MICHIGAN STATE
UNIVERSITY

ELECTRONIC BIDDING

MSU BASE CONTRACTORS ONLY
SPECIFICATION FOR

ENG RESEARCH COMPLEX - RENOVATE D115, CRYO-EM EXPANSION

PROJECT NUMBER

CP23116

Friday, June 21, 2024

AT

MICHIGAN STATE UNIVERSITY
EAST LANSING, MICHIGAN

Infrastructure Planning and Facilities
Planning, Design and Construction

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SCHEDULE OF DRAWINGS

Project Title: **ENG RESEARCH COMPLEX - RENOVATE D115, CRYO-EM EXPANSION**
Capital Project Number: **CP23116**
No. of Sheets: **42**

ADVERTISEMENT FOR BIDS

DATE: **June 21, 2024**

PROJECT TITLE: **ENG RESEARCH COMPLEX - RENOVATE D115, CRYO-EM EXPANSION**

PROJECT NUMBER: **CP23116**

for

MICHIGAN STATE UNIVERSITY

located at

EAST LANSING, MICHIGAN

OWNER: BOARD OF TRUSTEES
MICHIGAN STATE UNIVERSITY

ENGINEER/ARCHITECT: PLANNING, DESIGN AND CONSTRUCTION
Infrastructure Planning and Facilities
Michigan State University

DESIGN REPRESENTATIVE: **Dan Launstein 517-896-2989**

PROJECT MANAGER: **Zach Kiefer 248-425-0360**

Fishbeck
1515 Arboretum Drive S.E.
Grand Rapids, MI **49546**

BID DUE DATE: Until **3:00 p.m.** on **Tuesday, July 09, 2024**, the Owner will receive bids for the work as set forth in the Bidding Documents at via the Owner's Oracle Primavera Unifier Bid Manager, at which time and place all proposals will be publicly opened. Bidders are responsible for properly registering for this process, and familiarizing themselves with the system and its requirements. Registration information can be found at https://ipf.msu.edu/construction/partners/prospective-partners.

Proposals are invited for the following work:
Proposal 1 – General Construction Work

This project involves construction of an enclosure and support for a Krios G-4 microscope with a directly adjacent control room along with construction of another enclosure and support for a Helios microscope with support equipment within the same space. Allowances are included for the construction of a drive to the D115 loading dock and LN2 piping from bulk tank to new fill station inside D115 back loading dock. Scope also includes: (1) painting of rooms D120, D122, and D127 (2) flooring in the new microscope enclosures and rooms D120 & D127, (3) new cabinetry in D122 & D127, (4) new ceiling & lighting in D120 & D122, and (5) electrical/mechanical /T support for the two new microscope enclosures.

MSU Base Contractors: For materials and methods not specified within these documents, the Constructor is expected to refer to and comply with MSU technical standards and standard details.

The substantial construction completion date for the project, as set forth in the project manual and drawings is **October 31, 2024**. See applicable start date and interim completion dates in the General Requirements (Division One) – Part 1 Work Sequence section.

LIQUIDATED DAMAGES:
☐ Shall, or ☒ Shall not be assessed for Substantial Completion at:
$_____PER DAY

☐ Shall, or ☒ Shall not be assessed for Final Completion at:
$_____PER DAY

EXCLUSIONS FROM MUTUAL WAIVERS OF CONSEQUENTIAL DAMAGES:
DEFAULT IS NONE. (If exclusions apply, project team to insert applicable exclusions below).

The complete set of documents is also available for viewing through our new MSU Plan Room or via the MSU Planning, Design and Construction (PDC) web page at https://ipf.msu.edu/construction/partners/prospective-partners and then select “dedicated plan room”.

PLAN ROOMS

The Bidding documents are on file and may be examined at the following locations during regular business hours, Monday through Friday:

Builders Exchange of Lansing &
Central Michigan
1240 East Saginaw
Lansing, MI 48906

Dodge Data & Analytics
25330 Telegraph Road, Suite 350
Southfield, MI 48009

Dodge Data & Analytics
914 E. Vine Street
Kalamazoo, MI 49001

Dodge Data & Analytics
1311 South Linden Road, Suite B
Flint, MI 48532

Builders Exchange
P.O. Box 2031
Grand Rapids, MI 49501

Tri-City Builders & Traders Exchange
334 South Water
Saginaw, MI 48607

Construction Association of Michigan
43636 Woodward Avenue
P. O. Box 3204
Bloomfield Hills, MI 48302-3204

Builders Exchange
3431 East Kilgore
Kalamazoo, MI 49001

CNS Construction News Service
of West Michigan, Inc.
1793 R. W. Berends Dr. SW.
Wyoming, MI 49509-4993

MMSDC Michigan Minority Supplier
Development Council.
100 River Place STE 300
Detroit, MI 48207

Builders Exchange of NW MI, Inc.
1373 Barlow St. , Suite 4
Traverse City, MI 49686

Capital Imaging
2521 East Michigan Avenue
Lansing, MI 48912

A pre-bid site inspection will be held on **Thursday, June 27, 2024** at **10:00 a.m.**. All interested Contractors or Bidders are encouraged to attend. Interested parties should meet at the **Engineering Research Complex, 898 Woodlot Dr, East Lansing, MI 48823**. All Contractors submitting bids for the work will be held to have visited the site prior to submitting bids.

