems utilizing a hybrid technology, each element type shall be individually fused.
- 3. Every electrical current carrying conductor shall be fused such that every fault is isolated at the point of the fault or at the device level.
- 4. Fusing shall be present in all modes, including Neutral-to-Ground.
- 5. All overcurrent/fault current protection shall be UL248-1 Recognized as a stand-alone fuse.
- 6. All fusing must be UL248-1 Recognized and tested at 200kAIC. Testing shall be inclusive of all available product voltages.

7. In accordance with UL 248-1, all fuses and overcurrent/fault current devices must be tested with a 0.2 power factor.
8. All fuses and overcurrent/fault current protection devices shall consist of self-arch-quenching, sand-encapsulated UL 248-1 Recognized fuse arrays. Each fuse shall be individually sealed in a manner that eliminates cross arching.
9. The device shall be capable of withstanding the full single pulse surge current capacity for every mode without the operation or failure of overcurrent/fault current protection or fuses.

D. MONITORING

1. Where indicated on the drawings the product shall be provided with an integral multifunction power monitor analyzer. The monitoring system shall provide real time product performance data along with distribution system power analysis via multiport visual status indicators (LEDs) and a touchpad accessible LED data display.
2. The product shall be provided with a display event counter that makes available the cumulative number of transients the device has been subjected to. The detection circuitry must be current sensing to eliminate erroneous counts that may be produced from stray voltages and noise signals, both conducted and radiated.
3. The product shall be provided with enhanced status indication allowing for visual inspection of the online status of all hybrid elements: selenium, MOVs, and capacitors. Such indication shall be provided for each phase.
4. The product shall be provided with 2 sets of form “C” dry contacts (normally open and normally closed) to facilitate connection to a building management system or other remote monitoring system. The contacts shall be normally open or normally closed and shall change state upon failure of the suppression system or power loss in any of the phases.
5. The product shall be provided with a battery powered audible alarm that detects and provides notification of single or multiple phase failure of the suppression filter system. The alarm shall have a silence switch as well as a test switch for ensuring positive function and an alarm LED that illuminates when the alarm is disabled. The monitoring unit shall have an easily replaceable, commonly available battery for backup to ensure audible alarm function in the event of a total power failure. The unit shall have a battery backed-up LED which shall illuminate when battery requires replacement.
6. The monitoring shall provide the following:
 - a) Visual and audible indication of product fault occurring neutral-to-ground.
 - b) Digital display of neutral-to-ground current flowing in the system. Such indication may signal neutral-ground bonding issues within the distribution system.
 - c) True RMS voltage monitoring for all phases along with neutral-to-ground.
 - d) Visual indication and count of all voltage sags < 90% of nominal.
 - e) Visual indication and count of all voltage swells > 110% of nominal.

- f) Visual indication and count of all power dropouts < 1 cycle.
- g) Visual indication and count of all power outages > 1 cycle.

E. WARRANTY

- 1. The manufacturer shall provide a 15 Year Limited Warranty from date of shipment against failure when installed in compliance with applicable national/local electrical codes and the manufacturer's installation, operation and maintenance instructions.

PART 3. EXECUTION

A. INSTALLATION

- 1. The unit shall be installed as close as practical to the facility's wiring system in accordance with applicable national/local electrical codes and the manufacturer's recommended installation instructions.

END OF SECTION 26 4300

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SECTION 26 5000 - LIGHTING FIXTURES AND LAMPS

PART 1. GENERAL

A. RELATED DOCUMENTS

1. The requirements of Section 260000 govern the work specified in this section.

B. DESCRIPTION OF WORK

1. Provide complete lighting fixtures as specified herein and shown on the drawings. Light fixtures shall include all required materials for a complete installation.
2. All lighting fixtures shall be installed complete with lamps, ballasts, drivers, LED modules and other required equipment and components essential to fixture operation.

C. SUBMITTALS

1. Product Data: Submit lighting fixture brochures in a single, bound and indexed three-ring vinyl covered binder for all lighting fixtures specified.
 - a) Fixture brochures and catalog data shall contain manufacturer's name and catalog illustration and number, dimensions, details, ballast, LED module and driver, diffuser information, photometrics, metal gauges, and finish data. Include U.L. or other third party listing agency approval information. Provide fuse type and size when specified. Submittal shall be marked and clearly state options and select features for each fixture.
 - (1) Each catalog data sheet shall have the manufacturer's name, address, and telephone number, included on the page. Submittal package shall include manufacturer's representative name, address and telephone number.
 - (2) Where fixture is LED, each fixture data sheet shall indicate the LED driver manufacturer and model. Where this information is not available at time of submittal this information shall be provided when the fixtures are manufactured.
 - b) Maintenance Data: Submit maintenance data and parts list for each interior lighting fixture and accessory; including "trouble-shooting" maintenance guide. Include that data, product data, and shop drawings in a maintenance manual.
 - c) Submittal shall clearly state that spare drivers as specified within this specification section will be provided by the manufacturer.
2. Shop Drawings: Submit shop drawings indicating support details for fixed and suspended units.

D. DELIVERY, STORAGE AND HANDLING

1. Deliver lighting fixtures in factory-fabricated containers or wrappings, which properly protect fixtures from damage.

2. Store lighting fixtures in original packaging. Store inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures and humidity. Store laid flat and blocked off ground.
3. Handle lighting fixtures carefully to prevent damage, breaking, warping housing, soiling reflectors/lens and scoring of finishes. Do not install damaged units or components; replace with new. Wear gloves as recommended by manufacturer such as when handling specular finish reflectors (parabolic, louvers, downlights, etc.) and as required to prevent finger print etching on fixtures.

E. QUALITY ASSURANCE

1. Manufacturer's Qualifications: Firms regularly engaged in manufacture of lighting fixtures of sizes, types and ratings required, whose products are UL listed and/or labeled.

F. SEQUENCING AND SCHEDULING

1. Coordinate with other work including wires/cables, electrical boxes and fittings, raceways, and plumbing and mechanical systems to properly interface installation of lighting fixtures with other work.
2. Sequence lighting installation with other work to minimize possibility of damage and soiling during remainder of construction.

G. CODES AND STANDARDS

1. Electrical Code Compliance: Comply with applicable State code requirements of the authority having jurisdiction and NEC Articles 220, 410, and 510 as applicable to installation, and construction of building lighting fixtures.
2. NEMA Compliance: Comply with applicable requirements of NEMA Stds Pub/No.'s LE 1 and LE 2 pertaining to lighting equipment.
3. UL Compliance: Comply with UL standards, including UL 486A and B, pertaining to lighting fixtures.
4. CBM Labels: Provide fluorescent lamp ballasts which comply with Certified Ballast Manufacturers Association standards and carry the CBM label.

PART 2. PRODUCTS

A. GENERAL FIXTURE REQUIREMENTS

1. General: Provide lighting fixtures of sizes, types and ratings indicated, complete with, but not limited to, housings, energy efficient ballasts/drivers and lamps/LED modules, starters, wiring, poles and standards.
2. Wiring: Provide electrical wiring within fixture suitable for connecting to branch circuit wiring. Where indicated provide master/satellite wiring whip configuration, plug and associated components for wiring ballasts in one fixture to power lamps in an adjacent fixture. Whip shall be suitable length to serve required locations.

3. Fixture Types: Refer to "Light Fixture Schedule" on drawings. Where three or more manufacturers are listed, no substitutions will be considered.
4. Standards Compliance: The products shall conform to UL Standard 57.
 - a) Recessed incandescent fixtures shall comply with NEC and UL for thermal protection and contact with or installation in proximity to insulation.
5. Manufacturer: All fixtures of a similar type or description shall be by the same manufacturer.
6. Fixtures must comply with minimum requirements as stated herein. Review architectural drawings and specifications to verify ceiling types, modules, suspension systems appropriate to installation. Where fixture length and configuration is dependent on exact construction dimensions, such as perimeter systems, wall mount system from wall to wall or undercabinet lights mounted within cabinet bottom, contractor shall coordinate with appropriate contractor and measure actual field conditions in order to provide suitable lengths and configuration of fixtures.
7. Labels: Fixtures shall bear third party labeling and manufacturer's labels. Exit fixtures shall comply with NFPA 101 visibility standards.
8. Recessed troffer fixtures shall be nominal 4" deep, minimum 22 gauge cold rolled steel housing, painted after fabrication with baked white polyester powder enamel finish, ballast or driver secured with two bolts/nuts, gasketed at door/frame, lens/door and housing/mounting surface, and suitable for damp location. Fixture shall be gasketed at door/frame, lens/door and housing/mounting surface. Surface mount fixtures shall be similar except minimum 20 gauge cold rolled steel.
9. Fixtures installed in fire rated ceilings, walls or other assembly shall be suitable for installation in fire rated ceilings, walls or other assembly and shall be labeled as such. Entire installation shall meet applicable requirements of U. L. listed assembly.
10. Fixtures required to be secured to suspended ceiling system shall be secured with equipment supplied by light manufacturer per their recommendations and shall be approved for such.
11. Gasket materials for light fixtures shall be minimum 1/8" thick neoprene without exception.

B. LED FIXTURES

1. LED light fixtures shall be capable of having the driver and the LED modules replaced separately.
2. LED light fixtures shall provide the stated light output in lumens at the stated minimum percent life based and tested according to IES TM-21 standards.
3. LED light fixtures shall comply with IESNA LM-79 and LM-80 standards. LED modules shall meet ANSI C78.377a with a binning selection to a 3-step MacAdam ellipse.

4. LED fixtures shall meet the requirements of the most recent version of Design Lights Consortium (DLC).
5. Where LEDs are dimmed the dimming shall be capable of dimming to minimum 5% of normal light output unless indicated to provide 1% dimming.
6. LED light engine/module and LED driver shall have a minimum five year comprehensive warranty.
7. LED light fixtures shall have the following:
 - a) Correlated Color Temperature (CCT) shall be 4000K (nominal).
 - b) Power factor: ≥ 0.90 (at full luminaire output and across specified voltage range)
 - c) Total harmonic distortion: $\leq 20\%$ (at full luminaire output and across specified voltage range)
 - d) Transient and surge protection: ANSI C62.41-2002 Category A surge protection standards up to and including 2.5 kV for interior fixtures.
 - e) Sound: Class A not to exceed a measured value of 24dB
 - f) Warranty: 5 year non-prorated on complete fixture including driver.
 - g) LED arrays in the product(s) will be considered defective in material or workmanship if a total of 10% or more of the individual light-emitting diodes in the product(s) fail to illuminate during normal operation after installation.
 - h) Temperature Rating
 - (1) Each luminaire shall be designed to operate at an average operating temperature of 25°C.
 - (2) The operating temperature range shall be 0°C to 25°C.
 - i) Flicker criteria - Consider IESNA standards for flicker and IEEE PAR1789 Recommended Practice to limit flicker to acceptable levels. Flicker needs to be considered at both the luminaire level when fully powered and when dimmed.
 - j) EMI/RFI - The luminaire and associated on-board circuitry must meet Class A emission limits referred in Federal Communications Commission (FCC) Title 47, Subpart B, Section 15 Non-Consumer requirements for EMI/RFI Emissions.
 - k) Manufacturer Criteria - Manufacturers shall be firms regularly engaged in the manufacture of recessed lighting fixtures of types and ratings required, who have a service organization in the continental US, and whose products have been satisfactorily used in similar service for not less than 5 years. The manufacturer of the fixtures shall comply with the provisions of all applicable code and standards. All fixtures shall be tested before shipping.

C. LENSES

1. Each fixture requiring a lens shall be complete with appropriately framed 100% Virgin Acrylic prismatic lens unless otherwise noted.
 - a) Minimum Thickness: 0.125" minimum (0.125" nominal is not suitable).

b) Pattern: K-12.

2. OPERATING ROOM: Provide approved radio frequency (RF) shielding lens in lighting fixtures located in Operating/Surgery Rooms.

PART 3. EXECUTION

A. GENERAL

1. Install lighting fixtures at locations and heights as indicated, in accordance with fixture manufacturer's written instructions, applicable requirements of NEC, NECA's "Standard of Installation," NEMA standards, and with recognized industry practices to ensure that lighting fixtures fulfill requirements.
2. Install flush mounted fixtures properly to eliminate light leakage between fixture frame and finished surfaces.
3. Provide plaster frames for recessed fixtures installed in other than suspended grid type acoustical ceiling systems. Brace frames temporarily to prevent distortion during handling.
4. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Stds 486A and B, and the National Electrical Code.
5. Remote emergency egress lighting: Provide wiring from emergency egress battery fixture to remote fixtures sized as recommended by manufacturer for the given wattages and distances to compensate for voltage drop. Minimum wire size shall be #10.

B. EXAMINATION

1. Examine areas and conditions under which lighting fixtures are to be installed, and substrate for supporting lighting fixtures. Provide supports and fixture trim, accessories and mounting components suitable for the installation.
2. Notify Designer in writing of conditions detrimental to proper completion of the work.
3. Do not proceed with work until unsatisfactory conditions have been corrected.

C. FIELD QUALITY CONTROL

1. Replace defective and burned out lamps, ballasts, LED modules and LED drivers for a period of one year following the Date of Final Acceptance.
2. At Date of Final Acceptance, replace lamps in lighting fixtures which are observed to be noticeably dimmed after Contractor's use and testing, as judged by Architect and/or Designer.

D. GROUNDING

1. Provide equipment grounding connections for lighting fixtures as indicated and as specified in 'Grounding' specification section.
2. Tighten connections to comply with tightening torques specified in UL Std 486A to assure permanent and effective grounds.

E. ADJUSTING AND CLEANING

1. Clean lighting fixtures of dirt and construction debris upon completion of installation. Clean fingerprints and smudges from lenses.
2. Protect installed fixtures from damage during remainder of construction period.
3. Where fixtures are adjustable coordinate with the Owner and the Designer and aim and adjust fixtures as directed.

F. DEMONSTRATION

1. Upon completion of installation of lighting fixtures, and after building circuitry has been energized, apply electrical energy to demonstrate capability and compliance with requirements.
2. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.

G. LOCATION AND COORDINATION WITH CEILING

1. Coordinate the lighting fixtures with the ceiling construction before ordering. Refer to the finish schedule and reflected ceiling plans on the architectural drawings.
2. All lighting fixtures shall be located symmetrically with respect to room and ceiling arrangements unless otherwise indicated.

H. SUPPORT

1. Provide fixtures and/or fixture outlet boxes with hangers to properly support five times the fixture weight. Submit design of hangers, method of fastening, other than indicated or specified herein, for review by Designer.
2. Support surface mounted fixtures greater than 18" in length at one other point at each end in addition to the outlet box fixture stud.
3. Pendant mounted fixtures less than 16" wide shall be mounted using 1/4" threaded rod at each end and rods shall be attached to the building structure above the ceiling. Ceiling grid tees shall not be used for supporting surface mounted fixtures.

4. Fasten fixtures securely to indicated structural supports and ensure that pendant fixtures are plumb and level. Provide individually mounted pendant fixtures longer than 18" with twin stem hangers. Provide stem hanger with ball aligners and provisions for minimum one (1") inch vertical adjustment. Mount continuous rows of fixtures with an additional stem hanger greater than number of fixtures in the row.
5. Separately support recessed fixtures with minimum #9 galvanized wires attached securely to structure. Fixtures shall not be supported by finished ceiling construction or equipment hung by other trades (i.e., sheet metal ducts). Provide clips for securing lay-in fixtures in grid ceiling system.
 - a) For nominal 1' x 2', 1' x 4', 2' x 2', 2' x 4', and 4' x 4' fixtures, provide 4 wires, one at each corner.
 - b) Provide trapeze hangers at ductwork interferences.
 - c) Recessed fixtures installed in acoustical tile or grid type ceilings shall, in addition to wire supports at each corner, be screwed to main runners of ceiling grid at each corner.
6. Pendant mounting assemblies shall include swivel type, self aligning canopies. Provide a continuous, white finished, steel channel along the top of the fixtures where required for proper alignment.
7. Industrial fixtures in continuous row not mounted directly to structure shall be mounted to supporting channel which in turn shall be secured to the structure.
8. Support surface mounted fixtures 18" and greater in length at each end in addition to outlet box fixture stud. Support surface mount fixtures greater than one foot in width and two feet in length at each of four corners.
9. Coordinate with fixture manufacturer where fixture is surface mounted on sloped ceiling and provide short stems with swivel ball joints, pendant or other method provided and/or approved by fixture manufacturer such that fixture is mounted within the orientation and sloped angle as recommended by the manufacturer.

I. ACCESS

1. Recessed fixtures shall have code accessible supply to wiring and all required components. Use reach-thru type fixtures with suitable aperture diameter in non-accessible ceilings or other suitable means. Coordinate with ceiling installer.

J. FIXTURES AS RACEWAYS

1. Thru-wiring: In continuous rows of fluorescent lighting, a connection to a single point in the row indicates that the branch circuit conductors are to route through the fixture wiring compartment and a connection made to each ballast.
 - a) Thru-wiring in Ballast Compartment shall be type XHHW or THHN (per NEC 410).

K. CLEAN-UP

1. At time of acceptance, fixtures and lamps shall be cleaned thoroughly of all foreign matter, including finger prints. All visible labels shall be removed. Cleaning materials and methods shall comply with the fixture manufacturer's instructions and recommendations.

L. DAMAGED OR UNSATISFACTORY FIXTURES

1. Damaged fixtures or fixtures found to be unsatisfactory as determined by the Architect shall be replaced with new fixtures at no additional cost to the Owner.
2. Minor surface blemishes may be touch-up finished. The color and finish of the touch-up shall match the original fixture finish exactly.

M. SPARE PARTS

1. Provide the following spare parts for LED fixtures:
 - a) 1% of each type of LED driver, minimum two drivers of each type.
 - b) Two of each LED light module/engine.

N. TESTING

1. Test lighting fixtures in accordance with 'Testing and Start-Up' specification section.

END OF SECTION 26 5000

SECTION 27 0530 – COMMUNICATIONS SYSTEMS EMPTY RACEWAY SYSTEM

PART 1. GENERAL

A. RELATED DOCUMENTS

1. The requirements of Section 260000 govern the work specified in this section.

B. DESCRIPTION OF WORK

1. Provide a complete system of cable path and boxes including outlets, pull boxes, raceway, grounds, etc., as required for future installation of a complete system as indicated.
2. The systems which required an empty communications raceway system are security and telemetry. See drawings for complete description and requirements for each system.

C. SUBMITTALS - Not Required

D. QUALITY ASSURANCE

1. Comply with NFPA 70 "National Electrical Code" for components and installation.
2. Listing and Labeling: Provide products specified in this Section that are listed and labeled.
3. Standards of Compliance: Comply with the following standards, as applicable:
 - a) EIA/TIA-568 Commercial Building Standard for Telecommunications Wiring.
 - b) EIA/TIA-569 - Commercial Building Standard for Telecommunications Pathways and Spaces.
 - c) EIA/TIA-607 - Commercial Building Grounding/Bonding Requirements.
 - d) BICSI-TDM Manuals - Building Industry Consulting Service International Telecommunications Distribution Methods Manuals.
 - e) ANSI - American National Standards Institute
 - f) UL Listed - Underwriter's Laboratories Listed
 - g) UL Certified - Underwriter's Laboratories LAN Cable Certification Program
 - h) NEMA - National Electrical Manufacture's Association.
 - i) IEEE 802.3 Institute of Electrical and Electronics Engineers LAN Standard for Ethernet

PART 2. PRODUCTS

A. COMPONENTS

1. Outlets shall be 4" square by 2 1/8" deep, minimum with a double gang device cover

plaster ring or as indicated on drawings unless noted otherwise. The finished double gang outlet jack and plate shall be provided by the supplier of the voice/data system.

2. Security and telemetry service provisions shall be as indicated on the drawings.
3. Conduit: 3/4" minimum unless noted otherwise.

PART 3. EXECUTION

A. INSTALLATION

1. Refer to Section 260000.
2. Install empty conduit and boxes as indicated on drawings. Install pull boxes in all conduit runs having equivalent of two 90 degree bends or in runs more than 100 feet long.
3. Provide insulated type bushings for all conduit terminations.
4. Grounding: All vertical and horizontal metallic distribution systems conduit, cable tray and other raceway must be grounded in accordance with National Electric Code Article 250. Conduit from outlets and wall penetrating conduits shall be stubbed to cable tray within two inches and shall have a grounding bushing with a #8 grounding wire from the conduit grounding bushing connecting to the cable tray.
5. Acceptance Criteria:
 - a) The Designer will verify that all required activities have been performed in a final joint walk-through with the Contractor prior to system acceptance.
 - b) There shall be no provisions for automatic acceptance. A phased acceptance test may be performed; however, acceptance of any phase is conditional on the acceptance of the project as a whole. Acceptance testing/demonstration shall only occur based on the written notification to the Contractor from the Designer. The following criteria must be met:
 - (1) All outlets are completely installed and operational in the specified locations.
 - (2) The site is clean and neat, ready for permanent use by the Owner.
 - (3) All fire-stops and sealants have been installed after cable installation where applicable.