Each proposal shall be accompanied by a bid security as set forth in the Instructions to Bidders.

The Owner reserves the right to reject any or all proposals either in whole or in part and to waive any irregularities.

Withdrawal of any proposal is prohibited for a period of 120 days after the actual date of the opening thereof.

Performance and Labor and Material Bonds are required as set forth in the Instructions to Bidders.

All prospective Bidders, their Subcontractors and suppliers must be awardable by and in compliance with the directives and guidelines of the Contract Compliance Division of the Michigan Civil Rights Commission.

SUBCONTRACTING AND SUPPLIER DIVERSITY

The University makes a continuous effort to broaden its business relationships with Minority Business Enterprise (MBE) contractors, Women Business Enterprise (WBE) contractors, and small business concerns (including veteran-owned small business, service-disabled veteran owned small business, HUB Zone small business, and small disadvantaged business concerns certified by the U.S. Small Business Administration). For the purposes of this provision, suppliers are considered subcontractors. If third parties are needed to fulfill contractual obligations to the University, you are strongly encouraged to consider all qualified sources, including WBE, MBE, and small business subcontractors. For purposes of this paragraph, MBE is defined as a business enterprise of which more than 50% of the voting shares or interest in the business is owned, controlled, and operated by individuals who are members of a minority and with respect to which more than 50% of the net profit or loss attributable to the business accrues to shareholders who are members of a minority. WBE is defined as a business enterprise of which more than 50% of the voting shares or interest in the business is owned, controlled, and operated by women and with respect to which more than 50% of the net profit or loss attributable to the business accrues to the women shareholders.

The apparent Low Bidder shall, within 24 hours, after receipt of bids, provide the names of any MBE/WBE/small business subcontractors, description of work to be done by each, dollar value of work, and percentage of contract price. This information shall be included with the contract breakdown specified in Section 012000.1.4 of the specifications.

The Michigan State University Purchasing Department maintains a list of known Minority and Women Business Enterprises in the region for informational purposes. Bidders can obtain a copy of this list by calling (517) 355-0357. This list is not intended to be comprehensive. Similarly, it does not constitute an endorsement or certification of acceptability of the contractors and vendors included.

INSTRUCTION TO BIDDERS

ARTICLE 1

DEFINITIONS

1.1 Bidding Documents include the Advertisement or Invitation to Bid, Instruction to Bidders, the Bid Form, other sample bidding and Contract forms and the proposed Contract Documents including any Addenda issued prior to receipt of Bids.

1.2 All definitions set forth in ConsensusDocs 200- Standard Agreement and General Conditions Between Owner and Constructor (as modified by MSU) and in other Contract Documents are applicable to the Bidding Documents.

1.3 **Addenda** are written or graphic instruments, issued by the Architect prior to the receipt of Bids, which modify or interpret the Bidding Documents by addition, deletions, clarifications or corrections.

1.4 A **Bid** is a complete and properly signed proposal to do the Work or designated portion thereof, for the sums stipulated therein, supported by data called for by the Bidding Documents.

1.5 **Base Bid** is the sum stated in the Bid for which the Bidder offers to perform the Work described as the base, to which Work may be added or deducted for sums stated in Alternate Bids.

1.6 An **Alternate Bid** (or Alternate) is an amount stated in the Proposal to be added to or deducted from the amount of the Base Bid if the corresponding change in project scope or materials or methods of construction described in the Bidding Documents is accepted.

1.7 A **Unit Price** is an amount stated in the Bid as a price per unit of measurement for materials or services as described in the Contract Documents.

1.8 A **Bidder** is one who submits a Bid for a prime Contract with the Owner for the Work described in the proposed Contract Documents.

1.9 A **Sub-bidder** is one who submits a Bid to a Bidder for materials or labor for a portion of the Work.

1.10 **Bid Manager** is the Oracle Primavera Unifier Bid Manager application used the by the Owner to received competitive bids for this project.