B. CABLE INSTALLATION

1. Examine raceways and other elements to receive cable for compliance with cable installation requirements. Do not proceed with installation until unsatisfactory conditions have been corrected.

2. The cable installation by Others is part of this Contract where indicated on the drawings.
3. Do not bend cable, in handling or installation, to smaller radii than minimum recommended by manufacturer.

C. CLEANING

1. Upon completion of system installation, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasion. Remove debris from outlet boxes prior to installing devices.

END OF SECTION 27 0530

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SECTION 27 1000 - VOICE AND DATA TELECOMMUNICATION SYSTEM

PART 1. GENERAL

A. RELATED DOCUMENTS

1. The requirements of Section 260000 govern the work specified in this section.

B. DESCRIPTION OF WORK

1. Provide a complete system of conduit, raceway, boxes, and any associated appurtenances as indicated on the drawings and required for the installation of a complete voice and data telecommunication system.
2. The Owner shall furnish and install all required voice/data telecom cable. The Owner shall terminate and test the cable.
3. The Contractor shall organize and notify Owner and Designer of all required meetings.
4. The Animal Research Facility ('ARF') area requires particular materials and installation. See drawing E205 for area and requirements.

C. SUBMITTALS

1. General: Submit the following according to the Conditions of the Contract and Division 1 Specification Sections.
 - a) Product data for each component specified. Show types, dimensions, and finishes.

D. QUALITY ASSURANCE

1. Comply with NFPA 70 "National Electrical Code" for components and installation.
2. Listing and Labeling: Provide products specified in this Section that are listed and labeled.
3. Standards of Compliance: Comply with the following standards, as applicable:
 - a) EIA/TIA-568 Commercial Building Standard for Telecommunications Wiring.
 - b) EIA/TIA-569 - Commercial Building Standard for Telecommunications Pathways and Spaces.
 - c) EIA/TIA-607 - Commercial Building Grounding/Bonding Requirements.
 - d) BICSI-TDM Manuals - Building Industry Consulting Service International Telecommunications Distribution Methods Manuals.
 - e) ANSI - American National Standards Institute
 - f) UL Listed - Underwriter's Laboratories Listed
 - g) UL Certified - Underwriter's Laboratories LAN Cable Certification Program

- h) NEMA - National Electrical Manufacture's Association.
- i) IEEE 802.3 Institute of Electrical and Electronics Engineers LAN Standard for Ethernet
- j) IEEE 802.5 Institute of Electrical and Electronics Engineers LAN Standards for Token Ring

PART 2. PRODUCTS

A. COMPONENTS

1. Telecommunications Outlet Box: Recessed outlet boxes shall be 4" square x 2-1/8" deep with 1" knockout for 1" conduit unless noted otherwise. Box shall have single gang box device cover with appropriate raised depth for wall finish.
2. Communications Outlet Box in Animal Research Facility (ARF) Area: Flush/recess and surface boxes shall be single gang cast aluminum, minimum 2.69" deep. See Section 260535 for further description.
3. Pull Boxes: Pull boxes shall be minimum 4 11/16" square x 2 1/8" deep for single 1" conduits.
4. Conduit: 1" minimum, except conduit to wall mount telephone outlet may be 3/4".

PART 3. EXECUTION

A. INSTALLATION

1. Install conduit from each telecom outlet box to point as indicated on drawings. Install pull boxes in all conduit runs having equivalent of two or more 90 degree bends, and in runs more than 100 feet long. The uses of LB, LL and LR conduit body fittings is not allowed.
2. Provide measuring tape type pull string in all empty conduit.
3. Provide insulated type bushings for all conduit terminations.
4. Grounding: All vertical and horizontal metallic distribution systems conduit, cable tray and other raceway must be grounded in accordance with National Electric Code Article 250.
5. Scheduling: The contractor shall complete the construction of all raceway and outlet systems in order to permit the installation of building communications wiring.
 - a) The Designer will verify that all required activities have been performed in a final joint walk-through with the Contractor prior to system acceptance.
 - b) There shall be no provisions for automatic acceptance. The following criteria must be met:
 - (1) The site is clean and neat, ready for cable and system installation and permanent use by the Owner.
 - (2) All fire-stops and sealants have been installed after cable installation as required.

B. CABLE INSTALLATION

1. The telecom cable will be furnished and installed by the Owner or the Owner's contractor under a separate contract.
2. Examine raceways and other elements to receive cable for compliance with cable installation requirements.

C. CLEANING

1. Upon completion of system installation, inspect exposed finish. Remove dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasion.

END OF SECTION 27 1000

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SECTION 28 3100 - FIRE DETECTION AND ALARM

PART 1. GENERAL

A. RELATED DOCUMENTS

1. The requirements of Section 260000 govern the work specified in this section.

B. SUMMARY

1. Extent of fire alarm systems work is indicated by the Drawings, Schedules, and Riser Diagrams. The Contractor shall furnish all parts, materials, and labor customarily required or provided for a complete and operating system, in accordance with all requirements applicable, even if each needed item is not specifically shown or described in the project plans or specifications.
2. System shall be in full compliance with the State of North Carolina, Department of Administration, State Construction Office, Fire Alarm Guidelines and Policies, and is made a part of this specification, and hereby is a requirement of this section of specifications. The electrical contractor shall provide fire alarm system components and an installation in full compliance with these guidelines. These guidelines can be located at the following website:

<https://ncadmin.nc.gov/media/5485/open>

3. Authority Having Jurisdiction (AHJ), Building Permits, Submittal Approval:
 - a) For State-owned facilities in North Carolina the AHJ for Code compliance is the NC Department of Administration – State Construction Office. The AHJ for construction administration and inspection purposes is the Designer of Record. The Designer of Record has the responsibility of signing the forms as the Authority Having Jurisdiction (AHJ) for the Designer's specific area of expertise and professional license including all documents required by the National Fire Protection Association (NFPA) guidelines. The Designer of Record shall also approve results of all field testing on the project; and observe the operations of all building systems for determining compliance with specification requirements. However, the State Construction Office Electrical Inspector will perform all wiring inspections.
 - b) No building permit is required for construction or renovation of facilities that are owned by the State of North Carolina and located on State-owned land. However, State facilities are still required to comply with local zoning ordinances. Written NC Department of Administration – State Construction Office approval of the plans and specifications submitted for review is considered the equivalent of a building permit for State projects but that alone does not give authorization to proceed with construction. Such authorization requires written clearance from the entity that administers the contract.
4. The criteria herein are not intended to conflict with any Code or NFPA Standard. If conflict is observed, obtain a ruling from the AHJ who reviewed and approved the plans, before proceeding with purchase of materials or installation of the system.

C. SUBMITTALS

1. **Product Data:** Submit manufacturer's technical product data, including specifications and installation instructions, for each type of fire alarm system equipment.
2. **Shop Drawings:** Provide shop drawings showing equipment and device locations, wiring schematics and connecting wiring of entire fire alarm system. Include wiring and riser diagrams.
 - a) Include a copy of system battery sizing calculations with the shop drawing submittal. Use manufacturer's battery discharge curve to determine expected battery voltage after required battery capacity hours of providing standby power (60 or 24 hours as required by other sections). Then use calculated Notification Appliance Circuit current draw in the alarm mode to determine expected voltage drop at EOL, based on conductor resistance per manufacturer's data sheet or NEC, Table 8. Double the ohms per foot as required for two conductors powering the circuit. Include any inherent voltage drop caused by the system's power supply.
 - b) The voltage drop at EOL must not exceed 14% of the expected battery voltage, after the required standby time plus alarm time. (Typically, for a 24 volt system, this limits the voltage drop from the battery to the EOL to 3 volts). Determine "worst case" voltage at far end of each NAC, by subtracting its calculated V-drop from the expected battery voltage. The result must be no less than the minimum listed operating voltage for the alarm notification appliances used.
 - c) All of these calculations must be placed on a dedicated sheet of as-built drawings, for future reference by fire alarm service technicians. NAC voltage drop is to be verified during system tests.
 - d) Battery calculation shall be provided where new notification appliances are installed.
3. **Maintenance Data:** Submit maintenance data and parts lists for each type of fire alarm equipment installed, including furnished specialties and accessories. Include this data, product data, and shop drawings in maintenance manual.
4. Where requested by the Owner and the NCSU Life Safety Shop the submittals shall be submitted to and reviewed by the Owner and the NCSU Life Safety Shop.
5. Approval of samples, cut sheets, shop drawings, and other details submitted by the contractor shall not relieve the contractor's responsibility for full compliance with project plans and specifications, unless the electrical design engineer's attention is called to each non-complying feature, by accompanying letter, and the engineer subsequently gives the contractor specific written authorization for each deviation.

D. QUALITY ASSURANCE

1. **Codes and Standards:**
 - a) **NEC Compliance:** Comply with applicable requirements of NEC standards pertaining to fire alarm systems including NEC Article 760-Fire Alarm Systems.
 - b) Fire alarm systems specified in this section shall be in accordance with the North Carolina Building Code and the NFPA 72, National Fire Alarm Code. See Section 260000 for year edition of codes.

- c) UL Compliance and Labeling: Comply with provisions of UL safety standards pertaining to fire alarm systems; and provide products and components which are UL listed and/or labeled.

E. DELIVERY, STORAGE AND HANDLING

1. Handle fire alarm equipment carefully to prevent damage, breaking, and scoring. Do not install damaged equipment or components; replace with new.
2. Store fire alarm equipment in clean, dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.

PART 2. PRODUCTS

A. MANUFACTURERS

1. Fire alarm system shall be Fire-Lite, or approved equal by Simplex or Notifier. Fire alarm control panel shall be Fire-Lite Series 'ES-200X' or approved equal.

B. FIRE DETECTION AND ALARM SYSTEM

1. The system is to be the addressable type, with a 24Vdc nominal operating voltage. All equipment supplied must be specifically listed for the purpose for which it is used, and installed in accordance with any instructions included in its listing.
2. The system shall be non-coded, and fully supervised (including control circuits). All equipment supplied shall be new, must be listed for the purpose for which it is used, and installed with a warranty (parts and labor) of at least one year from the date of acceptance.
3. The Fire Alarm Control Panel (FACP) shall be of modular type, for ease of future system expansion or modification. The FACP must display a steady "Power On" light (green) and must have separate "Alarm" (red) and "Trouble" (amber) lights. LCD display shall indicate devices in alarm or trouble. Provide a minimum of one spare initiating zone and two spare notification circuits, and FACP space for the modules required to add four more zones and eight more notification circuits in the future.
4. Fire alarm control panel shall be the addressable, microprocessor based type. Using a two wire circuit, individual initiating devices such as automatic smoke detectors, heat detectors and manual pull stations can communicate their exact identity and status.
5. All initiating devices shall be individually addressable. All addressable spot type and duct smoke detectors shall be the analog type and the alarm system shall automatically compensate for detector sensitivity changes due to ambient conditions and dust build-up within detectors. This feature must be armed, and sensitivities set prior to acceptance of the system.
6. Notification appliance circuits (audible, visible, speakers, etc.) as well as other control circuits (supply fans, exhaust fans, dampers, etc.) shall be individually controlled.

7. The FACP power supply shall have a continuous rating adequate to power all zones and functions in full alarm continuously and must not exceed 80% of its output rating. Detection modules and alarm modules must be able to withstand prolonged short circuits in the field wiring, either line to line or line to ground, without damage. Signal circuits shall each be loaded to no more than 80% of their rated output capacity.
8. The FACP must have an alarm silence switch. Subsequent Alarm (alarm resound) feature is required. Any remote annunciators or graphic displays located away from the area alarmed must also include an audible signal with subsequent alarm.
9. Both audible and visible alarm signals shall be provided. Visible signals must be the strobe (flash discharge) type, with white or clear lens, and shall comply with current ADA requirements for intensity and placement.
10. No proprietary systems (i.e. systems which are programmable by the manufacturer only) shall be accepted.
11. Provide all backboxes, processors, adapters, lenses, relay bases, etc. for a complete and operable system whether specifically identified or not.
12. The system is to have multiple access levels so owner's authorized personnel can disable individual alarm inputs or normal system responses (outputs) for alarms, without changing the system's executive programming or affecting operation of the rest of the system. How to do this must be included in the training required to be given to the owner's designated personnel, and must also be part of the written documentation provided by the fire alarm equipment supplier.
13. A supervised "Air Handling Unit (AHU) Shutdown Defeat" toggle switch must be provided in/adjacent to the Fire Alarm Control Panel (FACP) or as a key-operated function in the Remote Annunciator (RA), if provided. If the RA option is utilized, provide an informative engraved label at the FACP about this function. The switch must cause a system "trouble" indication when it's placed in the off-normal ("Shutdown Defeated") position.
14. Each addressable fire alarm system must include an LED-type "zone" annunciator at (or in) the FACP, or in another location if acceptable to the AHJ. As a minimum, this annunciator is to indicate the specific type of alarm or supervisory signal (smoke detector, waterflow, sprinkler valve closed, etc.), for groups of addressable devices. The area ("zone") that is represented by each LED shall not exceed 1 floor or 22,500 square feet, and must not cross building fire divisions.
 - a) EXCEPTION #1: Systems in 1 or 2-story buildings, which have 30 or fewer initiating devices, are permitted to omit the LED-type "zone" annunciator.
 - b) EXCEPTION #2: Systems with a Graphic Annunciator (GA) are permitted to omit the LED-type "zone" annunciator.
 - c) EXCEPTION #3: The LED annunciator is permitted to be omitted if the FACP has a multi-line display that automatically defaults to displaying the first alarm, plus the first 3 (minimum) waterflow alarms and the last alarm. This is permitted to be done using 2 automatically alternating screens. If there is no sprinkler system, program the FACP to show the first 4 alarms plus the last alarm received.

15. The location of each fire alarm zone initiating device shall be clearly indicated on each FACP. This may be accomplished by graphic displays. Label tape or handwritten labels are not acceptable. For addressable systems, a framed map covered with plexiglass indicating the location of each device and its identifying label shall be included. Provide indication means for zone annunciation per AHJ requirements.
16. Alarm notification appliances, both audible and visible, shall comply with NFPA 72 requirements for intensity and placement. The standard audible evacuation signal shall be the ANSI S3.41 three-pulse temporal pattern described in NFPA 72, except the ANSI signal shall not be used where the planned action during a fire emergency is to relocate occupants, or protect them in place, instead of immediate evacuation (e.g., some health care facilities, prisons). For strobe lights, proper selection and placement are essential and synchronization is recommended to prevent potential problems with ADA compliance. Contact the AHJ for additional information on this, and for approval of any alternative design.
17. The following protection against voltage transients and surges must be provided by the fire alarm equipment supplier, and installed by the electrical contractor:
 - a) On AC Input: A feed-through (not a shunt-type) branch circuit transient arrestor such as the Ditek #DTK-120SRD, Leviton #51020-WM, or approved equal UL 1449 SPD by Eaton or Schneider. Install suppressor in a listed enclosure near the electrical panelboard, and trim excess lead lengths. Wind small coil in the branch circuit conductor just downstream of the suppressor connection. Coil to be 10 turns, about 1" diameter, and securely tie-wrapped. This series impedance will improve the effectiveness of the arrestor in suppressing voltage transients.
 - b) On DC Circuits Extending Outside Building: Adjacent to the FACP, and also near point of entry to outlying building, provide "pi"-type filter on each leg, consisting of a primary arrestor, series impedance, and a fast acting secondary arrestor that clamps at 30v to 40v. Some acceptable models: Simplex 2081-9027 and 2081-9028, Transtector TSP8601, Ditek DTKxLVL series, Citel America B280-24V, and Northern Technologies DLP-42. Submit specifications on others to the engineer for approval. UL 497B listing is normally a prerequisite for their consideration.
18. Systems are to be provided with a separate and independent source of secondary power. The State does not contract for full Central Station Service (with runners), so all systems that report to a Central or Remote Supervising Station shall have a minimum of 60 hours secondary power capacity, plus 5 minutes of full alarm load. Proprietary and other systems require 24 hours capacity plus 5 minutes alarm load.
 - a) EXCEPTION #1: For emergency voice/alarm systems, use 15 minutes for alarm load.
 - b) The voltage drop at EOL must not exceed 14% of the expected battery voltage, after the required standby time plus alarm time. (Typically, for a 24 volt system, this limits the voltage drop from the battery to the EOL to 3 volts). Determine "worst case" voltage at far end of each NAC, by subtracting its calculated V-drop from the expected battery voltage. The result must be no less than the minimum listed operating voltage for the alarm notification appliances used.
 - c) All of these calculations must be placed on a dedicated sheet of as-built drawings, for future reference by fire alarm service technicians. NAC voltage drop is to be verified during system tests.

19. Manual pull stations shall be of very rugged construction, to withstand vigorous operation and unauthorized reset attempts. They must require the use of a key or allen wrench for reset.

C. SMOKE AND FIRE DETECTOR INITIATING DEVICES

1. All addressable spot type and duct smoke detectors shall be the analog type and the alarm system shall automatically compensate for detector sensitivity changes due to ambient conditions and dust build-up within detectors. This feature must be armed and sensitivities set prior to acceptance of the system. (See Part 3. D.)
2. Spot-type detectors must be the plug-in type, with a separate base (not a mounting ring), to facilitate their replacement and maintenance. The base shall have integral terminal strips for circuit connections, rather than wire pigtails. Each detector or detector base shall incorporate an LED to indicate alarm.
3. Spot-type smoke detectors shall have a built-in locking device to secure the head to the base, for tamper resistance. For detectors mounted within 12 feet of the floor, activate this lock after the system has been inspected and given final acceptance.
4. Unless suitably protected against dust, paint, etc., spot type smoke detectors shall not be installed until the final construction clean-up has been completed. In the event of contamination during construction, the detectors must be replaced.
 - a) NOTE: Covers supplied with smoke detector heads do not provide protection against heavy construction dust, spray painting, etc., and must not be used for that purpose. They are suitable only during final, minor cleanup or touchup operations.
5. Identification of individual detectors is required. Assign each a unique number as follows, in sequence starting at the FACP: (Addressable Loop # -- Device #) Put on the as-built plans, and also permanently mount on each detector's base so that it's readable standing on the floor below without having to remove the smoke detector. Exception: For detectors with housings (i.e., air duct, projected beam, air sampling, flame), apply the identification to a suitable location on exterior of their housing.
6. All air duct/plenum detectors must have a Remote Alarm Indicator Lamp (RAIL) installed in the nearest corridor or public area and identified by an engraved label affixed to the wall or ceiling. Duct smoke detectors are permitted to be installed only inside an air duct. It is not appropriate to mount them in front of a return air opening. Duct detectors shall also be installed in a manner that provides suitable, convenient access for required periodic cleaning and calibration.
7. Duct detector sampling tubes shall extend the full width of the duct. Those over 36 inches long must be provided with far end support for stability.
8. Each duct detector installation shall have a hinged or latched duct access panel, 12x12 inches minimum, for sampling tube inspection and cleaning. Indicate airflow direction on the duct, adjacent to the detector.

D. EQUIPMENT AND DEVICES

1. Manufacturer and model numbers of equipment manufactured by particular manufacturers have been specified to establish a standard of quality. Products manufactured by Fire-Lite, Notifier or Simplex shall be provided. Equal and approved equipment manufactured by System Sensor and Wheelock, which is compatible and operational with the provided FACP and components, is acceptable.
2. Power supply/battery: 120VAC operation at 60 Hz. Battery and charging system shall provide minimum 60 hours of standby and 5 minutes of alarm battery. Submit calculation for battery selection.
3. Double action addressable manual pull station shall be Fire-Lite Series 'BG-12LX', or approved equal.
4. Photoelectric smoke detectors shall be Fire-Lite Series 'SD365', or approved equal.
5. Heat detectors, 135° fixed temperature, shall be Fire-Lite Series 'H365', or approved equal.
6. Heat detectors, combination 135° and rate-of-rise rated for 15° per minute shall be Fire-Lite Series 'H365-R, or approved equal.
7. Heat detectors, high temp 190° fixed temperature, shall be Fire-Lite Series 'H365-HT', or approved equal.
8. Audible and visual notification wall mount horn/strobe appliance shall be red, and have selectable candela output and selectable high or low dB output. Unit shall be Fire-Lite Series 'P2RL', or approved equal.
9. Visual notification wall mount strobe appliance shall be red, and have selectable candela output. Unit shall be Fire-Lite Series 'SRL', or approved equal.
10. Audible and visual notification ceiling mount horn/strobe appliance shall be red, and have selectable candela output and selectable high or low dB output. Unit shall be Fire-Lite Series 'PC2RL', or approved equal.
11. Visual notification ceiling mount strobe appliance shall be red, and have selectable candela output. Unit shall be Fire-Lite Series 'SCRL', or approved equal.
12. Audible and visual notification weatherproof wall mount horn/strobe appliance shall be red, and have selectable candela output and selectable high or low dB output. Unit shall be Fire-Lite Series 'P2RK', or approved equal.
13. Visual notification weatherproof wall mount strobe appliance shall be red, and have selectable candela output. Unit shall be Fire-Lite Series 'SRK', or approved equal.
14. Audible and visual notification weatherproof ceiling mount horn/strobe appliance shall be red, and have selectable candela output and selectable high or low dB output. Unit shall be Fire-Lite Series 'PC2RK', or approved equal.
15. Visual notification ceiling mount weatherproof strobe appliance shall be red, and have selectable candela output. Unit shall be Fire-Lite Series 'SCRK', or approved equal.

16. Addressable monitor module shall be Fire-Lite Series 'MDF-300', or approved equal.
17. Signaling line circuit isolation monitor module shall be Fire-Lite Series 'I300', or approved equal. Provide minimum one per 20 devices, minimum one near schematic center of SLC, plus two (2) per panel.
18. Remote annunciator shall be Fire-Lite Series 'ANN-80', or approved equal.
19. Fire alarm document cabinet shall be Fire-Lite Series 'SRD', or approved equal.
20. Provide a synchronization module for synchronizing strobe multiple lights where light from more than one lights is visible.
21. All notification appliances shall be red and have marking 'FIRE' on appliance.

E. DIGITAL ALARM COMMUNICATOR TRANSMITTER (DACT)

1. The 'DACT' shall be Digital Security Controls #3G3070-CF, or approved equal. The Owner shall have final approval on the 'DACT' given that the system will communicate the Owner's central station equipment.
2. Each system shall be equipped with a 4-channel (minimum) Digital Alarm Communicator Transmitter (DACT) for transmission of fire alarm, supervisory, and trouble signals to a Central Station, Remote Supervising Station, or Proprietary Supervising Station. The following signals shall be reported as applicable.
 - a) Fire Alarm
 - b) Sprinkler Waterflow Alarm
 - c) Sprinkler Valve Tamper (Closed) Supervisory Signal
 - d) Sprinkler Low Temperature / Air Pressure Supervisory Signal
 - e) Burglary / Intrusion / Duress / Other Security or Emergency Alarm
 - f) Fire Alarm System AC Power Trouble (only if 120vac interrupted for 8 hours)
3. Coordinate with Owner for exact requirements of monitoring and supervising station and provide DACT suitable for communication to receiving station.
4. The precedence of signals transmitted to the Supervising Station shall be as follows:
 1. Fire Alarm
 2. Security Alarm
 3. Supervisory Signal
 4. Trouble Signal
 - a) Fire Alarm System AC Power Trouble signal must not be sent unless maintained for 8 hours, to avoid nuisance transmissions to the supervising station from short term 120vac power outages (from switching transients, thunderstorms, etc.).
 - b) NOTE: Do not confuse fire suppression system "supervisory" signals with fire alarm system "trouble" signals. These are completely different types of signals, annunciated and transmitted as separate and distinct events.

5. The Contractor must provide a type of DACT that is compatible with the owner's alarm receiving equipment, or the Supervising Station selected by the owner, as applicable. He must also program the PROM, connect each DACT to the telephone/internet line(s) provided to him, and verify proper signal receipt by the Supervising Station.

- a) NOTE: See NFPA 72 for means of transmission requirements. It permits the phone line(s) to be shared, since the DACT can capture a line that's busy if needed. However, PBX station circuits are not permitted to be used.

F. FIRE ALARM FLOOR PLAN (ZONE MAP)

1. Exterior/Weatherproof Type – The exterior/weatherproof type fire alarm floor plan (zone map) shall be a black screened printed image on a 1/8" clear anodized aluminum sheet. Fire alarm devices shall be red. All fire alarm devices and equipment, including but not limited to panels, notification appliances, initiation devices, modules, NAC, etc., shall be shown. All room numbers and device addresses shall be shown; plan shall have a red dot designating 'You Are Here'; device and equipment shall be clearly legible and text shall be minimum 1/8" high; plan shall be minimum 18" wide x 12" high; plan shall be mounted to wall with four stainless steel bolts with neoprene washers. After all device locations have been confirmed and installation finalized provide a PDF version of the final floor plan for review prior to installing the floor plan. Plan shall be manufactured by H. R. Kirkland, or approved equal by Notifier or Honeywell.

G. RACEWAY

1. All fire alarm circuitry shall be installed in conduit. Minimum size of any type conduit shall be 3/4".
2. All fire alarm conduit shall be red with finish applied at the factory.
3. Conduit fittings shall be insulated throat type.

H. WIRING

1. Addressable loop (signaling line) circuits shall be wired with type FPL/FPLR/FPLP fire alarm cable, AWG 18 minimum, low capacitance, twisted shielded copper pair. Cable shield drain wires are to be connected at each device on the loop to maintain continuity, taped to insulate from ground, and terminated at the FACP. Acceptable cables include Atlas 228-18-1-1STP, BSCC S1802s19 (same as EEC 7806LC), West Penn D975, D991 (AWG 16), D995 (AWG 14), or equal wire having capacitance of 30pf/ft. maximum between conductors. Belden 5320FJ acceptable if only FPL rating needed. The cable jacket color shall be red, with red (+) and black (-) conductor insulation.
 - a) EXCEPTION #1: Unshielded cable, otherwise equal to the above, is permitted to be used where the manufacturer's installation instructions unequivocally require, or state preference for, the use of unshielded cable for all systems.
 - b) EXCEPTION #2: In underground conduit, use Type TC or PLTC cable (PE insulated) to avoid problems from moisture.
2. Except as required otherwise, all other circuits in the system shall be wired with AWG 14, stranded copper, THHN/THWN conductors, installed in conduit. Color code as shown below throughout the system, without color change in any wire run:

- a) Alarm notification Appliance Circuits (horns and strobes).....Blue (+)/Black (-)
- b) Separate 24vdc Operating Power (for system equipment).....Yellow (+)/Brown (-)
- c) Door Control Circuits (magnet power, if from system).....Orange

PART 3. EXECUTION

A. GENERAL

1. The FACP and all other control equipment locations, including any transponders, sub-panels, and booster power supplies, must be protected by a spot type smoke detector located within 15 feet of the equipment (measured horizontally).
2. Alarm notification appliance circuits (NAC) are to be Class B. Load connected to each circuit must not exceed 80% of rated module output and the coverage of each circuit shall not exceed 3 floors (to limit the effect of faults, and to facilitate trouble-shooting). NAC voltage drop during alarm must never exceed 14% of the voltage measured across the batteries at that time. NAC voltage drop shall be calculated based on wire size, length of circuit, device load, inherent voltage loss within the FACP's power supply, etc. Contractor shall use power outage testing to verify that the NAC circuit was installed as designed.
3. All conduits that penetrate outside walls from air conditioned space must have internal sealing (duct-seal), to prevent condensation from infiltrating humid air.
4. Addressable interface modules (used for all contact type initiating devices) must be located in a conditioned environment which does not exceed listing test parameters, to prevent failures due to temperature/humidity extremes. They may be permitted to serve more than one contact device in the same limited area, subject to approval of the AHJ. (For supervisory switches, up to 3 per module is generally accepted.)
5. Notification Appliance Circuit booster ("ADA") power supplies must be individually monitored for integrity and are not permitted to be located above a ceiling, or in non-conditioned space. Any 24vdc power circuits serving addressable control relays must also be monitored for integrity.
6. All junction boxes shall be painted red prior to pulling the wire. Those installed in finished areas are permitted to be painted outside to match the finish color.
7. FACP, DACT and other system panels and similar components shall be installed in conditioned spaces. The contractor shall coordinate final location with proposed installed conditions and shall provide the aforementioned equipment in a conditioned space.
8. As requested by the Owner and the NCSU Life Safety Shop the submittals shall be submitted to and reviewed by the Owner and the NCSU Life Safety Shop.
9. Circuit breakers serving fire alarm system equipment, including fire alarm control panels and notification appliance circuit panels, shall be provided with a locking tab, shall be labeled 'FIRE ALARM CIRCUIT', and shall have red identification to meet the requirements of the NEC Article 760-Fire Alarm Systems.

B. WIRING

1. All addressable loop controller (signaling line) circuits must be fully Class "A," with no "T" taps made. Each must have a minimum of 20% spare addresses, for future use. Individual loops are permitted to cover more than one floor of the building.
2. To minimize wiring fault impact, isolation modules shall be provided as follows. If ceiling height ≤ 10 feet, isolator base type initiating devices are permitted to be used. Each isolation module must be clearly labeled, readily accessible for convenient inspection (not above a lay-in ceiling), and shown on as-built drawings.
 - a) After each 20 devices and control points maximum on any addressable circuit
 - b) For each addressable circuit that extends outside the building walls
 - c) In or immediately adjacent to the FACP, at each end of the addressable loop. These two isolators must be in the same room as the FACP and within 15 feet.
 - d) For loops covering more than one floor, install isolator at terminal cabinet on each floor (with additional isolator[s] on any floor with over 25 addresses).
3. All fire alarm system wiring shall be in EMT metal conduit.
4. There shall be no splices in the system other than at device terminal blocks, or on terminal blocks in cabinets. "Wire nuts" and crimp splices will not be permitted. Permanent wire markers shall be used to identify all connections at the FACP and other control equipment, at power supplies, and in terminal cabinets.

C. SYSTEM OPERATION

1. The system shall be electrically supervised against open circuits and grounds in the wiring to the alarm initiating, alarm indicating or control devices. Control circuit shall indicate system trouble if it is in other than normal operating mode. An open or ground in the system shall cause a visual and audible signal to sound continuously until the system is restored to normal or silenced by means of a silence switch on the control panel.
2. Operation of any manual station, heat detector or smoke detector shall cause the sounding of a general alarm on all signals, automatically signal the supervisory agency, operate all flashing lights, shut down all recirculating air handling units, annunciate the zone in which the signal originated, and indicate the device activated.

D. SYSTEM PROGRAMMING, TESTING AND CERTIFICATION

1. All connections to the FACP and the system's programming shall be done only by the manufacturer, or by an authorized distributor that stocks a full compliment of spare parts for the system. The technicians who do this are required to be trained and individually certified by the manufacturer, for the FACP model/series being installed. This training and certification must have occurred within the most recent 24 months. Copies of the certifications must be part of the contractor's submittal to the engineer, prior to installation. The submittal cannot be approved without this info.
 - a) NOTE: This means the electrical contractor is not permitted to apply power to the FACP or any system power supplies, or to make any connections to them. However, the electrical contractor is responsible for installing and making field connections to initiating devices, notification appliances, control relays, other components.

2. When programming the system, activate the automatic drift compensation feature for all spot-type smoke detectors. Whether or not to activate the alarm verification feature for such detectors is to be determined by the design engineer/owner's rep. In the absence of clear guidance on the latter, do not use alarm verification.
 - a) NOTE: Most applications of analog addressable smoke detectors do not require alarm verification to reduce nuisance alarms, as they are better able to discriminate between fire and common non-fire ambient events. A short operational test with normal occupancy can determine if transient ambient events are a problem.
3. Set spot-type smoke detector sensitivities to normal/medium, unless directed otherwise by the design engineer/owner's rep.
 - a) NOTE: High sensitivity may be appropriate in relatively benign, clean environments such as art museums and libraries, to improve system response time without causing nuisance alarms.
4. Print a complete System Status and Programming Report, after the above steps have been done. This must include the program settings for each alarm initiating device and the current sensitivity of each analog addressable smoke detector.
5. The manufacturer or authorized distributor must 100% test all site-specific software functions for the system and then provide a detailed report or check list showing the system's operational matrix. This documentation must be part of the "System Status and Programming Report".
 - a) NOTE: If AHU shutdown occurs for any alarm, then the matrix would indicate the specific control relay(s) for that function being commanded to operate for alarm from any initiating device. If a rolling steel fire door is to drop only upon waterflow alarm from its sprinkler zone, or upon any two spot smoke detectors in adjacent spaces being simultaneously in alarm, the matrix would show the door's control relay activating upon alarm from the applicable waterflow switch(es), or from any two smoke detectors in the selected spaces (AND gate).
6. Upon completion of the installation and its programming, the fire alarm technician shall test every alarm initiating device for proper response and indication, and all alarm notification appliances for effectiveness. Also, in coordination with the other building system contractors, all other system functions shall be verified, including (where applicable) elevator capture and the control of HVAC systems, door locks, pressurization fans, fire or smoke doors/dampers/shutters, etc. The engineer and AHJ must be notified in advance of these 100% tests, to permit witnessing them if desired. The manufacturer's authorized representative shall be present for the test.
7. The contractor must fill out and submit the following documentation to the owner, through the engineer, prior to the AHJ's system acceptance inspection:
 - a) The NFPA 72-2013, Figure 7. 8. 2(a), "System Record of Completion" Form. Use this form (no substitutes) to detail the system installation and also to certify that:
 - (1) It was done per Code,
 - (2) The Code-required 100% test was performed. If a representative of the AHJ, owner, or engineer witnesses the tests, they sign the last line of the form to signify that fact only (annotating the form as needed).

- b) Measured sensitivity of each smoke detector.
 - c) NFPA 82A "Fire Alarm System Certification and Description".
 - d) The System Status and Programming Report. This must be generated on the day of the system acceptance inspection.
 - (1) NOTE: The purpose of generating this report on the day of the inspection is to assure detector sensitivity has not been affected by construction dust. Prudent contractors will have taken measures to prevent detector contamination during construction, and will also have had the system do a detector sensitivity test and printout prior to the day of the inspection, to make certain all devices are properly programmed and operating within their limits.
8. After completion of the 100% system test and submission of documentation, the contractor is to request the engineer to set up an inspection. The system must operate for at least two days prior to this inspection.
- a) Notify the responding Fire Department of this, for pre-fire planning purposes. On private sector projects, local fire authorities may also want to participate in system acceptance inspections. However, for State-owned property they have no inspection jurisdiction and, if present, are only to observe.
9. The fire alarm system will be inspected, with portions of it functionally tested. This will normally include the use of appropriate means to simulate smoke for testing detectors, as well as functionally testing the system interface with building controls, fire extinguishing systems and any off-premises supervising station. Operation of any smoke removal system will be checked with smoke candles or by other means. This statistical (sampling) inspection is intended to assure that the contractor has properly installed the system and performed the 100% operational test as required by NFPA 72. The contractor normally provides two-way radios, ladders, and other materials needed for testing the system (smoke candles, other smoke source, etc.).
10. Acceptance of the system will begin after the AHJ inspection, test and all related punch list and contract items have been corrected, and after all required documentation has been received.
11. After successful completion of AHJ inspection, test and acceptance, the warranty period may begin. In the event of any system malfunctions or nuisance alarms, the Contractor will take appropriate corrective action. However, this may necessitate a repeat of the response test, if the AHJ desires. Continued improper performance during warranty shall be cause to require the Contractor to remove the system.
12. Testing will be conducted of the applications and database software at the same time the devices are tested to ensure all are fully functional, accurate and operational.
13. Any specialized equipment necessary to diagnose, program or service equipment such as sensitivity tester, peak reading voltmeter, personal computer, terminal CRT, hand help programmers, and programming software, etc. shall be furnished as part of the system.

14. The Contractor shall have the Manufacturer's Authorized Representative provide a quotation for regular preventative maintenance, in accordance with the requirements of NFPA 72-2002. This will cover the first 12 month period after expiration of the standard warranty. The quotation will provide the Owner with information on internal versus contract maintenance cost. One extra copy will be sent to the AHJ, State Property Fire Insurance Fund Division.

E. DOCUMENTATION, AND OWNER TRAINING

1. The contractor shall provide to the engineer two bound copies of the following technical information, for transmittal to the owner:
 - a) As-built wiring diagram showing all loop numbers and device addresses in the system, plus equipment terminal numbers,
 - b) Manufacturer's detailed maintenance requirements,
 - c) Technical literature on all control equipment, isolation modules, power supplies, alarm/supervisory signal initiating devices, alarm notification appliances, relays, etc,
 - d) The as-built battery power and audio amplifier "calculations" sheet referenced previously.
2. Complete configuration data (site-specific programming) for the system must be stored on electronic media and archived by the fire alarm system manufacturer or authorized distributor. A diskette or CD copy of this data shall be submitted to the engineer for transmission to the owner on the day the system is commissioned.
3. The manufacturer, or authorized distributor, must maintain software version (VER) records on the system installed. The system software shall be upgraded free of any charge if a new VER is released during the warranty period. For new VER to correct operating problems, free upgrade shall apply during the entire life of the system.
4. Basic operating instructions shall be framed and permanently mounted at the FACP. (If the owner concurs, they may instead be affixed to the inside of the FACP's door.) In addition, the NFPA 72 "Record of Completion" must either be kept at/in the FACP, or its location shall be permanently indicated there by engraved label.
5. Provide an engraved label inside the FACU identifying its 120vac power source, as follows: Panelboard location, panelboard identification, and branch circuit number.
6. The manufacturer's authorized representative must instruct the owner's designated employees in operation of the system, and in all required periodic maintenance. A minimum of 2 hours on-site time will be allocated for this purpose and, for those facilities operating on a 24-hour basis (prisons, hospitals, etc.), one additional hour of instruction will be individually provided for the 2nd and 3rd shift. Two copies of a written, bound summary will be provided, for future reference.

F. SPARE PARTS

1. The following spare parts shall be provided with the system, each one individually packaged and labeled. For multi-building projects, calculate the quantity separately for each building that contains a dedicated fire alarm control panel. If the FACP also serves auxiliary buildings (e.g., storage, boiler/chiller, etc.), calculate as if just one building total. Increase any resulting decimal quantities of spare parts to the next higher whole number:
 - a) Fuses.....2 of each size used in the system
 - b) Manual Fire Alarm Pull Boxes.....2% of installed quantity
 - c) Indoor Horns, Chimes, Speakers & Strobes....4% of installed quantity
 - d) Spot Type Smoke Detectors & Bases.....6% of installed quantity
 - e) Heat Detectors & Bases.....6% of installed quantity
 - f) Isolation Modules.....2% of installed quantity
 - g) Monitor/Relay Modules.....2% of installed quantity
 - h) No spares are required for projected beam, air sampling, or duct smoke detectors.

Note: Increase decimal quantities to the next higher whole number.

TABLE I -- APPLICATIONS MATRIX FOR DETECTION DEVICES

SMOKE/FIRE DETECTOR APPLICATION	ACCEPTABLE DETECTOR TYPES			
	ION	PHOTO	IR/UV FLAME	HEAT
Atriums/Auditoriums		PB*		
Corridors – Residential		X		
Corridors – Institutional		X		
Corridors – Other Occupancies		X		
Office Areas	X	X		
Cable Rooms (PVC)		X		
Elevator Equip. Rooms	X			
Furnace/Boiler Rooms				X
Gymnasiums		PB*		
Laboratories (Chemical)			X	X
Linen Rooms		X		
Mech/Elect. Equip. Rooms	X	X		X
Motor-Generator Rooms			X	X
Attics (Non-Conditioned Environment)				X
Loading Docks				X
Storage (Non-Conditioned Environment)			X	X
Storage (Conditioned Environment)	X	X		
Duct Smoke Detectors		X		

* "PB" symbol indicates Projected Beam (Linear Beam) type smoke detector with separate transmitter and receiver, or with transceiver and prism reflector. Typical operating range limits are 30-300 feet but best service is obtained when the IR light beam spans 50-200 feet. Consider potential obstructions (banners, etc.) and accessibility for required maintenance.

CAUTION: Vehicle exhaust, nearby cooking, ambient temperatures in non-conditioned spaces, or very high humidity may preclude the use of smoke detectors in some locations. Heat detectors should include the rate-of-rise feature unless installed where temperature increases may exceed 15°F/minute from vehicle exhaust, space heaters, other equipment, etc. *Always consider detection device ratings vs. environment of planned installations*

END OF SECTION 28 3100

SECTION 31 1000 - SITE CLEARING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Protecting existing vegetation to remain.
 - 2. Removing existing vegetation.
 - 3. Clearing and grubbing.
 - 4. Stripping and stockpiling topsoil.
 - 5. Stripping and stockpiling rock.
 - 6. Removing above- and below-grade site improvements.
 - 7. Disconnecting, capping or sealing, and removing site utilities and/or abandoning site utilities in place.
 - 8. Temporary erosion and sedimentation control.

1.3 DEFINITIONS

- A. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.
- B. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil," but in disturbed areas such as urban environments, the surface soil can be subsoil.
- C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow.
- D. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects larger than 2 inches in diameter; and free of weeds, roots, toxic materials, or other non-soil materials.
- E. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction and indicated on Drawings.

- F. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction and indicated on Drawings.
- G. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 PRE-INSTALLATION MEETINGS

- A. Pre-installation Conference: Conduct conference at Project site.

1.5 MATERIAL OWNERSHIP

- A. Except for materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.6 INFORMATIONAL SUBMITTALS

- A. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.
 - 1. Use sufficiently detailed photographs or video recordings.
 - 2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plant designated to remain.
- B. Topsoil stripping and stockpiling program.
- C. Rock stockpiling program.
- D. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.
- E. Burning: Documentation of compliance with burning requirements and permitting of authorities having jurisdiction. Identify location(s) and conditions under which burning will be performed.

1.7 QUALITY ASSURANCE

- A. Topsoil Stripping and Stockpiling Program: Prepare a written program to systematically demonstrate the ability of personnel to properly follow procedures and handle materials and equipment during the Work. Include dimensioned diagrams for placement and protection of stockpiles.
- B. Rock Stockpiling Program: Prepare a written program to systematically demonstrate the ability of personnel to properly follow procedures and handle materials and equipment during the Work. Include dimensioned diagrams for placement and protection of stockpiles.

1.8 FIELD CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
 - 2. Provide alternate routes around closed or obstructed trafficways if required by Owner or authorities having jurisdiction.
- B. Improvements on Adjoining Property: Authority for performing site clearing indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.
 - 1. Do not proceed with work on adjoining property until directed by Architect.
- C. Salvageable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.
- D. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.
- E. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant-protection measures are in place.
- F. Tree- and Plant-Protection Zones: Protect according to requirements in Section 015639 "Temporary Tree and Plant Protection."
- G. Soil Stripping, Handling, and Stockpiling: Perform only when the soil is dry or slightly moist.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Verify that trees, shrubs, and other vegetation to remain or to be relocated have been flagged and that protection zones have been identified and enclosed according to requirements in Section 015639 "Temporary Tree and Plant Protection."
- C. Protect existing site improvements to remain from damage during construction.
 - 1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.
- B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.
- C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
- D. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 TREE AND PLANT PROTECTION

- A. Protect trees and plants remaining on-site according to requirements in Section 015639 "Temporary Tree and Plant Protection."
- B. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations according to requirements in Section 015639 "Temporary Tree and Plant Protection."

3.4 EXISTING UTILITIES

- A. Owner will arrange for disconnecting and sealing indicated utilities that serve existing structures before site clearing, when requested by Contractor.
 - 1. Verify that utilities have been disconnected and capped before proceeding with site clearing.
- B. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.
 - 1. Arrange with utility companies to shut off indicated utilities.
 - 2. Owner will arrange to shut off indicated utilities when requested by Contractor.
- C. Locate, identify, and disconnect utilities indicated to be abandoned in place.
- D. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others, unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify Architect not less than two days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Architect's written permission.
- E. Excavate for and remove underground utilities indicated to be removed.

- F. Removal of underground utilities is included in earthwork sections; in applicable fire suppression, plumbing, HVAC, electrical, communications, electronic safety and security, and utilities sections; and in Section 024116 "Structure Demolition" and Section 024119 "Selective Demolition."

3.5 CLEARING AND GRUBBING

- A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.
 - 1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
 - 2. Grind down stumps and remove roots larger than 2 inches in diameter, obstructions, and debris to a depth of 18 inches below exposed subgrade.
 - 3. Use only hand methods or air spade for grubbing within protection zones.
 - 4. Chip removed tree branches and stockpile in areas approved by Architect.
- B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
 - 1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches and compact each layer to a density equal to adjacent original ground.

3.6 TOPSOIL STRIPPING

- A. Remove sod and grass before stripping topsoil.
- B. Strip topsoil to depth indicated on Drawings in a manner to prevent intermingling with underlying subsoil or other waste materials.
 - 1. Remove subsoil and non-soil materials from topsoil, including clay lumps, gravel, and other objects larger than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.
- C. Stockpile topsoil away from edge of excavations without intermixing with subsoil or other materials. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.
 - 1. Limit height of topsoil stockpiles to 72 inches.
 - 2. Do not stockpile topsoil within protection zones.
 - 3. Dispose of surplus topsoil. Surplus topsoil is that which exceeds quantity indicated to be stockpiled or reused.
 - 4. Stockpile surplus topsoil to allow for re-spreading deeper topsoil.

3.7 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

- B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.
 - 1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
 - 2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.
- B. Burning tree, shrub, and other vegetation waste is permitted according to burning requirements and permitting of authorities having jurisdiction. Control such burning to produce the least smoke or air pollutants and minimum annoyance to surrounding properties. Burning of other waste and debris is prohibited.
- C. Separate recyclable materials produced during site clearing from other non-recyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION 31 1000

SECTION 31 2000 - EARTH MOVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Excavating and filling for rough grading the Site.
 - 2. Preparing subgrades for slabs-on-grade, walks, pavements, turf and grasses and plants.
 - 3. Excavating and backfilling for buildings and structures.
 - 4. Drainage course for concrete slabs-on-grade.
 - 5. Subbase course for concrete walks and pavements.
 - 6. Subbase course and base course for asphalt paving.
 - 7. Subsurface drainage backfill for walls and trenches.
 - 8. Excavating and backfilling trenches for utilities and pits for buried utility structures.
 - 9. Excavating well hole to accommodate elevator-cylinder assembly.
- B. Related Requirements:
 - 1. Section 033000 "Cast-in-Place Concrete" for granular course if placed over vapor retarder and beneath the slab-on-grade.
 - 2. Section 311000 "Site Clearing" for site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.
 - 3. Section 329200 "Turf and Grasses" for finish grading in turf and grass areas, including preparing and placing planting soil for turf areas.
 - 4. Section 329300 "Plants" for finish grading in planting areas and tree and shrub pit excavation and planting.

1.3 UNIT PRICES

- A. Work of this Section is affected by unit prices for earth moving specified in Section 012200 "Unit Prices."
- B. Quantity allowances for earth moving are included in Section 012100 "Allowances."

- C. Rock Measurement: Volume of rock actually removed, measured in original position, but not to exceed the following. Unit prices for rock excavation include replacement with approved materials.
 - 1. 24 inches outside of concrete forms other than at footings.
 - 2. 12 inches outside of concrete forms at footings.
 - 3. 6 inches outside of minimum required dimensions of concrete cast against grade.
 - 4. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
 - 5. 6 inches beneath bottom of concrete slabs-on-grade.
 - 6. 6 inches beneath pipe in trenches, and the greater of 24 inches wider than pipe or 42 inches wide.

1.4 DEFINITIONS

- A. Backfill: Soil material or controlled low-strength material used to fill an excavation.
 - 1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
 - 2. Final Backfill: Backfill placed over initial backfill to fill a trench.
- B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.
- C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.
- D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.
- E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.
- F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
 - 1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices.
 - 2. Bulk Excavation: Excavation more than 10 feet in width and more than 30 feet in length.
 - 3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.
- G. Fill: Soil materials used to raise existing grades.
- H. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 1 cu. yd. for bulk excavation or 3/4 cu. yd. for

footing, trench, and pit excavation that cannot be removed by rock-excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:

1. Equipment for Footing, Trench, and Pit Excavation: Late-model, track-mounted hydraulic excavator; equipped with a 42-inch-maximum-width, short-tip-radius rock bucket; rated at not less than 138-hp flywheel power with bucket-curling force of not less than 28,700 lbf and stick-crowd force of not less than 18,400 lbf with extra-long reach boom.
 2. Equipment for Bulk Excavation: Late-model, track-mounted loader; rated at not less than 230-hp flywheel power and developing a minimum of 47,992-lbf breakout force with a general-purpose bare bucket.
- I. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material 3/4 cu. yd. or more in volume that exceed a standard penetration resistance of 100 blows/2 inches when tested by a geotechnical testing agency, according to ASTM D 1586.
 - J. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
 - K. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.
 - L. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.
 - M. Utilities: On-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.

1.5 PRE-INSTALLATION MEETINGS

- A. Pre-installation Conference: Conduct pre-excavation conference at Project site.
 1. Review methods and procedures related to earthmoving, including, but not limited to, the following:
 - a. Personnel and equipment needed to make progress and avoid delays.
 - b. Coordination of Work with utility locator service.
 - c. Coordination of Work and equipment movement with the locations of tree- and plant-protection zones.
 - d. Extent of trenching by hand or with air spade.
 - e. Field quality control.

1.6 QUALITY ASSURANCE

- A. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E 329 and ASTM D 3740 for testing indicated.

1.7 FIELD CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth-moving operations.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
 - 2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.
- B. Improvements on Adjoining Property: Authority for performing earth moving indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.
 - 1. Do not proceed with work on adjoining property until directed by Architect.
- C. Utility Locator Service: Notify utility locator service for area where Project is located before beginning earth-moving operations.
- D. Do not commence earth-moving operations until temporary site fencing and erosion- and sedimentation-control measures specified in Section 015000 "Temporary Facilities and Controls" and Section 311000 "Site Clearing" are in place.
- E. Do not commence earth-moving operations until plant-protection measures specified in Section 015639 "Temporary Tree and Plant Protection" are in place.
- F. The following practices are prohibited within protection zones:
 - 1. Storage of construction materials, debris, or excavated material.
 - 2. Parking vehicles or equipment.
 - 3. Foot traffic.
 - 4. Erection of sheds or structures.
 - 5. Impoundment of water.
 - 6. Excavation or other digging unless otherwise indicated.
 - 7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.
- G. Do not direct vehicle or equipment exhaust towards protection zones.
- H. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
- B. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, and SM according to ASTM D 2487, or a combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.
- C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups.
 - 1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.
- D. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940/D 2940M; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.
- E. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 294/D 2940M 0; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve.
- F. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940/D 2940M; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.
- G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940/D 2940M; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.
- H. Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and zero to 5 percent passing a No. 8 sieve.
- I. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and zero to 5 percent passing a No. 4 sieve.
- J. Sand: ASTM C 33/C 33M; fine aggregate.
- K. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 GEOTEXTILES

- A. Subsurface Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
 1. Survivability: Class 2; AASHTO M 288.
 2. Survivability: As follows:
 - a. Grab Tensile Strength: 157 lbf; ASTM D 4632.
 - b. Sewn Seam Strength: 142 lbf; ASTM D 4632.
 - c. Tear Strength: 56 lbf; ASTM D 4533.
 - d. Puncture Strength: 56 lbf; ASTM D 4833.
 3. Apparent Opening Size: No. 40 sieve, maximum; ASTM D 4751.
 4. Permittivity: 0.5 per second, minimum; ASTM D 4491.
 5. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.
- B. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters; with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
 1. Survivability: Class 2; AASHTO M 288.
 2. Survivability: As follows:
 - a. Grab Tensile Strength: 247 lbf; ASTM D 4632.
 - b. Sewn Seam Strength: 222 lbf; ASTM D 4632.
 - c. Tear Strength: 90 lbf; ASTM D 4533.
 - d. Puncture Strength: 90 lbf; ASTM D 4833.
 3. Apparent Opening Size: No. 60 sieve, maximum; ASTM D 4751.
 4. Permittivity: 0.02 per second, minimum; ASTM D 4491.
 5. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

2.3 ACCESSORIES

- A. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored as follows:
 1. Red: Electric.
 2. Yellow: Gas, oil, steam, and dangerous materials.
 3. Orange: Telephone and other communications.
 4. Blue: Water systems.
 5. Green: Sewer systems.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth-moving operations.
- B. Protect and maintain erosion and sedimentation controls during earth-moving operations.
- C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 DEWATERING

- A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.
- B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
 - 1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

3.3 EXPLOSIVES

- A. Explosives: Do not use explosives.

3.4 EXCAVATION, GENERAL

- A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.
 - 1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
 - 2. Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:
 - a. 24 inches outside of concrete forms other than at footings.
 - b. 12 inches outside of concrete forms at footings.
 - c. 6 inches outside of minimum required dimensions of concrete cast against grade.
 - d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.

- e. 6 inches beneath bottom of concrete slabs-on-grade.
- f. 6 inches beneath pipe in trenches and the greater of 24 inches wider than pipe or 42 inches wide.

3.5 EXCAVATION FOR STRUCTURES

- A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
 - 1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
 - 2. Pile Foundations: Stop excavations 6 to 12 inches above bottom of pile cap before piles are placed. After piles have been driven, remove loose and displaced material. Excavate to final grade, leaving solid base to receive concrete pile caps.
 - 3. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended as bearing surfaces.
- B. Excavations at Edges of Tree- and Plant-Protection Zones:
 - 1. Excavate by hand or with an air spade to indicated lines, cross sections, elevations, and subgrades. If excavating by hand, use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
 - 2. Cut and protect roots according to requirements in Section 015639 "Temporary Tree and Plant Protection."

3.6 EXCAVATION FOR WALKS AND PAVEMENTS

- A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.7 EXCAVATION FOR UTILITY TRENCHES

- A. Excavate trenches to indicated gradients, lines, depths, and elevations.
 - 1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.
- 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.

1. Clearance: 12 inches each side of pipe or conduit.
- C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.
1. For pipes and conduit less than 6 inches in nominal diameter, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
 2. For pipes and conduit 6 inches or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe or conduit circumference. Fill depressions with tamped sand backfill.
 3. For flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support conduit on an undisturbed subgrade.
 4. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.
- D. 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.
1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.
- E. Trenches in Tree- and Plant-Protection Zones:
1. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
 2. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.
 3. Cut and protect roots according to requirements in Section 015639 "Temporary Tree and Plant Protection."

3.8 SUBGRADE INSPECTION

- A. Notify Architect when excavations have reached required subgrade.
- B. If Architect determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
- C. Proof-roll subgrade below the building slabs and pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
 1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.

2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.
- D. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices.
- E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.9 UNAUTHORIZED EXCAVATION

- A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by Architect.
 1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Architect.

3.10 STORAGE OF SOIL MATERIALS

- A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
 1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.11 BACKFILL

- A. Place and compact backfill in excavations promptly, but not before completing the following:
 1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
 2. Surveying locations of underground utilities for Record Documents.
 3. Testing and inspecting underground utilities.
 4. Removing concrete formwork.
 5. Removing trash and debris.
 6. Removing temporary shoring, bracing, and sheeting.
 7. Installing permanent or temporary horizontal bracing on horizontally supported walls.
- B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.12 UTILITY TRENCH BACKFILL

- A. Place backfill on subgrades free of mud, frost, snow, or ice.
- B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
- C. Trenches under Footings: Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Section 033000 "Cast-in-Place Concrete."
- D. Trenches under Roadways: Provide 4-inch-thick, concrete-base slab support for piping or conduit less than 30 inches below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches of concrete before backfilling or placing roadway subbase course. Concrete is specified in Section 033000 "Cast-in-Place Concrete."
- E. Backfill voids with satisfactory soil while removing shoring and bracing.
- F. Initial Backfill:
 - 1. Soil Backfill: Place and compact initial backfill of subbase material or satisfactory soil, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.
 - a. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.
 - 2. Controlled Low-Strength Material: Place initial backfill of controlled low-strength material to a height of 12 inches over the pipe or conduit. Coordinate backfilling with utilities testing.
- G. Final Backfill:
 - 1. Soil Backfill: Place and compact final backfill of satisfactory soil to final subgrade elevation.
 - 2. Controlled Low-Strength Material: Place final backfill of controlled low-strength material to final subgrade elevation.
- H. Warning Tape: Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.13 SOIL FILL

- A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.
- B. Place and compact fill material in layers to required elevations as follows:

1. Under grass and planted areas, use satisfactory soil material.
2. Under walks and pavements, use satisfactory soil material.
3. Under steps and ramps, use engineered fill.
4. Under building slabs, use engineered fill.
5. Under footings and foundations, use engineered fill.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.14 SOIL MOISTURE CONTROL

- A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
 2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.15 COMPACTION OF SOIL BACKFILLS AND FILLS

- A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- B. Place backfill and fill soil materials evenly on all sides of structures to required elevations and uniformly along the full length of each structure.
- C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698:
1. Under structures, building slabs, steps, and pavements, scarify and re-compact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent.
 2. Under walkways, scarify and re-compact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 95 percent.
 3. Under turf or unpaved areas, scarify and re-compact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 90 percent.
 4. For utility trenches, compact each layer of initial and final backfill soil material at 90 percent.

3.16 GRADING

- A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
1. Provide a smooth transition between adjacent existing grades and new grades.

2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
- B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to elevations required to achieve indicated finish elevations, within the following subgrade tolerances:
 1. Turf or Unpaved Areas: Plus or minus 1 inch.
 2. Walks: Plus or minus 1 inch.
 3. Pavements: Plus or minus 1/2 inch.
- C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.17 SUBSURFACE DRAINAGE

- A. Subsurface Drain: Place subsurface drainage geotextile around perimeter of subdrainage trench. Place a 6-inch course of filter material on subsurface drainage geotextile to support subdrainage pipe. Encase subdrainage pipe in a minimum of 12 inches of filter material, placed in compacted layers 6 inches thick, and wrap in subsurface drainage geotextile, overlapping sides and ends at least 6 inches.
 1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D 698.
- B. Drainage Backfill: Place and compact filter material over subsurface drain, in width indicated, to within 12 inches of final subgrade, in compacted layers 6 inches thick. Overlay drainage backfill with one layer of subsurface drainage geotextile, overlapping sides and ends at least 6 inches.
 1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D 698.
 2. Place and compact impervious fill over drainage backfill in 6-inch-thick compacted layers to final subgrade.

3.18 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

- A. Place subbase course and base course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place subbase course and base course under pavements and walks as follows:
 1. Install separation geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
 2. Place base course material over subbase course under hot-mix asphalt pavement.
 3. Shape subbase course and base course to required crown elevations and cross-slope grades.

4. Place subbase course and base course 6 inches or less in compacted thickness in a single layer.
 5. Place subbase course and base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
 6. Compact subbase course and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 698.
- C. Pavement Shoulders: Place shoulders along edges of subbase course and base course to prevent lateral movement. Construct shoulders, at least 12 inches wide, of satisfactory soil materials and compact simultaneously with each subbase and base layer to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.19 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

- A. Place drainage course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:
1. Install subdrainage geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
 2. Place drainage course 6 inches or less in compacted thickness in a single layer.
 3. Place drainage course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
 4. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.20 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
1. Determine prior to placement of fill that site has been prepared in compliance with requirements.
 2. Determine that fill material classification and maximum lift thickness comply with requirements.
 3. Determine, during placement and compaction that in-place density of compacted fill complies with requirements.
- B. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.

- C. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.
- D. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.
- E. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2937, and ASTM D 6938, as applicable. Tests will be performed at the following locations and frequencies:
 - 1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. or less of paved area or building slab but in no case fewer than three tests.
 - 2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet or less of wall length but no fewer than two tests.
 - 3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet or less of trench length but no fewer than two tests.
- F. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; re-compact and retest until specified compaction is obtained.

3.21 PROTECTION

- A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
 - 1. Scarify or remove and replace soil material to depth as directed by Architect; reshape and re-compact.
- C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
 - 1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.22 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

- B. Transport surplus satisfactory soil to designated storage areas on Owner's property. Stockpile or spread soil as directed by Architect.
 - 1. Remove waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 31 2000

SECTION 32 1313 - CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes exterior cement concrete pavement for the following:
 - 1. Driveways and roadways.
 - 2. Parking lots.
 - 3. Curbs and gutters.
 - 4. Walkways.

1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

1.4 SUBMITTALS

- A. Product Data: For each type of manufactured material and product indicated.
- B. Design Mixtures: For each concrete pavement mixture. Include alternate mixture designs when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
- C. Material Certificates: Signed by manufacturers certifying that each of the following materials complies with requirements:
 - 1. Cementitious materials.
 - 2. Steel reinforcement and reinforcement accessories.
 - 3. Fiber reinforcement.
 - 4. Admixtures.
 - 5. Curing compounds.
 - 6. Applied finish materials.
 - 7. Bonding agent or epoxy adhesive.
 - 8. Joint fillers.
- D. Field quality-control test reports.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products who complies with ASTM C 94/C 94M requirements for production facilities and equipment.
 - 1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
- B. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.
 - 1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.
- C. ACI Publications: Comply with ACI 301, "Specification for Structural Concrete," unless modified by requirements in the Contract Documents.
- D. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.
- E. Mockups: Cast mockups of full-size sections of concrete pavement to demonstrate typical joints, surface finish, texture, color, and standard of workmanship.
 - 1. Build mockups in the location and of the size indicated or, if not indicated, as directed by Architect.
 - 2. Notify Architect seven days in advance of dates and times when mockups will be constructed.
 - 3. Obtain Architect's approval of mockups before starting construction.
 - 4. Maintain approved mockups during construction in an undisturbed condition as a standard for judging the completed pavement.
 - 5. Demolish and remove approved mockups from the site when directed by Architect.
 - 6. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- F. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."
 - 1. Before submitting design mixtures, review concrete pavement mixture design and examine procedures for ensuring quality of concrete materials and concrete pavement construction practices. Require representatives, including the following, of each entity directly concerned with concrete pavement, to attend conference:
 - a. Contractor's superintendent.
 - b. Independent testing agency responsible for concrete design mixtures.
 - c. Ready-mix concrete producer.
 - d. Concrete pavement subcontractor.

1.6 PROJECT CONDITIONS

- A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

2.2 FORMS

- A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces.
 - 1. Use flexible or curved forms for curves with a radius 100 feet or less.
- B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

2.3 STEEL REINFORCEMENT

- A. Plain-Steel Welded Wire Reinforcement: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.
- B. Deformed-Steel Welded Wire Reinforcement: ASTM A 497, flat sheet.
- C. Epoxy-Coated Welded Wire Fabric: ASTM A 884/A 884M, Class A, plain steel.
- D. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed.
- E. Galvanized Reinforcing Bars: ASTM A 767/A 767M, Class II zinc coated, hot-dip galvanized after fabrication and bending; with ASTM A 615/A 615M, Grade 60 deformed bars.

- F. Epoxy-Coated Reinforcing Bars: ASTM A 775/A 775M or ASTM A 934/A 934M; with ASTM A 615/A 615M, Grade 60 deformed bars.
- G. Steel Bar Mats: ASTM A 184/A 184M; with ASTM A 615/A 615M, Grade 60, deformed bars; assembled with clips.
- H. Deformed-Steel Wire: ASTM A 496.
- I. Joint Dowel Bars: Plain steel bars, ASTM A 615/A 615M, Grade 60. Cut bars true to length with ends square and free of burrs.
- J. Epoxy-Coated Joint Dowel Bars: ASTM A 775/A 775M; with ASTM A 615/A 615M, Grade 60, plain steel bars.
- K. Tie Bars: ASTM A 615/A 615M, Grade 60, deformed.
- L. Hook Bolts: ASTM A 307, Grade A, internally and externally threaded. Design hook-bolt joint assembly to hold coupling against pavement form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.
- M. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete, and as follows:
 - 1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.
 - 2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.
- N. Epoxy Repair Coating: Liquid two-part epoxy repair coating, compatible with epoxy coating on reinforcement.
- O. Zinc Repair Material: ASTM A 780.

2.4 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source throughout the Project:
 - 1. Portland Cement: ASTM C 150, Type I/II. Supplement with the following:
 - a. Fly Ash: ASTM C 618, Class C or F.
- B. Normal-Weight Aggregates: ASTM C 33, Class 3M coarse aggregate, uniformly graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar pavement applications and service conditions using similar aggregates and cementitious materials.
- C. Water: ASTM C 94/C 94M.

- D. Air-Entraining Admixture: ASTM C 260.
- E. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.
 - 1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
 - 2. Retarding Admixture: ASTM C 494/C 494M, Type B.
 - 3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
 - 4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
 - 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
 - 6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.5 FIBER REINFORCEMENT

- A. Synthetic Fiber: Monofilament or fibrillated polypropylene fibers engineered and designed for use in concrete pavement, complying with ASTM C 1116, Type III, 1/2 to 1-1/2 inches long.

2.6 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry.
- B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- C. Water: Potable.

2.7 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork.
- B. Slip-Resistive Aggregate Finish: Factory-graded, packaged, rustproof, non-glazing, abrasive aggregate of fused aluminum-oxide granules or crushed emery with emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials.
- C. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- D. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to requirements, and as follows:
 - 1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

- E. Chemical Surface Retarder: Water-soluble, liquid-set retarder with color dye, for horizontal concrete surface application, capable of temporarily delaying final hardening of concrete to a depth of 1/8 to 1/4 inch.

2.8 PAVEMENT MARKINGS

- A. Pavement-Marking Paint: According to NCDOT standard specifications and details.

2.9 CONCRETE MIXTURES

- A. Prepare design mixtures, proportioned according to ACI 301, with the following properties:
 - 1. Compressive Strength (28 Days): As specified on the Drawings.
 - 2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.45.
 - 3. Slump Limit: 4 inches.
 - 4. Air Content: 5 percent plus or minus 1.5 percent.

2.10 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M and ASTM C 1116. Furnish batch certificates for each batch discharged and used in the Work.
 - 1. When air temperature is between 85 deg F and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine exposed subgrades and sub-base surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.
- B. Proof-roll prepared sub-base surface below concrete pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding.
 - 1. Completely proof-roll sub-base in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph.
 - 2. Proof-roll with a loaded 10-wheel tandem-axle dump truck weighing not less than 15 tons.
 - 3. Sub-base with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch require correction according to requirements in Division 31 Section "Earth Moving."

- C. Proceed with concrete pavement operations only after nonconforming conditions have been corrected and subgrade is ready to receive pavement.

3.2 PREPARATION

- A. Remove loose material from compacted sub-base surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

- A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for pavement to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
- B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.
- C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.
- D. Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.
- E. Zinc-Coated Reinforcement: Use galvanized steel wire ties to fasten zinc-coated reinforcement. Repair cut and damaged zinc coatings with zinc repair material.
- F. Epoxy-Coated Reinforcement: Use epoxy-coated steel wire ties to fasten epoxy-coated reinforcement. Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963/D 3963M.
- G. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch overlap of adjacent mats.

3.5 JOINTS

- A. General: Form construction, isolation, and contraction joints and tool edgings true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline, unless otherwise indicated.
 1. When joining existing pavement, place transverse joints to align with previously placed joints, unless otherwise indicated.
- B. Construction Joints: Set construction joints at side and end terminations of pavement and at locations where pavement operations are stopped for more than one-half hour unless pavement terminates at isolation joints.
 1. Continue steel reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of pavement strips, unless otherwise indicated.
 2. Provide tie bars at sides of pavement strips where indicated.
 3. Butt Joints: Use epoxy bonding adhesive at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
 4. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys, unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.
 5. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt-coat one-half of dowel length to prevent concrete bonding to one side of joint.
- C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.
 1. Locate expansion joints at intervals of 50 feet, unless otherwise indicated.
 2. Extend joint fillers full width and depth of joint.
 3. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.
 4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
 5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
 6. Protect top edge of joint filler during concrete placement with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.
- D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows to match jointing of existing adjacent concrete pavement:
 1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 3/8-inch radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover marks on concrete surfaces.

2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.
 3. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.
- E. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial floating with an edging tool to a 3/8-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate tool marks on concrete surfaces.

3.6 CONCRETE PLACEMENT

- A. Inspection: Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast in. Notify other trades to permit installation of their work.
- B. Remove snow, ice, or frost from sub-base surface and reinforcement before placing concrete. Do not place concrete on frozen surfaces.
- C. Moisten sub-base to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.
- D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.
- E. Do not add water to concrete during delivery or at Project site.
- F. Do not add water to fresh concrete after testing.
- G. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
- H. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.
 1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.
- I. Place concrete in two operations; strike off initial pour for entire width of placement and to the required depth below finish surface. Lay welded wire fabric or fabricated bar mats immediately in final position. Place top layer of concrete, strike off, and screed.

1. Remove and replace concrete that has been placed for more than 15 minutes without being covered by top layer, or use bonding agent if approved by Architect.
- J. Screed pavement surfaces with a straightedge and strike off.
- K. Commence initial floating using bull floats or darbies to impart an open textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.
- L. Curbs and Gutters: When automatic machine placement is used for curb and gutter placement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing as specified for formed concrete. If results are not approved, remove and replace with formed concrete.
- M. Slip-Form Pavers: When automatic machine placement is used for pavement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce pavement to required thickness, lines, grades, finish, and jointing as required for formed pavement.
1. Compact sub-base and prepare subgrade of sufficient width to prevent displacement of paver machine during operations.
- N. When adjoining pavement lanes are placed in separate pours, do not operate equipment on concrete until pavement has attained 85 percent of its 28-day compressive strength.
- O. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
 2. Do not use frozen materials or materials containing ice or snow.
 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mix designs.
- P. Hot-Weather Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:
1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.

3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.7 FLOAT FINISHING

- A. General: Do not add water to concrete surfaces during finishing operations.
- B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats, or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.
 1. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch deep with a stiff-bristled broom, perpendicular to line of traffic.

3.8 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
- B. Comply with ACI 306.1 for cold-weather protection.
- C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:
 1. Moist Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

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

3.9 PAVEMENT TOLERANCES

- A. Comply with tolerances of ACI 117 and as follows:

1. Elevation: 1/4 inch.
2. Thickness: Plus 3/8 inch, minus 1/4 inch.
3. Surface: Gap below 10-foot-long, unleveled straightedge not to exceed 1/4 inch.
4. Lateral Alignment and Spacing of Tie Bars and Dowels: 1 inch.
5. Vertical Alignment of Tie Bars and Dowels: 1/4 inch.
6. Alignment of Tie-Bar End Relative to Line Perpendicular to Pavement Edge: 1/2 inch.
7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Pavement Edge: Length of dowel 1/4 inch per 12 inches.
8. Joint Spacing: 3 inches.
9. Contraction Joint Depth: Plus 1/4 inch, no minus.
10. Joint Width: Plus 1/8 inch, no minus.

3.10 PAVEMENT MARKING

- A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.
- B. Allow concrete pavement to cure for 28 days and be dry before starting pavement marking.
- C. Sweep and clean surface to eliminate loose material and dust.
- D. Apply paint with mechanical equipment to produce pavement markings of dimensions indicated with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

3.11 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
 1. Testing Frequency: Obtain at least 1 composite sample for each 100 cu. yd. or fraction thereof of each concrete mix placed each day.
 - a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at

least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mix. Perform additional tests when concrete consistency appears to change.
 3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.
 4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
 5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
 6. Compressive-Strength Tests: ASTM C 39/C 39M; test 1 specimen at 7 days and 2 specimens at 28 days.
 - a. A compressive-strength test shall be the average compressive strength from 2 specimens obtained from same composite sample and tested at 28 days.
- C. Strength of each concrete mix will be satisfactory if average of any 3 consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
- D. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
- E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
- F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.
- G. Remove and replace concrete pavement where test results indicate that it does not comply with specified requirements.
- H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.12 REPAIRS AND PROTECTION

- A. Remove and replace concrete pavement that is broken, damaged, or defective or that does not comply with requirements in this Section.

- B. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with portland cement concrete bonded to pavement with epoxy adhesive.
- C. Protect concrete from damage. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.
- D. Maintain concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep concrete pavement not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 32 1313

SECTION 32 9200 - TURF AND GRASSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Seeding.
 - 2. Hydroseeding.
 - 3. Turf renovation.
 - 4. Erosion-control materials.

1.3 DEFINITIONS

- A. Finish Grade: Elevation of finished surface of planting soil.
- B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- D. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
- E. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For landscape Installer.
- B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture, stating the botanical and common name, percentage by weight of each

species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.

- C. Product Certificates: For fertilizers, from manufacturer.
- D. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.
- B. Bulk Materials:
 - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 - 3. Accompany each delivery of bulk materials with appropriate certificates.

1.6 FIELD CONDITIONS

- A. Planting Restrictions: Coordinate planting periods with initial maintenance periods to provide required maintenance from date of Substantial Completion.
- B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 SEED

- A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Rules for Testing Seeds" for purity and germination tolerances.
- B. Seed Species:
 - 1. Quality, State Certified: State-certified seed of grass species as listed below for solar exposure.
 - 2. Quality, Non-State Certified: Seed of grass species as listed below for solar exposure, with not less than 85 percent germination, not less than 95 percent pure seed, and not more than 0.5 percent weed seed:
 - 3. Full Sun, Warm-Season Grass: Bermudagrass (*Cynodon dactylon*).

4. Full Sun, Cool-Season Grass: Kentucky bluegrass (*Poa pratensis*), a minimum of three cultivars.
5. Sun and Partial Shade, Cool-Season Grass: Proportioned by weight as follows:
 - a. 50 percent Kentucky bluegrass (*Poa pratensis*).
 - b. 30 percent chewings red fescue (*Festuca rubra* variety).
 - c. 10 percent perennial ryegrass (*Lolium perenne*).
 - d. 10 percent redtop (*Agrostis alba*).
6. Shade, Cool-Season Grass: Proportioned by weight as follows:
 - a. 50 percent chewings red fescue (*Festuca rubra* variety).
 - b. 35 percent rough bluegrass (*Poa trivialis*).
 - c. 15 percent redtop (*Agrostis alba*).

2.2 FERTILIZERS

- A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
 1. Composition:
 - a. 1 lb/1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
 - b. Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.
- B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
 1. Composition:
 - a. 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
 - b. Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

2.3 MULCHES

- A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.
- B. Sphagnum Peat Mulch: Partially decomposed sphagnum peat moss, finely divided or of granular texture, and with a pH range of 3.4 to 4.8.

- C. Muck Peat Mulch: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture, with a pH range of 6 to 7.5, and having a water-absorbing capacity of 1100 to 2000 percent, and containing no sand.
- D. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch sieve; soluble salt content of 2 to 5 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
 - 1. Organic Matter Content: 50 to 60 percent of dry weight.
 - 2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.
- E. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.
- F. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.
- G. Asphalt Emulsion: ASTM D977, Grade SS-1; nontoxic and free of plant-growth or germination inhibitors.

2.4 PESTICIDES

- A. General: Pesticide, registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
- B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
- C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

2.5 EROSION-CONTROL MATERIALS

- A. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples, 6 inches long.
- B. Erosion-Control Fiber Mesh: Biodegradable burlap or spun-coir mesh, a minimum of 0.92 lb/sq. yd., with 50 to 65 percent open area. Include manufacturer's recommended steel wire staples, 6 inches long.
- C. Erosion-Control Mats: Cellular, nonbiodegradable slope-stabilization mats designed to isolate and contain small areas of soil over steeply sloped surface, of 3-inch nominal

mat thickness. Include manufacturer's recommended anchorage system for slope conditions.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to be planted for compliance with requirements and other conditions affecting installation and performance of the Work.
 - 1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
 - 2. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
 - 3. Uniformly moisten excessively dry soil that is not workable or which is dusty.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

3.2 PREPARATION

- A. Protect structures; utilities; sidewalks; pavements; and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
 - 1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
 - 2. Protect grade stakes set by others until directed to remove them.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 PREPARATION FOR EROSION-CONTROL MATERIALS

- A. Prepare area as specified in "Turf Area Preparation" Article.
- B. For erosion-control mats, install planting soil in two lifts, with second lift equal to thickness of erosion-control mats. Install erosion-control mat and fasten as recommended by material manufacturer.
- C. Fill cells of erosion-control mat with planting soil and compact before planting.

- D. For erosion-control blanket or mesh, install from top of slope, working downward, and as recommended by material manufacturer for site conditions. Fasten as recommended by material manufacturer.
- E. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

3.4 SEEDING

- A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph.
 - 1. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
 - 2. Do not use wet seed or seed that is moldy or otherwise damaged.
 - 3. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.
- B. Sow seed at a total rate of 3 to 4 lb/1000 sq. ft.
- C. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.
- D. Protect seeded areas with slopes exceeding 1:4 with erosion-control blankets and 1:6 with erosion-control fiber mesh installed and stapled according to manufacturer's written instructions.
- E. Protect seeded areas with erosion-control mats where indicated on Drawings; install and anchor according to manufacturer's written instructions.
- F. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1-1/2 inches in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment.
 - 1. Anchor straw mulch by crimping into soil with suitable mechanical equipment.
 - 2. Bond straw mulch by spraying with asphalt emulsion at a rate of 10 to 13 gal./1000 sq. ft. Take precautions to prevent damage or staining of structures or other plantings adjacent to mulched areas. Immediately clean damaged or stained areas.
- G. Protect seeded areas from hot, dry weather or drying winds by applying compost mulch, peat mulch, or planting soil within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of 3/16 inch, and roll surface smooth.

3.5 HYDROSEEDING

- A. Hydroseeding: Mix specified seed, commercial fertilizer or slow-release fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application.

Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.

1. Mix slurry with non-asphaltic or fiber-mulch manufacturer's recommended tackifier.
2. Spray-apply slurry uniformly to all areas to be seeded in a one-step process. Apply slurry at a rate so that mulch component is deposited at not less than 1500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate.
3. Spray-apply slurry uniformly to all areas to be seeded in a two-step process. Apply first slurry coat at a rate so that mulch component is deposited at not less than 500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate. Apply slurry cover coat of fiber mulch (hydromulching) at a rate of 1000 lb/acre.

3.6 TURF RENOVATION

- A. Renovate existing turf where indicated.
- B. Renovate turf damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.
 1. Reestablish turf where settlement or washouts occur or where minor regrading is required.
 2. Install new planting soil as required.
- C. Remove sod and vegetation from diseased or unsatisfactory turf areas; do not bury in soil.
- D. Remove topsoil containing foreign materials, such as oil drippings, fuel spills, stones, gravel, and other construction materials resulting from Contractor's operations, and replace with new planting soil.
- E. Mow, dethatch, core aerate, and rake existing turf.
- F. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.
- G. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off Owner's property.
- H. Till stripped, bare, and compacted areas thoroughly to a soil depth of 6 inches.
- I. Apply soil amendments and initial fertilizer required for establishing new turf and mix thoroughly into top 4 inches of existing soil. Install new planting soil to fill low spots and meet finish grades.
 1. Initial Fertilizer: Commercial fertilizer or Slow-release fertilizer applied according to manufacturer's recommendations.

- J. Apply seed and protect with straw mulch as required for new turf.
- K. Water newly planted areas and keep moist until new turf is established.

3.7 TURF MAINTENANCE

- A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.
 - 1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
 - 2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
 - 3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.
- B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.
 - 1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
 - 2. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.
- C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than one-third of grass height. Remove no more than one-third of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:
- D. Turf Postfertilization: Apply commercial fertilizer or slow-release fertilizer after initial mowing and when grass is dry.
 - 1. Use fertilizer that provides actual nitrogen of at least 1 lb/1000 sq. ft. to turf area.

3.8 SATISFACTORY TURF

- A. Turf installations shall meet the following criteria as determined by Architect:
 - 1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.

2. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.
 3. Satisfactory Plugged Turf: At end of maintenance period, the required number of plugs has been established as well-rooted, viable patches of grass, and areas between plugs are free of weeds and other undesirable vegetation.
 4. Satisfactory Sprigged Turf: At end of maintenance period, the required number of sprigs has been established as well-rooted, viable plants, and areas between sprigs are free of weeds and other undesirable vegetation.
- B. Use specified materials to reestablish turf that does not comply with requirements, and continue maintenance until turf is satisfactory.

3.9 PESTICIDE APPLICATION

- A. Apply pesticides and other chemical products and biological control agents according to requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.
- B. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

3.10 CLEANUP AND PROTECTION

- A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.
- C. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.
- D. Remove nondegradable erosion-control measures after grass establishment period.

3.11 MAINTENANCE SERVICE

- A. Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in "Turf Maintenance" Article. Begin maintenance immediately after each area is planted and continue until acceptable turf is established, but for not less than the following periods:
1. Seeded Turf: 60 days from date of Substantial Completion.

- a. When initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season.

END OF SECTION 32 9200

SECTION 33 1113 – SITE WATER DISTRIBUTION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. The proposed utility construction shall meet the applicable requirements of North Carolina State University and the City of Raleigh's "Public Utilities Handbook". The edition/revision of the referenced publications shall be the latest date as of the date of the Contract Documents, unless otherwise specified.
- B. This Section includes water-distribution piping and specialties outside the building.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Detail or Shop Drawings for the following:
 - 1. Valves.
 - 2. Piping.
 - 3. Fire Hydrants.
 - 4. Tapping sleeves and tapping saddles.
- C. Field test reports.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Application" 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, NSF 61, and NSF 372.
- C. Hard Copper Tube: ASTM B88, Type K, water tube, drawn temper.
 - 1. Copper, Solder-Joint Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.

- D. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end. Furnish Class 300 flanges if required to match piping.
- 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.
- F. Ductile Iron Water Mains
 - 1. Ductile iron pipe Class 50, 51, or 52 designed in accordance with AWWA Standard C-150-96 or PVC AWWA C900 Pipe Class 200 with bell end with gasket and with spigot end.
 - 2. The thickness design for external and internal pressures shall use the following conditions:
 - a. 3 feet minimum cover or as shown on the plans;
 - b. Laying condition - Type 1;
 - c. A minimum working pressure of 150 psi for pipes 16 inches and smaller in diameter, and for 24 inches and larger pipe, the design working pressure shall be as determined by the Public Utilities Director, and
 - d. A surge pressure of 300 psi.
 - 3. The ductile iron pipe shall be manufactured in accordance with all applicable requirements of AWWA Standard C-151-96. The ductile iron pipe shall be supplied in nominal lengths of 18 or 20 feet. Recycled Content: Not less than 80%.
 - 4. The ductile iron pipe shall be cement-mortar lined with a sealcoat in accordance with AWWA Standard C-104-95. Ductile iron pipe shall be externally bituminous coated in accordance with AWWA C-151-96.
 - 5. Pipe joints shall be mechanical or "push-on" manufactured in accordance with AWWA Standard C-111-95.
 - 6. Each joint of ductile iron pipe shall be hydrostatically tested before the outside coating and inside lining are applied at the point of manufacture to 500 psi. Testing may be performed prior to machining bell and spigot. Failure of ductile iron pipe shall be defined as any rupture or leakage of the pipe wall.
 - 7. All materials used in the production of the pipe are to be tested in accordance with AWWA Standard C-151-96 for their adequacy within the design of the pipe, and certified test results are to be provided to the City upon request. All certified tests, hydrostatic and material are to be performed by an independent testing laboratory at the expense of the pipe manufacturer.
 - 8. Push-on and mechanical joint pipe shall be as manufactured by the American Cast Iron Pipe Company, United States Pipe and Foundry Company, Griffin Pipe Products Company, or McWane Cast Iron Pipe Company.
 - 9. Restrained joints shall be TR Flex or Lok Tyte as manufactured by U.S. Pipe, Lok-Fast or Lok-Ring as manufactured by American Pipe, Super-Lock as manufactured by Clow, or Bolt-lok or Rigid-lok as manufactured by Griffin.
 - 10. Fittings

- a. All fittings shall be manufactured in accordance with AWWA C-110-98 or C-153-88 for ductile iron compact fittings. The fittings shall be tested and the manufacturer shall provide certified test results when requested by the City. This testing shall include hydrostatic proof testing of the fittings.
- b. All fittings shall be all-bell or mechanical joint. Mechanical joints shall be manufactured in accordance with AWWA Standard C-111-95.
- c. All fittings shall be cast iron or ductile iron and shall have a minimum working pressure rating of 250 psi and minimum iron strength of 25,000 psi.
- d. All fitting interiors shall be cement-mortar lined in accordance with AWWA Standard C-104-95, and the outside shall be bituminous coated.
- e. Megalug glands may be used where restraint is needed except when welded restraining rings are required. Megalugs provide additional restraint, but not intended to replace concrete blocking.

G. PVC Pipe and Fittings

1. PVC, Schedule 80 Pipe: ASTM D 1785.
 - a. PVC, Schedule 80 Socket Fittings: ASTM D 2467.
 - b. PVC, Schedule 80 Threaded Fittings: ASTM D 2464.
2. PVC, AWWA Pipe: AWWA C900, Class 200, with bell end with gasket, and with spigot end.
 - a. Comply with UL 1285 for fire-service mains if indicated.
 - b. PVC Fabricated Fittings: AWWA C900, Class 200, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
 - c. PVC Molded Fittings: AWWA C907, Class 150, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
 - d. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 - i. Gaskets: AWWA C111, rubber.
 - e. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 - i. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

H. Gate Valves

1. Cast iron or ductile iron resilient wedge style vertical or horizontal gate valves and tapping valves shall be used for all main line and hydrant branch valves in sizes from 6 inches through 24 inches. American, Mueller, Kennedy, AVK, Clow, M&H, and Waterous valves in accordance with AWWA C-509-94, C-515, or the appropriate AWWA standard as applicable, shall be used. All resilient wedge valves shall have internal and external epoxy coating, O-ring seals at the stuffing box and bonnet to body and dual O-rings at the stem seal above the thrust collar.
2. Tapping valves shall be the same valves as gate valves listed above, subject to the standards, providing that tapping valves shall have the tapping ring.

3. Gate valves twelve (12) inches in diameter and smaller, shall be mechanical joint or hub-end all-bell. They shall be "O" ring, open-left valves of the non-rising stem type. These valves shall be designed for a minimum of 175 psi working pressure and 300 psi hydrostatic test pressure with a two (2) inch operating nut. Valves shall be cast iron or ductile iron.
 4. Valves sixteen (16) inches in diameter or greater may be the horizontal gate type or butterfly type, as specified on construction plans, or gate valves as specified above.
 5. Gate valves, horizontal gate valves or butterfly valves shall be used for all main line and hydrant branch valves in sizes 16 inches through 24 inches.
- I. Fire Hydrants must meet NCSU specifications and preferred vendor (Mueller).
- J. Valve Boxes
1. Adjustable valve boxes shall be gray cast iron of the dimensions specified in the CORPUD standard details. Lids shall have the word "Water" cast into the lid. See Detail W-13. All load-bearing castings must be domestically cast and so indicated by the manufacturers name and "USA" in castings. All traffic castings must be Class 35 or greater.
- K. Tapping Sleeves and Tapping Saddles
1. Tapping sleeves shall be Mueller mechanical joint, Mueller Outlet Seal, American Uniseal, Kennedy Square Seal, or Clow F5205 or F5207. 100% stainless steel sleeves may also be used, as manufactured by Rockwell, Romac, Ford, or JCM provided that all metallic parts of the sleeves shall be 100% stainless steel including bolts. Ductile iron flanges may be included on sleeves or saddles. All sleeves shall have a minimum of 150 psi working pressure. All taps shall be machine drilled—no burned taps will be allowed.
 2. Tapping saddles may be used on mains 16-inches and larger. In 16 and 24 inch saddles as manufactured by Mueller, American, Kennedy and Clow tapping saddles shall be manufactured of ductile iron providing a factor of safety of 2.5 at a working pressure of 250 psi. In main sizes of 30-inch and larger, ductile iron tapping saddles as manufactured by American Pipe Company or US Pipe Company shall be utilized.
 3. Saddles shall be equipped with a standard AWWA C-110-98 flange connection. Sealing gaskets shall be "O" ring type, high quality molded rubber having approximate seventy durometer hardness, placed into a groove on the curved surface of the tapping saddle. Straps shall be of alloy steel. Saddles may be used for taps one-half the size of the main or less (i.e. 8-inch tapping saddle for use on a 16-inch main).

PART 3 - EXECUTION

3.1 SCOPE OF WORK

- A. The contractor shall furnish all materials, equipment, and labor for excavation, installation, backfilling of water mains and related appurtenances as shown on the plans.
- B. It shall be the contractor's responsibility to notify the Owner at least twenty-four hours in advance of beginning any construction work on any project.
- C. Once construction has begun, the contractor shall contact the Owner each morning to notify where and what will be done that day.
- D. "Field changes" are not considered approved by the Owner unless revised plans have been submitted to the Engineer, reviewed and approved. Therefore, the contractor that proceeds with construction prior to this approval is at his/her own risk.

3.2 HANDLING AND STORAGE OF MATERIALS

- A. The contractor shall be responsible for the shipping and storing of all water materials. The contractor shall replace any material which is damaged or defective.
- B. The loading and unloading of all pipe, valves, hydrants, and other accessories shall be in accordance with the manufacturer's recommended practices and shall at all times be performed with care to avoid any damage to the material.
- C. The contractor shall locate and provide the necessary storage areas for materials and equipment. If private property is being used for storage areas, then the contractor must have the written consent from the owner. Without this written consent, all material and equipment shall be stored within the existing rights-of-way and easements of the project. Pipe may not be prestrung along job site; it must be delivered to and removed from job site each day. In extenuating circumstances when the inspector authorizes pipe to remain on the project from one day to the next, the ends of the pipe must be sealed.
- D. All materials, once on the job site, shall be stored in accordance with the manufacturer's recommendations.
- E. All pipes shall be kept free of dirt and other debris. Any damage relating to the coating of the various materials for water mains shall be repaired in a manner approved by the Owner.
- F. The contractor shall be responsible for safeguarding and protecting all material and equipment stored on the job site. The contractor shall be responsible for the storage of materials in a safe and workmanlike manner to prevent injuries, during and after working hours, until the project is complete.

3.3 BARRICADES, SIGNS AND STREET PROVISIONS

- A. Signs, barricades, warning lights, guard rails and flaggers shall be employed as necessary when construction endangers either vehicular or pedestrian traffic. These devices shall remain in place until the traffic may proceed normally again. The

contractor shall hold the Owner harmless for any damages or injuries caused by the construction of water mains.

3.4 PROPERTY PROTECTION

- A. Trees, fences, poles and all other property shall be protected unless their removal is authorized, and any property not authorized for removal, but damaged by the contractor, shall be restored by the contractor to the owner's satisfaction.

3.5 GENERAL CONSTRUCTION SAFETY

- A. The contractor and any subcontractors shall be responsible for the total compliance with all federal, state and local ordinances, laws and regulations as related to safe construction practices and to protecting the employees and the public's health and safety.
- B. The contractor shall ensure that all Occupational Safety and Health Administration (OSHA) regulations and standards are followed during all phases of the construction project.
- C. The Owner shall not be responsible for the contractor's adherence to OSHA regulations and standards. However, the Owner may report known violations or unsafe practices to the appropriate enforcement agency.
- D. The contractor shall be required to furnish safety equipment necessary to inspect the work including, but not limited to ladders, gas detectors/oxygen sensors, blowers, etc.

3.6 PERMITS

- A. The contractor shall be responsible for securing all other local, state and federal permits required for the utility construction.
- B. The contractor must have an approved set of permitted construction plans on site at all times.

3.7 PAVEMENT REMOVAL AND REPLACEMENT

- A. All pavement to be removed shall be cut along straight lines with the appropriate equipment.
- B. Pavement cuts shall be confined to a maximum trench bottom width as shown in the City of Raleigh Standard Details, plus six inches on either side.

3.8 VALVE OPERATIONS

- A. No valve in the existing system shall be operated without following the procedure outlined below. Failure to comply with these requirements shall be grounds for

suspension of pipe-laying operations until written assurance can be obtained from a company official that such noncompliance will not occur again. The contractor should be aware that the Owner regards violations of these requirements as justifying punitive measures.

B. Notification procedures are as follows:

1. The contractor shall notify the NCSU UD Shop in order to request the operation of any valves. At least twenty-four hours notice must be given to the Owner, and at least twenty-four hours notice must be given to each customer affected by a water cut-off. The contractor is responsible for notifying the affected customers. All valve operations shall be done by a NCSU UD Shop personnel for a particular project.
2. When calling the NCSU UD Shop as required prior to granting approval for operating the valves and dispatching a crew, the contractor shall provide the following:
 - a. Name of person calling;
 - b. Name of company;
 - c. Telephone number of company;
 - d. Location of valve and map number is available;
 - e. Reason for requesting operating and whether to be closed or open;
 - f. Time valve to be opened or closed, and
 - g. Approximate time water line to be out of service.
3. Each time a contractor needs a valve operated, he/she shall again secure permission, following the steps outlined.
4. System valves shall be defined as any valve, which has main pressure against either gate face. Newly installed tapping valves and control valves to networks not yet accepted for service are considered as system valves. Valves within a network still under construction are not considered as system valves.

3.9 CONSTRUCTION WATER

- A. The Contractor will coordinate with the Owner on the use construction water for their job site.

3.10 EXCAVATION

- A. Prior to any excavation or construction, the contractor shall locate all existing utilities in the field. If help is needed in locating utilities operated by the Owner, the contractor should contact the NCSU UD Shop.
- B. Trench width shall be a minimum of six inches plus outside diameter of pipe and a maximum of twenty-four inches plus outside diameter of pipe, unless OSHA requires additional trench width. Trench width shall be measured between the faces of the cut at the top elevation of the pipe bell as shown in the City of Raleigh Standard Details.

- C. Trench bottom conformation, where no special bedding is required, may be that referred to herein as flat bottom where the trench bottom is excavated slightly above grade and cut down to pipe grade by hand in the fine-grading operation. Where the trench bottom is inadvertently cut below grade, it shall be filled to grade with an approved material and thoroughly tamped compacted to 95% or use #67 stone to bring to grade.
- D. The maximum length of open trench shall be no more than three hundred feet, unless approval is obtained from the Owner.
- E. The contractor shall, at his/her own expense, keep all trenches free from water during the excavation for construction of foundations, masonry, water mains. The water shall be pumped out of the trench or build check dams to keep it out of the ditch in such a manner as not to cause injury to the public health, private property or the work in progress. Erosion control measures shall be taken during this pumping.
- F. In trenches where water is present or dewatering is required, the trench shall be stabilized with #67 stone. When the contractor encounters material during trench excavation, at the opinion of the inspector, or Owner, that is unsuitable (i.e. "muck"), this material shall be replaced with material that is considered suitable prior to the pipe laying operations. In this case, construction fabrics may be required to prevent the migration of side support away from the pipe.
- G. Safety and convenience of the public necessitate that all work, including excavation, be done in such a manner as to cause minimum traffic interruption, both pedestrian and vehicular. Utilities such as fire hydrants, valves, etc., shall be accessible at all times. Gutters and drains shall be left open and clear at all times, and the contractor shall be responsible for all drainage around his work. Unless specifically waived by the Owner, provisions shall be made to maintain vehicular traffic on all streets in which work is in progress, and suitable walkways shall be maintained for pedestrian travel.
- H. Sheet piling or bracing shall be used wherever necessary to prevent failure of the trench banks. All sheet piling shall conform to AASHTO and OSHA safety standards. The removal of sheet piling shall be done in such a manner as to minimize the loss of friction between the backfill and trench walls.

3.11 TRENCH PREPARATION

- A. Trench excavation is unclassified and shall conform to the line and depth shown on the plans. The trench shall be properly braced and drained so that workers may work therein safely and efficiently. When water is being pumped from the trench, the pump discharge shall follow natural drainage channels, drains or storm sewers. In discharging trench water, it will be necessary to follow standard erosion control measures so as to minimize erosion and sedimentation. In no case may trench water or groundwater be pumped into or allowed to enter the sanitary sewer system.
- B. The width of the trench may vary with the depth of cut and other conditions the trench shall be in accordance with the dimensions set forth by OSHA and other information shown in the City of Raleigh Standard Details.

- C. The foundations for ductile iron shall be a firm and stable flat bottom (Type 1) trench with bell holes so that the pipe rests uniformly on the entire barrel length. See the City of Raleigh Standard Details.
- D. Pipe clearance in rock shall be a minimum of six inches below and on each side of the pipe for sized sixteen inches and less in diameter. For sizes larger than sixteen inches in diameter, the minimum clearance shall be nine inches below and on each side.

3.12 PIPE INSTALLATION

- A. Ductile iron pipe shall be installed in accordance with the requirements of AWWA Standard C-600-87.
- B. Water pipe shall be laid to the line and grade shown on the plans with all valves and hydrants located as shown on the plans.
- C. Protection shall be afforded to all underground and surface structures using methods acceptable to the Public Utilities Director or Engineer. This protection shall be furnished by the contractor at the contractors' own expense.
- D. Deviation from line and grade may be made only on revised plans upon approval by Public Utilities Department and identified on "as built" when such deviations arise from grade or line conflicts with existing utilities, structures or other sources of conflict.
- E. Subsurface explorations shall be made by the contractor at the direction of the Owner or Engineer where it is necessary to determine the location of existing pipes, valves or other underground structures.
- F. Depth of pipe cover, unless shown otherwise on the plans shall be three feet. Depth of cover shall be measured from the established street grade or the surface of the permanent improvement to the top of the barrel of the pipe.
- G. After the foundation has been properly graded, bedded when applicable, and the bell holes dug, the pipe and accessories shall be carefully lowered into the trench by approved methods. Under no circumstances shall the pipe or accessories be dropped or dumped into the trench. All damaged pipe and accessories shall be removed from the job.
- H. Pipe shall be swabbed clean with sodium hypochlorite solution before it is laid, and any pipe which cannot be cleaned with a swab shall be removed and cleaned with suitable apparatus. Any pipe showing evidence of oil, tar or grease shall be permanently marked and removed from the job.
- I. Laying of pipe and jointing of pipe shall be done according to manufacturer's recommendation with care being taken to provide uniform bearing for the pipe. Bell and spigot of pipe shall be cleaned and properly lubricated where a mechanical joint of a "push on" type joint is employed. No chlorine powder or tablets shall be put in the lines during installation.

- J. Open ends of pipe shall be plugged with a standard plug or cap at all times when pipe laying is not in progress. Trench water shall not be permitted to enter pipe.
- K. Pipe cutting for inserting valves, fittings or closure pieces shall be done in a neat and workmanlike manner in accordance with the manufacturer's recommendations and without damage to the pipe.
- L. Bell ends will face the direction of laying unless otherwise directed by the Owner or Engineer. For lines on an appreciable slope, the Owner or Engineer may also require that bell ends face upgrade.
- M. Maximum horizontal deflections for ductile iron pipe shall be as follows for an eighteen foot joint of pipe:
 - 1. For a 6-inch diameter pipe, maximum joint deflection shall be 27 inches with a 19-inch push-on-joint.
 - 2. For an 8-inch diameter pipe, maximum joint deflection shall be 20 inches with a 19-inch push-on-joint.
 - 3. For a 10-inch diameter pipe, maximum joint deflection shall be 20 inches with a 19-inch push-on-joint.
 - 4. For a 12-inch diameter pipe, maximum joint deflection shall be 20 inches with a 19-inch push-on-joint.
- N. When installing a water main, the horizontal separation between water and sewer shall be ten feet. If this separation cannot be maintained due to existing conditions, the only variation allowed is the water main in a separate trench with the elevation of the water main at least 18 inches above the top of the sewer and must be approved by the Owner. All distances are measured from outside diameter to outside diameter.
- O. When a water main crosses over a sewer main, there must be eighteen inches of vertical separation. If the water main must go under the sewer main, both these lines must be of ductile iron for a distance of ten feet on either side of the crossing with a twelve-inch vertical separation. The crossing of other underground pipe requires a minimum of twelve inches of vertical separation. Any changes in these clearances must be approved by the Owner. All crossings within these vertical clearances shall be filled with #67 stone. All distances are measured from outside diameter to outside diameter.
- P. When a water line passes over or under a storm sewer, vertical separation of 18 inches shall be maintained unless both lines are of ductile iron or encased in concrete. A concrete pad shall be poured between the two. Distances are measured from outside diameter to outside diameter.
- Q. All water crossings under the state system roads shall be made in accordance with the requirements of the NCDOT "Standard Specification for Roads and Structures" and as defined in their encroachment permits.
- R. Where conditions are, in the opinion of the Owner or Engineer, unsuitable for laying pipe because of weather or trench conditions, the contractor shall be required to cease work until permission is given by the Owner or Engineer for work to commence again providing such conditions have been corrected.

S. Relation of a Water Main to Other Utilities

1. Underground telephone, cable TV, and gas utilities or conduit banks shall be crossed maintaining a minimum of 12- inch separation or clearance.
2. Crossing over electrical primary conductor shall maintain a minimum of 12 inches of undisturbed soil encasing the conductor. Wherever possible, electrical crossings shall be performed while the conductor is de-energized, and at all times in the presence of the service provider.

3.13 REACTION BLOCKING

- A. All fittings or components subject to hydrostatic thrust shall be securely anchored by the use of concrete thrust blocks poured in place, unless otherwise directed by the engineer. The reaction areas required for these thrust blocks shall be given to the contractor by the inspector, and the contractor shall install the blocks according to directions provided by the inspector. Where concrete must be reinforced, the contractor shall furnish such reinforcing as is required.
- B. Required reaction bearing areas will be taken from the schedule herein. Refer to the City of Raleigh Standard Details. Areas given are vertical plans measured in solid material normal to the thrust line of the fitting.
- C. Material for reaction blocking shall be transit-mixed concrete. This concrete shall have a twenty-eight day compressive strength of 2500 psi. Any metal used to resist thrust which is not encased in concrete shall be galvanized or otherwise treated for corrosion resistance or shall be painted as directed by the engineer.
- D. Valves on ductile iron lines shall be anchored with thrust collars as shown in the City of Raleigh Standard Details.

3.14 BACKFILLING PIPE (Ductile Iron)

- A. The backfilling of the trench after the pipe installation and testing shall be in accordance with the City of Raleigh Standard Details for ductile iron and plastic pipe. Ductile iron pipe shall be backfilled with suitable native material. No rocks, boulders or stone four inches or larger shall be included in the backfill for at least two feet above the top of the pipe.
- B. All backfill shall be compacted in six-inch lifts measured from the pipe foundation upward. Backfill for roadway shall be compacted to at least 95% of maximum soil density in those areas where the supporting capacity of the soil is of prime consideration. Laboratory determination of maximum soil density will follow the procedure of AASHTO T99-86. Field determination of the density of the soil in place shall follow the procedure of AASHTO T191-86 or T204-86. The result of any one test may be a minimum of 90% of maximum density, but the average of any three tests in an area shall be 95% of maximum density. The contractor shall then be required to submit satisfactory evidence that his ditch compaction meets the specifications.

- C. Deficiency of backfill material shall be supplied by the contractor where this deficiency results from any cause other than rejection of unsuitable backfill material (other than rock) by the Owner or Engineer. In cases where the Owner or Engineer directs, the contractor shall dispose of unsuitable backfill material and provide suitable backfill material. Where excavated material has been rendered unsuitable, either before or after excavation, by inclement weather or type of material, the contractor must correct the moisture or furnish replacement backfill material.
- D. When a ditch is flooded or the weather is unsuitable, the contractor shall not backfill unless permission is given by the Owner or Engineer. No backfilling with frozen material shall be allowed.

3.15 BACKFILLING PIPE (PVC)

- A. Backfilling of PVC pipe should be completed in accordance with ASTM F1668 and ASTM D2774.
- B. The trench bottom should be over excavated to permit placement of bedding materials when encountering rock, boulders or other materials that could damage the pipe due to point loading. Over excavate and place a minimum of 4" of bedding. The bedding should consist of an evenly graded, free flowing, granular material which is free of large stones and with particle sizes no larger than 1 ½" in size.
- C. All backfill shall be compacted in six-inch lifts measured from the pipe foundation upward. The first stage (haunching) should be placed in layers of no more than 6" at a time up to the springline of the pipe. Compact as directed. The second stage of initial backfill is again placed in no more than 6" layers from the springline to a point 12" above the top of the pipe. Both stages of initial backfill material shall be free of stones (1 ½" or larger) and debris. Attention should be given to assure that no voids remain between the pipe, trench bottom, and sides of trench.
- D. Backfill for roadway shall be compacted to at least 95% of maximum soil density in those areas where the supporting capacity of the soil is of prime consideration. Laboratory determination of maximum soil density will follow the procedure of AASHTO T99-86. Field determination of the density of the soil in place shall follow the procedure of AASHTO T191-86 or T204-86. The result of any one test may be a minimum of 90% of maximum density, but the average of any three tests in an area shall be 95% of maximum density. The contractor shall then be required to submit satisfactory evidence that his ditch compaction meets the specifications.
- E. Deficiency of backfill material shall be supplied by the contractor where this deficiency results from any cause other than rejection of unsuitable backfill material (other than rock) by the Owner or Engineer. In cases where the Owner or Engineer directs, the contractor shall dispose of unsuitable backfill material and provide suitable backfill material. Where excavated material has been rendered unsuitable, either before or after excavation, by inclement weather or type of material, the contractor must correct the moisture or furnish replacement backfill material.

- F. When a ditch is flooded or the weather is unsuitable, the contractor shall not backfill unless permission is given by the Owner or Engineer. No backfilling with frozen material shall be allowed.

3.16 SETTING VALVES AND VALVE BOXES

- A. Valves shall be set at locations shown on the plans with care being taken to support the valve properly and to accurately position the valve box over the operating nut of the valve. Where pavement is existing, the box shall be adjusted to finished street grade as shown in Detail W-17. When valves are located in street rights-of-way, but out of pavement, the boxes shall be adjusted to finished grade and a concrete pad two-feet square and six-inches thick shall be poured around the box one-half inch from the top. When valves are located outside of street rights-of-way, the boxes shall be at finish grade, and a concrete block two-feet square and six-inches thick shall be poured around the box at grade line.
- B. When a tapping sleeve and valve are being used, the valve, sleeve and machine assembly shall be air tested to hold at 150 psi for five-minute duration in the presence of the inspector prior to drilling or tapping the main. The valve shall be in the closed position during the testing.

3.17 SETTING FITTINGS

- A. Fittings shall be set at locations shown on the plans with care being taken to properly "bell-up" joints and support the body of the fitting. All dead-end lines shall be plugged with mechanical joint plugs or caps and anchored by using thrust collars and blocking as shown in the City of Raleigh Standard Details.

3.18 SETTING HYDRANTS

- A. Specific directions are required for the setting of all hydrants. In streets where paving is proposed in the near future, the contractor will be given line and grade stakes for hydrants. It is mandatory for the contractor to preserve these stakes for the inspector to verify that the hydrant was set correctly and had this fact verified by the inspector. In areas where paving is not anticipated in the near future, hydrants shall be set according to the inspector's directions. In general, hydrants shall be located in a manner to provide complete accessibility and minimize possibility of damage from vehicles or injury to pedestrians.
- B. Hydrant installation shall be as shown in the City of Raleigh Standard Details and will be rodded from the main to the hydrant, with one coupler. If the distance is greater than one coupling the hydrant is rodded to the thrust blocker. When hydrants are used as blow-off assemblies, the valves will be rodded to the thrust blockers. Restraining rods shall be hot dipped galvanized.
- C. Before a hydrant is set, all dirt and foreign matter shall be removed from the interior of the hydrant.

3.19 SURFACE RESTORATION

- A. All disturbed surfaces and property thereon, shall be restored to a condition equal to that existing before construction began, and the contractor shall maintain and be responsible for all ditches in paved streets, curbs, gutters or sidewalks until the contractor repaves the trench cuts. The contractor, with permission of the inspector, may place temporary or permanent asphaltic material in the cut.

3.20 EROSION CONTROL

- A. Erosion control measures shall be performed by the contractor, conforming to the requirements of, and in accordance with plans approved by the State of North Carolina Department of Environment Quality, North Carolina Sedimentation Control Commission, and as per the erosion control plan portion of the construction drawings and these specifications. The sedimentation and erosion control plan and permit shall remain on site at all times. The contractor shall not allow mud and debris to accumulate in the streets. Should the contractor pump water from trenches during construction, appropriate siltation preventative measures shall be taken prior to the entry into any storm drain or stream. All measures must be taken so that stormwater runoff does not go to the pipes or manholes of the utility system. All materials used for erosion control shall be approved by the Engineer prior to installation by the contractor.

3.21 GENERAL WATER MAIN TESTING SEQUENCE

- A. Water mains shall be tested in the following general sequence:
 - 1. "Pigging" main (mains with gate valves)
 - 2. Flush the main;
 - 3. Perform the hydrostatic tests;
 - 4. Introduce the appropriate amount of chlorine by tapping the main;
 - 5. Hold the chlorine solution in the main for at least twenty-four hours and no more than seventy-two hours;
 - 6. Flush the main; and
 - 7. Sample for the bacteriological tests.

3.22 PIGGING

- A. All new mains with gate valves must be pigged with a polyethylene "pig", 5#/cubic foot density at the conclusion of installation.
- B. The Contractor shall install a temporary blow off at one end of the 12" main in order to blow the pig.

3.23 HYDROSTATIC TESTS

- A. All main installations including private distribution and fire lines to the buildings shall be pressure tested between each main line valve in accordance with AWWA C-600-87.

The test shall be performed using a suitable pump and an accurate pressure gauge. Immediately upon completion of a section of main, 150 psi (± 5 psi) of pressure shall be applied and held for two hours. The acceptable leakage rate shall not exceed .092 gallons per inch of pipe diameter per 1,000 feet of pipe per hour. Failure of the water main to comply with the above acceptable leakage rate, shall require the contractor to replace any defective materials to insure a watertight installation. After any inadequacies have been corrected, the leakage rate will again be tested. This test shall be repeated until that portion of main is brought to compliance with the permissible leakage rate.

- B. One hydrostatic test will be completed prior to placement of backfill. A second hydrostatic test will be completed after backfill is complete for the PVC piping.
- C. Pre-requisite conditions for inspection prior to testing shall be as follows:
 - 1. Hydrants shall be properly located, operable, plumb and at correct elevation.
 - 2. Valves shall be properly located, operable and at correct elevation. Valve boxes or manholes shall be centered over operating nuts, and the top of the box or manhole shall be at proper elevation.
 - 3. Lines shall be properly vented where entrapped air is a consideration.

3.24 CHLORINATION

- A. All additions or replacements to the water system, including fire lines and backflow prevention devices, shall be chlorinated before being placed in service. Such chlorination must take place under the supervision of an inspector.
- B. Pipe subjected to contaminating materials shall be treated as directed by the Owner or Engineer. Should such treatment fail to cleanse the pipe, replacement shall be required. The Owner shall bear no portion of any cost sustained by the contractor in meeting this specification.
- C. Chlorination of a completed line shall be carried out after completing the pressure test and in the following manner.
 - 1. Taps will be made at the control valve at the upstream end of the line and at all extremities of the line including valves. These taps shall be located in such a manner as to allow HTH solution to be fed into all parts of the line.
 - 2. A solution of water containing high test hypochlorite (70%) available chlorine or chlorine gas solution shall be introduced into the line by regulated pumping at the control valve tap. The solution shall be of such a concentration that the line shall have a uniform concentration of 50 ppm total chlorine immediately after chlorination. The chart below shows the required quantity of 70% HTH compound to be contained in solution in each 1000-foot section of line to produce the desired concentration of 50 ppm.
 - a. 6-Inch Diameter Pipe: 0.88 pounds of high test hypochlorite (70%) per 1000 feet of line.
 - b. 8-Inch Diameter Pipe: 1.56 pounds of high test hypochlorite (70%) per 1000 feet of line.

- c. 10-Inch Diameter Pipe: 2.42 pounds of high test hypochlorite (70%) per 1000 feet of line.
 - d. 12-Inch Diameter Pipe: 3.50 pounds of high test hypochlorite (70%) per 1000 feet of line.
- 3. The HTH solution shall be circulated in the main opening the control valve and systematically manipulating hydrants and taps at the line extremities. The HTH solution must be pumped in at a constant rate for each discharge rate in order that a uniform concentration will be produced in the mains.
- 4. Services shall be sterilized by methods acceptable to the Owner or Engineer, and the contractor shall have the same responsibility for laterals as for mains in regard to bearing full cost of any corrective measures needed to comply with bacteriological or other requirements.
- 5. HTH solution shall remain in lines for no less than twenty-four hours, unless otherwise directed by the Owner or Engineer.
- 6. Extreme care will be exercised at all times to prevent the HTH solution from entering existing mains.

3.25 BACTERIOLOGICAL SAMPLING

- A. Free residual chlorine after twenty-four hours shall be at least 10 ppm, or the Owner or Engineer will require the lines be re-chlorinated.
- B. Mains will be flushed with a blow-off assembly of sufficient size to effectively clean the main. Flushing of lines may proceed after twenty-four hours, provided the free residual chlorine analysis is satisfactory. Flushing shall be continued until chlorine returns to normal level. In times of water shortages or distribution main problems, the flushing operation may be delayed. The Owner shall determine when flushing is allowable. The contractor shall advise the inspector prior to the chlorination and flushing so that the inspector can advise the Owner of the construction location, size and length of mains. All tests will be done in the presence of an inspector. Flushing will be for short duration. Sufficient precautions must be taken to the satisfaction of the inspector to ensure that the impact of the water is absorbed and the water is conveyed without erosion or property drainage.
- C. After flushing is completed, the Contractor shall collect samples for turbidity and bacteriological analysis for each section of pipe between main line valves. A custody seal shall be placed on each set of turbidity and bacteriological bottles. A chain of custody form must be completed for sample set(s) collected and must be delivered along with the sample(s). A turbidity test will be done. If the turbidity exceeds 1 NTU, the sample fails and a bacteriological test will not be set up.
- D. In the event that two successive bacteriologic tests fail, that section of the main shall be re-chlorinated by the contractor and new tests performed prior to moving to the next section of main.

3.26 SERVICE CONNECTIONS

- A. Taps shall be made only on a line under pressure and after the main has been tested and chlorinated. No taps on dry lines shall be allowed, unless specific authorization from the engineer is obtained.
- B. Services larger than two inches shall be made by using a tapping sleeve and valve. The service line from the main shall be:
 - 1. 4-inch D.I. for 4-inch services;
 - 2. 6-inch D.I. for 6-inch services; and
 - 3. 8-inch D.I. for 8-inch services.
 - 4. The typical tapping sleeve and valve is shown in the City of Raleigh Standard Details.
- C. Before any water services are installed, the main shall be thoroughly flushed using a flow velocity sufficient to scour the pipe interior.

3.27 SEALED AS BUILT PLANS

- A. Certified surveyed “As Built” plans and profiles, sealed by a Professional Land Surveyor, shall be furnished to the Engineer upon completion and acceptance of the public main by the Owner and completion of private systems. The surveyed “as built” plans shall have North Carolina Geodetic Survey grid coordinates to all meter boxes, valves, manholes, and mains along with the depth information. The water permit number information must also be included. Surveyed “as built” plans of installed utilities shall be furnished to the Owner prior to the issuance of the letter of acceptance. All service stubs shall be shown on the surveyed “as built” plans.
- B. Certified surveyed “As Built” shall be provided in a digital format. The digital file of utilities needs to show the overall water and sewer system layout along with the property or subdivision boundaries and connecting manhole. The water distribution system drawings should show mains sizes, material, hydrants, valves, blow-off assemblies, and any other relevant information (backflow preventers, air release valves, etc.). The digital file should be delivered in DXF format. If this is not possible, then, DWG, DGN, and SHP are also acceptable formats.

3.28 GENERAL ACCEPTANCE

- A. The Contractor or his representative must notify the Owner, in writing, before installation and for scheduling inspection. Once the project is complete a punch list and inspection is scheduled noting any deficient items. Once the deficient items are repaired and/or replaced to meet Owner standards and specifications, the developer or his/her representative shall submit the following items to the Owner.
 - 1. A professional engineer’s certified statement of the cost of the public utilities installed.
 - 2. A professional engineer’s certified statement indicating that the work has been built in accordance with the approved set of construction plans.
 - 3. A release of liens statement from the owner/developer stating that all materials and workmanship associated with the water main has been paid in full.

4. A certified surveyed “As Built” plans and profile shall be furnished by the engineer upon completion and acceptance by the Owner as stated above.
5. The developer is responsible for ensuring a one-year written warranty to the Owner prior to issuance of the letter of acceptance.
6. The engineer shall keep a copy of the “as-built” plans on file indefinitely.

END OF SECTION 22 1113

SECTION 33 1313 - SITE SANITARY SEWERS

PART 1 - GENERAL

1.1 COMPLIANCE

- A. All work associated with the sanitary sewer system is to be completed in accordance with the City of Raleigh Standards and Specifications.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

- A. Section Includes:
 - 1. Ductile-iron, gravity sewer pipe and fittings.
 - 2. PVC pipe and fittings.
 - 3. Cleanouts.
 - 4. Manholes.
 - 5. Concrete.

1.4 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Pipe and fittings.
 - 2. Cleanouts.
- B. Shop Drawings: For manholes. Include plans, elevations, sections, details, and frames and covers.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings:
 - 1. Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from sewer system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.
 - 2. Show system piping in profile. Draw profiles to horizontal scale of not less than 1 inch equals 50 feet and to vertical scale of not less than 1 inch equals 5 feet.

Indicate manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing system piping.

- B. Product Certificates: For each type of pipe and fitting.
- C. Field quality-control reports.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Do not store plastic manholes, pipe, and fittings in direct sunlight.
- B. Protect pipe, pipe fittings, and seals from dirt and damage.
- C. Handle manholes according to manufacturer's written rigging instructions.

1.7 FIELD CONDITIONS

- A. Interruption of Existing Sanitary Sewerage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
 - 1. Notify Architect and Construction Manager no fewer than two days in advance of proposed interruption of service.
 - 2. Do not proceed with interruption of service without Architect's and Construction Manager's written permission.

PART 2 - PRODUCTS

2.1 DUCTILE-IRON, GRAVITY SEWER PIPE AND FITTINGS

- A. Pipe: ASTM C150 and C151.
- B. Standard Fittings: AWWA C110/A21.10, ductile or gray iron, for push-on joints.
- C. Compact Fittings: AWWA C153/A21.53, ductile iron, for push-on joints.
- D. Gaskets: AWWA C111/A21.11, rubber.
- E. For 10-inch diameter and smaller gravity sewer mains, pipe lining shall be cement mortar with a seal coat of bituminous material, all in accordance with AWWA C104.

2.2 PVC PIPE AND FITTINGS

- A. PVC Cellular-Core Sewer Piping:
 - 1. Pipe: ASTM F891, Sewer and Drain Series, PS 50 minimum stiffness, PVC cellular-core pipe with plain ends for solvent-cemented joints.

2. Fittings: ASTM D3034, SDR 35, PVC socket-type fittings.

B. PVC Profile Sewer Piping:

1. Pipe: ASTM F794, PVC profile, gravity sewer pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: ASTM D3034, PVC with bell ends.
3. Gaskets: ASTM F477, elastomeric seals.

C. PVC Gravity Sewer Piping:

1. Pipe and Fittings: ASTM F679, T-1 wall thickness, PVC gravity sewer pipe with bell-and-spigot ends and with integral ASTM F477, elastomeric seals for gasketed joints.

2.3 CLEANOUTS

A. Cast-Iron Cleanouts:

1. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
2. Top-Loading Classification(s): Heavy Duty.
3. Sewer Pipe Fitting and Riser to Cleanout: ASTM A74, Service class, cast-iron soil pipe and fittings.

B. PVC Cleanouts:

1. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

2.4 MANHOLES

A. Standard Precast Concrete Manholes:

1. Description: ASTM C478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
2. Diameter: 48 inches minimum unless otherwise indicated.
3. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
4. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section; with separate base slab or base section with integral floor.
5. Riser Sections: 4-inch minimum thickness, of length to provide depth indicated.
6. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated; with top of cone of size that matches grade rings.
7. Joint Sealant: ASTM C990, bitumen or butyl rubber.
8. Resilient Pipe Connectors: ASTM C923, cast or fitted into manhole walls, for each pipe connection.

9. Steps: Individual FRP steps or FRP ladder; wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches.
10. Adjusting Rings: Interlocking HDPE rings, with level or sloped edge in thickness and diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
11. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, with diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope.

B. Manhole Frames and Covers:

1. Description: Ferrous; 24-inch ID by 7- to 9-inch riser, with 4-inch-minimum-width flange and 26-inch-diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "SANITARY SEWER."
2. Material: ASTM A48/A48M, Class 35 gray iron unless otherwise indicated.

2.5 CONCRETE

A. General: Cast-in-place concrete complying with ACI 318, ACI 350, and the following:

1. Cement: ASTM C150/C150M, Type II.
2. Fine Aggregate: ASTM C33/C33M, sand.
3. Coarse Aggregate: ASTM C33/C33M, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A1064/A1064M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A615/A615M, Grade 60 deformed steel.

C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.

1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
 - a. Invert Slope: 2 percent through manhole.
2. Benches: Concrete, sloped to drain into channel.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Section 31 20 00 "Earth Moving."

3.2 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawing plans and details to indicate general location and arrangement of underground sanitary sewer piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.
- C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.
- D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.
- F. Install gravity-flow, non-pressure, drainage piping according to the following:
 - 1. Install piping pitched down in direction of flow, at minimum slope of **1** percent unless otherwise indicated.
 - 2. Install piping with 48-inch minimum cover.
 - 3. Install ductile-iron, gravity sewer piping according to ASTM A746.
 - 4. Install PVC cellular-core sewer piping according to ASTM D2321 and ASTM F1668.
 - 5. Install PVC profile sewer piping according to ASTM D2321 and ASTM F1668.
 - 6. Install PVC gravity sewer piping according to ASTM D2321 and ASTM F1668.
- G. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

3.3 PIPE JOINT CONSTRUCTION

- A. Join gravity-flow, non-pressure, drainage piping according to the following:

1. Join ductile-iron, gravity sewer piping according to AWWA C600 for push-on joints.
2. Join PVC cellular-core sewer piping according to ASTM D2321 and ASTM F891 for solvent-cemented joints.
3. Join PVC profile sewer piping according to ASTM D2321 for elastomeric-seal joints or ASTM F794 for gasketed joints.
4. Join PVC gravity sewer piping according to ASTM D2321 and ASTM D3034 for elastomeric-seal joints or ASTM D3034 for elastomeric-gasket joints.

3.4 MANHOLE INSTALLATION

- A. General: Install manholes complete with appurtenances and accessories indicated.
- B. Install precast concrete manhole sections with sealants according to ASTM C891.
- C. Form continuous concrete channels and benches between inlets and outlet.
- D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches above finished surface elsewhere unless otherwise indicated.
- E. Install manhole-cover inserts in frame and immediately below cover.

3.5 CONCRETE PLACEMENT

- A. Place cast-in-place concrete according to ACI 318.

3.6 CLEANOUT INSTALLATION

- A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts, and use cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
 1. Use Heavy-Duty, top-loading classification cleanouts in all areas.
- B. Set cleanout frames and covers in earth in cast-in-place-concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding grade.
- C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.7 CONNECTIONS

- A. Connect non-pressure, gravity-flow drainage piping to building's sanitary building drains specified in Section 221316 "Sanitary Waste and Vent Piping."

- B. Connect force-main piping to building's sanitary force mains specified in Section 221316 "Sanitary Waste and Vent Piping." Terminate piping where indicated.
- C. Make connections to existing piping and underground manholes.
 - 1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye fitting plus 6-inch overlap with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
 - 2. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
 - 3. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

3.8 CLOSING ABANDONED SANITARY SEWER SYSTEMS

- A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:
 - 1. Close open ends of piping with at least 8-inch-thick, brick masonry bulkheads.
 - 2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.
- B. Abandoned Manholes: Excavate around manhole as required and use either procedure below:
 - 1. Remove manhole and close open ends of remaining piping.
 - 2. Remove top of manhole down to at least 36 inches below final grade. Fill to within 12 inches of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.
- C. Backfill to grade according to Section 312000 "Earth Moving."

3.9 IDENTIFICATION

- A. Comply with requirements in Section 312000 "Earth Moving" for underground utility identification devices. Arrange for installation of green warning tapes directly over piping and at outside edges of underground manholes.
 - 1. Use warning tape or detectable warning tape over ferrous piping.
 - 2. Use detectable warning tape over nonferrous piping and over edges of underground manholes.

3.10 FIELD QUALITY CONTROL

- A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
 1. Submit separate report for each system inspection.
 2. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
 - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
 - c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
 - d. Infiltration: Water leakage into piping.
 - e. Exfiltration: Water leakage from or around piping.
 3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
 4. Reinspect and repeat procedure until results are satisfactory.
- B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
 1. Do not enclose, cover, or put into service before inspection and approval.
 2. Test completed piping systems according to requirements of authorities having jurisdiction.
 3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
 4. Submit separate report for each test.
 5. Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:
 - a. Fill sewer piping with water. Test with pressure of at least 10-foot head of water, and maintain such pressure without leakage for at least 15 minutes.
 - b. Close openings in system and fill with water.
 - c. Purge air and refill with water.
 - d. Disconnect water supply.
 - e. Test and inspect joints for leaks.
 6. Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
 - a. Test plastic gravity sewer piping according to ASTM F1417.
 - b. Test concrete gravity sewer piping according to ASTM C1628.
 7. Manholes: Perform hydraulic test according to ASTM C969.
- C. Leaks and loss in test pressure constitute defects that must be repaired.
- D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.11 CLEANING

- A. Clean dirt and superfluous material from interior of piping. Flush with potable water.

END OF SECTION 22 1313

SECTION 33 4200 - STORMWATER CONVEYANCE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Pipe and fittings.
 - 2. Cleanouts.
 - 3. Drains.
 - 4. Manholes.
 - 5. Catch basins.
 - 6. Stormwater inlets.
 - 7. Pipe outlets.

1.3 ACTION SUBMITTALS

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

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Do not store plastic manholes, pipe, and fittings in direct sunlight.
- B. Protect pipe, pipe fittings, and seals from dirt and damage.
- C. Handle manholes according to manufacturer's written rigging instructions.
- D. Handle stormwater inlets according to manufacturer's written rigging instructions.

1.5 PROJECT CONDITIONS

- A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
 - 1. Notify Architect no fewer than two days in advance of proposed interruption of service.
 - 2. Do not proceed with interruption of service without Architect's written permission.

PART 2 - PRODUCTS

2.1 PE PIPE AND FITTINGS

- A. Corrugated PE Drainage Pipe and Fittings NPS 3 to NPS 10: AASHTO M 252M, Type S, with smooth waterway for coupling joints.
 - 1. Silt-tight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with tube and fittings.
 - 2. Soil-tight Couplings: AASHTO M 252M, corrugated, matching tube and fittings.
- B. Corrugated PE Pipe and Fittings NPS 12 to NPS 60: AASHTO M 294M, Type S, with smooth waterway for coupling joints.
 - 1. Silt-tight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with pipe and fittings.
 - 2. Soil-tight Couplings: AASHTO M 294M, corrugated, matching pipe and fittings.

2.2 PVC PIPE AND FITTINGS

- A. PVC Cellular-Core Piping:
 - 1. PVC Cellular-Core Pipe and Fittings: ASTM F 891, Sewer and Drain Series, PS 50 minimum stiffness, PVC cellular-core pipe with plain ends for solvent-cemented joints.
 - 2. Fittings: ASTM D 3034, SDR 35, PVC socket-type fittings.
- B. PVC Corrugated Sewer Piping:
 - 1. Pipe: ASTM F 949, PVC, corrugated pipe with bell-and-spigot ends for gasketed joints.
 - 2. Fittings: ASTM F 949, PVC molded or fabricated, socket type.
 - 3. Gaskets: ASTM F 477, elastomeric seals.
- C. PVC Profile Sewer Piping:
 - 1. Pipe: ASTM F 794, PVC profile, gravity sewer pipe with bell-and-spigot ends for gasketed joints.
 - 2. Fittings: ASTM D 3034, PVC with bell ends.
 - 3. Gaskets: ASTM F 477, elastomeric seals.
- D. PVC Type PSM Sewer Piping:
 - 1. Pipe: ASTM D 3034, SDR 35, PVC Type PSM sewer pipe with bell-and-spigot ends for gasketed joints.
 - 2. Fittings: ASTM D 3034, PVC with bell ends.
 - 3. Gaskets: ASTM F 477, elastomeric seals.
- E. PVC Gravity Sewer Piping:

1. Pipe and Fittings: ASTM F 679, T-1 or T-2 wall thickness, PVC gravity sewer pipe with bell-and-spigot ends and with integral ASTM F 477, elastomeric seals for gasketed joints.

F. Adhesive Primer: ASTM F 656.

G. Solvent Cement: ASTM D 2564.

2.3 CONCRETE PIPE AND FITTINGS

A. Reinforced-Concrete Sewer Pipe and Fittings: ASTM C 76.

1. Bell-and-spigot or tongue-and-groove ends and sealant joints with ASTM C 990, bitumen or butyl-rubber sealant
2. Class III.

2.4 CLEANOUTS

A. Cast-Iron Cleanouts:

1. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
2. Top-Loading Classification(s): Heavy Duty.
3. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.

B. PVC Cleanouts:

1. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

2.5 DRAINS

A. Cast-Iron Area Drains:

1. Description: ASME A112.6.3 gray-iron round body with anchor flange and round secured grate. Include bottom outlet with inside calk or spigot connection, of sizes indicated.
2. Top-Loading Classification(s): Heavy Duty.

2.6 MANHOLES

A. Standard Precast Concrete Manholes:

1. Description: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.

2. Diameter: 48 inches minimum unless otherwise indicated.
3. Ballast: Increase thickness of precast concrete sections or add concrete to base section as required to prevent flotation.
4. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
5. Riser Sections: 4-inch minimum thickness, and lengths to provide depth indicated.
6. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated, and top of cone of size that matches grade rings.
7. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
8. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.
9. Steps: Individual FRP steps or FRP ladder, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches.
10. Adjusting Rings: Interlocking HDPE rings with level or sloped edge in thickness and diameter matching manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
11. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover, and height as required to adjust manhole frame and cover to indicated elevation and slope.

B. Manhole Frames and Covers:

1. Description: Ferrous; 24-inch ID by 7- to 9-inch riser with 4-inch-minimum width flange and 26-inch-diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."
2. Material: ASTM A 536, Grade 60-40-18 ductile iron unless otherwise indicated.

2.7 CONCRETE

A. General: Cast-in-place concrete according to ACI 318, ACI 350/350R, and the following:

1. Cement: ASTM C 150, Type II.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

- C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.
 - 1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
 - a. Invert Slope: 1 percent through manhole.
 - 2. Benches: Concrete, sloped to drain into channel.
 - a. Slope: 4 percent.
- D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water/cementitious materials ratio.
 - 1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
 - 2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

2.8 CATCH BASINS

- A. Standard Precast Concrete Catch Basins:
 - 1. Description: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
 - 2. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
 - 3. Riser Sections: 4-inch minimum thickness, 48-inch diameter, and lengths to provide depth indicated.
 - 4. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
 - 5. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
 - 6. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and shape matching catch basin frame and grate. Include sealant recommended by ring manufacturer.
 - 7. Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch total thickness, that match 24-inch-diameter frame and grate.
 - 8. Steps: Individual FRP steps or FRP ladder, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of catch basin to finished grade is less than 60 inches.
 - 9. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.
- B. Frames and Grates: ASTM A 536, Grade 60-40-18, ductile iron designed for A-16, structural loading. Include flat grate with small square or short-slotted drainage openings.

1. Size: 24 by 24 inches minimum unless otherwise indicated.
 2. Grate Free Area: Approximately 50 percent unless otherwise indicated.
- C. Frames and Grates: ASTM A 536, Grade 60-40-18, ductile iron designed for A-16, structural loading. Include 24-inch ID by 7- to 9-inch riser with 4-inch minimum width flange, and 26-inch- diameter flat grate with small square or short-slotted drainage openings.
1. Grate Free Area: Approximately 50 percent unless otherwise indicated.

2.9 PIPE OUTLETS

- A. Head Walls: Cast-in-place reinforced concrete, with apron and tapered sides.
- B. Riprap Basins: Broken, irregularly sized and shaped, graded stone according to NSSGA's "Quarried Stone for Erosion and Sediment Control."
1. Average Size: NSSGA No. R-3, screen opening 2 inches.
 2. Average Size: NSSGA No. R-4, screen opening 3 inches.
 3. Average Size: NSSGA No. R-5, screen opening 5 inches.
- C. Filter Stone: According to NSSGA's "Quarried Stone for Erosion and Sediment Control," No. FS-2, No. 4 screen opening, average-size graded stone.
- D. Energy Dissipaters: According to NSSGA's "Quarried Stone for Erosion and Sediment Control," No. A-1, 3-ton average weight armor stone, unless otherwise indicated.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavation, trenching, and backfilling are specified in Section 312000 "Earth Moving."

3.2 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
- C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

- D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.
- F. Install gravity-flow, non-pressure drainage piping according to the following:
 - 1. Install piping pitched down in direction of flow.
 - 2. Install piping NPS 6 and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place concrete supports or anchors.
 - 3. Install piping with 36-inch minimum cover.
 - 4. Install PE corrugated sewer piping according to ASTM D 2321.
 - 5. Install PVC cellular-core piping according to ASTM D 2321 and ASTM F 1668.
 - 6. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.
 - 7. Install PVC profile gravity sewer piping according to ASTM D 2321 and ASTM F 1668.
 - 8. Install reinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."

3.3 PIPE JOINT CONSTRUCTION

- A. Join gravity-flow, non-pressure drainage piping according to the following:
 - 1. Join corrugated PE piping according to ASTM D 3212 for push-on joints.
 - 2. Join PVC cellular-core piping according to ASTM D 2321 and ASTM F 891 for solvent-cemented joints.
 - 3. Join PVC corrugated sewer piping according to ASTM D 2321 for elastomeric-seal joints.
 - 4. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasketed joints.
 - 5. Join PVC profile gravity sewer piping according to ASTM D 2321 for elastomeric-seal joints or ASTM F 794 for gasketed joints.
 - 6. Join reinforced-concrete sewer piping according to ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.

3.4 CLEANOUT INSTALLATION

- A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
 - 1. Use Heavy-Duty, top-loading classification cleanouts in all areas.
- B. Set cleanout frames and covers in earth in cast-in-place concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding earth grade.

- C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.5 MANHOLE INSTALLATION

- A. General: Install manholes, complete with appurtenances and accessories indicated.
- B. Install precast concrete manhole sections with sealants according to ASTM C 891.
- C. Where specific manhole construction is not indicated, follow manhole manufacturer's written instructions.
- D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches above finished surface elsewhere unless otherwise indicated.

3.6 CATCH BASIN INSTALLATION

- A. Construct catch basins to sizes and shapes indicated.
- B. Set frames and grates to elevations indicated.

3.7 STORMWATER OUTLET INSTALLATION

- A. Construct inlet head walls, aprons, and sides of reinforced concrete, as indicated.
- B. Construct riprap of broken stone, as indicated.
- C. Install outlets that spill onto grade, anchored with concrete, where indicated.
- D. Install outlets that spill onto grade, with flared end sections that match pipe, where indicated.
- E. Construct energy dissipaters at outlets, as indicated.

3.8 CONCRETE PLACEMENT

- A. Place cast-in-place concrete according to ACI 318.

3.9 CONNECTIONS

- A. Connect non-pressure, gravity-flow drainage piping in building's storm building drains specified in Section 221413 "Facility Storm Drainage Piping."
- B. Connect force-main piping to building's storm drainage force mains specified in Section 221413 "Facility Storm Drainage Piping." Terminate piping where indicated.

C. Make connections to existing piping and underground manholes.

1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch overlap, with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
2. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
3. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

3.10 IDENTIFICATION

A. Materials and their installation are specified in Section 312000 "Earth Moving." Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.

1. Use warning tape or detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.11 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.

1. Submit separate reports for each system inspection.
2. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
 - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
 - c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
 - d. Infiltration: Water leakage into piping.
 - e. Exfiltration: Water leakage from or around piping.
3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Re-inspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.

2. Test completed piping systems according to requirements of authorities having jurisdiction.
 3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
 4. Submit separate report for each test.
 5. Gravity-Flow Storm Drainage Piping: Test according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
 - a. Exception: Piping with soil-tight joints unless required by authorities having jurisdiction.
 - b. Option: Test plastic piping according to ASTM F 1417.
 - c. Option: Test concrete piping according to ASTM C 924.
- C. Leaks and loss in test pressure constitute defects that must be repaired.
- D. Replace leaking piping using new materials and repeat testing until leakage is within allowances specified.

3.12 CLEANING

- A. Clean interior of piping of dirt and superfluous materials. Flush with water.

END OF SECTION 33 4200

SECTION 33 4600 - SUBDRAINAGE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Perforated-wall pipe and fittings.
 - 2. Geotextile filter fabrics.

1.3 ACTION SUBMITTALS

- A. Product Data:
 - 1. Drainage conduits, including rated capacities.
 - 2. Geotextile filter fabrics.

PART 2 - PRODUCTS

2.1 PERFORATED-WALL PIPES AND FITTINGS

- A. Perforated PE Pipe and Fittings:
 - 1. NPS 6 and Smaller: ASTM F 405 or AASHTO M 252, Type CP; corrugated, for coupled joints.
 - 2. NPS 8 and Larger: ASTM F 667; AASHTO M 252, Type CP; or AASHTO M 294, Type CP; corrugated; for coupled joints.
 - 3. Couplings: Manufacturer's standard, band type.

2.2 SOIL MATERIALS

- A. Soil materials are specified in Section 312000 "Earth Moving."

2.3 GEOTEXTILE FILTER FABRICS

- A. Description: Fabric of PP or polyester fibers or combination of both, with flow rate range from 110 to 330 gpm/sq. ft. when tested according to ASTM D 4491.
- B. Structure Type: Nonwoven, needle-punched continuous filament.
 - 1. Survivability: AASHTO M 288 Class 2.
 - 2. Styles: Flat and sock.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces and areas for suitable conditions where subdrainage systems are to be installed.
- B. If subdrainage is required for landscaping, locate and mark existing utilities, underground structures, and aboveground obstructions before beginning installation and avoid disruption and damage of services.
- C. Verify that drainage panels installed as part of foundation wall waterproofing is properly positioned to drain into subdrainage system.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Section 312000 "Earth Moving."

3.3 FOUNDATION DRAINAGE INSTALLATION

- A. Place impervious fill material on subgrade adjacent to bottom of footing after concrete footing forms have been removed. Place and compact impervious fill to dimensions indicated, but not less than 6 inches deep and 12 inches wide.
- B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.
- C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches.
- D. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with adhesive or tape.
- E. Install drainage piping as indicated in Part 3 "Piping Installation" Article for foundation subdrainage.

- F. Add drainage course to width of at least 6 inches on side away from wall and to top of pipe to perform tests.
- G. After satisfactory testing, cover drainage piping to width of at least 6 inches on side away from footing and above top of pipe to within 12 inches of finish grade.
- H. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.
- I. Place layer of flat-style geotextile filter fabric over top of drainage course, overlapping edges at least 4 inches.
- J. Place backfill material over compacted drainage course. Place material in loose-depth layers not exceeding 6 inches. Thoroughly compact each layer. Final backfill to finish elevations and slope away from building.

3.4 UNDERSLAB DRAINAGE INSTALLATION

- A. Excavate for underslab drainage system after subgrade material has been compacted but before drainage course has been placed. Include horizontal distance of at least 6 inches between drainage pipe and trench walls. Grade bottom of trench excavations to required slope, and compact to firm, solid bed for drainage system.
- B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.
- C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches.
- D. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with adhesive or tape.
- E. Add drainage course to width of at least 6 inches on side away from wall and to top of pipe to perform tests.
- F. After satisfactory testing, cover drainage piping with drainage course to elevation of bottom of slab, and compact and wrap top of drainage course with flat-style geotextile filter fabric.

3.5 RETAINING-WALL DRAINAGE INSTALLATION

- A. Lay flat-style geotextile filter fabric in trench and overlap trench sides.
- B. Place supporting layer of drainage course over compacted subgrade to compacted depth of not less than 4 inches.
- C. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with adhesive or tape.
- D. Add drainage course to width of at least 6 inches on side away from wall and to top of pipe to perform tests.

- E. After satisfactory testing, cover drainage piping to width of at least 6 inches on side away from footing and above top of pipe to within 12 inches of finish grade.
- F. Place drainage course in layers not exceeding 3 inches in loose depth; compact each layer placed and wrap top of drainage course with flat-style geotextile filter fabric.
- G. Place layer of flat-style geotextile filter fabric over top of drainage course, overlapping edges at least 4 inches.
- H. Fill to Grade: Place satisfactory soil fill material over compacted drainage course. Place material in loose-depth layers not exceeding 6 inches. Thoroughly compact each layer. Fill to finish grade.

3.6 LANDSCAPING DRAINAGE INSTALLATION

- A. Provide trench width to allow installation of drainage conduit. Grade bottom of trench excavations to required slope, and compact to firm, solid bed for drainage system.
- B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.
- C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches.
- D. After satisfactory testing, cover drainage conduit to within 12 inches of finish grade.
- E. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.
- F. Place layer of flat-style geotextile filter fabric over top of drainage course, overlapping edges at least 4 inches.
- G. Fill to Grade: Place satisfactory soil fill material over drainage course. Place material in loose-depth layers not exceeding 6 inches. Thoroughly compact each layer. Fill to finish grade.

3.7 PIPING INSTALLATION

- A. Install piping beginning at low points of system, true to grades and alignment indicated, with unbroken continuity of invert. Bed piping with full bearing in filtering material. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions and other requirements indicated.
 - 1. Foundation Subdrainage: Install piping level and with a minimum cover of 36 inches unless otherwise indicated.
 - 2. Underslab Subdrainage: Install piping level.
 - 3. Retaining-Wall Subdrainage: When water discharges at end of wall into stormwater piping system, install piping level and with a minimum cover of 36 inches unless otherwise indicated.

4. Landscaping Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of 0.5 percent and with a minimum cover of 36 inches unless otherwise indicated.
 5. Lay perforated pipe with perforations down.
 6. Excavate recesses in trench bottom for bell ends of pipe. Lay pipe with bells facing upslope and with spigot end entered fully into adjacent bell.
- B. Use increasers, reducers, and couplings made for different sizes or materials of pipes and fittings being connected. Reduction of pipe size in direction of flow is prohibited.

3.8 PIPE JOINT CONSTRUCTION

- A. Join perforated PE pipe and fittings with couplings according to ASTM D 3212 with loose banded, coupled, or push-on joints.

3.9 CLEANOUT INSTALLATION

- A. Comply with requirements for cleanouts specified in Section 334100 "Storm Utility Drainage Piping."
- B. Cleanouts for Foundation, Retaining-Wall, and Landscaping Subdrainage:
1. Install cleanouts from piping to grade. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
 2. In all areas, use NPS 4 cast-iron soil pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, 18 by 18 by 12 inches deep. Set top of cleanout flush with grade.
- C. Cleanouts for Underslab Subdrainage:
1. Install cleanouts and riser extensions from piping to top of slab. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
 2. Use NPS 4 cast-iron soil pipe and fittings for piping branch fittings and riser extensions to cleanout flush with top of slab.

3.10 CONNECTIONS

- A. Comply with requirements for piping specified in Section 334100 "Storm Utility Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect low elevations of subdrainage system to building's solid-wall-piping storm drainage system.

3.11 IDENTIFICATION

- A. Arrange for installation of green warning tapes directly over piping. Comply with requirements for underground warning tapes specified in specified in Section 312000 "Earth Moving."
 - 1. Install PE warning tape or detectable warning tape over ferrous piping.
 - 2. Install detectable warning tape over nonferrous piping and over edges of underground structures.

3.12 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. After installing drainage course to top of piping, test drain piping with water to ensure free flow before backfilling.
 - 2. Remove obstructions, replace damaged components, and repeat test until results are satisfactory.
- B. Drain piping will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.13 CLEANING

- A. Clear interior of installed piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plugs in ends of uncompleted pipe at end of each day or when work stops.

END OF SECTION 33 4600