ARTICLE 2

BIDDER'S REPRESENTATION

2.1 Each Bidder, by making his/her Bid, represents that:

2.1.1 They have read and understand the Bidding Documents and their Bid is made in accordance therewith.

2.1.2 They have visited the site and are familiar with the local conditions under which the Work is to be performed.

2.1.3 Their Bid is based upon the materials, systems and equipment described in the Bidding Documents, without exceptions.

ARTICLE 3

BIDDING DOCUMENTS

3.1 COPIES

3.1.1 Bidders may obtain complete sets of the Bidding Documents via the MSU PLANNING, DESIGN AND CONSTRUCTION web page at https://ipf.msu.edu/construction/partners/prospective-partners, or as outlined in the Advertisement for Bids, page AB-2.

3.1.2 Complete sets of Bidding Documents shall be used in preparing Bids; neither the Owner nor the Architect assume any responsibility for errors or misinterpretations resulting from the use of incomplete sets of Bidding Documents.

3.1.3 The Owner or Architect, in making copies of the Bidding Documents available on the above terms, does so only for the purpose of obtaining Bids on the Work and does not confer a license or grant for any other use.

3.2 INTERPRETATION OR CORRECTION OF BIDDING DOCUMENTS

3.2.1 Bidders shall promptly notify the Architect of any ambiguity, inconsistency or error which they may discover upon examination of the Bidding Documents or of the site and local conditions.

3.2.2 Bidders requiring clarification or interpretation of the Bidding Documents shall make a written request to be received by the Architect at least fourteen days prior to the date for receipt of Bids.

3.2.3 Any interpretation, correction or change of the Bidding Documents will be made by Addendum. Interpretations, corrections or changes of the Bidding Documents made in any other manner will not be binding, and Bidders shall not rely upon such interpretations, corrections and changes.

3.3 SUBSTITUTIONS

3.3.1 The materials, products and equipment described in the Bidding Documents establish a standard of required function, dimension, appearance and quality to be met by any proposed substitution.

3.3.2 No substitution will be considered unless written request for approval has been submitted by the Bidder and has been received by the Architect at least fourteen days prior to the date for receipt of Bids. Each such request shall include the name of the material or equipment for which it is to be substituted and a complete description of the proposed substitute including drawings, cuts, performance and test data, and any other information necessary for an evaluation. A statement setting forth any changes in other materials, equipment or work that incorporation of the substitute would require shall be included. It is the burden of the bidder proposing the substitution to establish its merits. The Architect's decision of approval or disapproval of a proposed substitution shall be final.

3.3.3 If the Architect approves any proposed substitution, such approval will be set forth in an Addendum. Bidders shall not rely upon approvals made in any other manner.

3.4 ADDENDA

3.4.1 The Architect and Owner will endeavor to notify all known plan holders of addenda issued, but it is the Bidder’s responsibility to verify receipt of all addenda.

3.4.2 Copies of Addenda will be made available for inspection wherever Bidding Documents are on file for that purpose.

3.4.3 Normally Addenda will not be issued later than five days prior to the date for receipt of Bids except an Addendum, if necessary, postponing the date for receipt of Bids or withdrawing the request for Bids.

3.4.4 Each Bidder shall ascertain prior to submitting their Bid that they have received all Addenda issued, and receipt of all Addenda shall be acknowledged on their bid.

ARTICLE 4

BIDDING PROCEDURE

4.1 FORM AND STYLE OF BIDS

4.1.1 Bids shall be submitted via the Bid Manager on the form specified.

4.1.2 All fields on the Bid Form shall be completed.

4.1.3 All requested Alternates shall be listed and quoted in the Bid Manager. Failure to quote a requested Alternate will be cause to reject the Bid.

4.1.3.1 If an alternate is added via Addendum, bidders will include by [adding new line to bid form, clearly labeling ALTERNATE X(x being the number)] or [providing pricing on an attachment, also clearly labeling pricing for Alternate.]

4.1.4 All requested Unit Prices shall be listed and quoted via attachment in the Bid Manager. Failure to quote a requested Unit Price will be cause to reject the Bid.

4.1.5 Acknowledge the receipt of the last Addendum on the Bid Form. By acknowledging this addendum, Bidder also acknowledges receipt of all prior consecutive addenda (e.g., acknowledging Addendum 3 also acknowledges Addendum 1 and 2).

4.1.6 Bidder shall make no additional stipulations on the Bid Form nor qualify its Bid in any manner.

4.1.7 By submitting a Bid via the Bid Manager, the Bidder has committed the offer to perform the Work. The Owner will rely on this document as properly signed by the Bidder. The Owner may rely on this commitment, including submitting a claim on the Bidder's Bid Bond if they fail to enter into a contract per the project manual.

4.2 BID SECURITY

4.2.1 Any base bid greater than $50,000 shall be accompanied by a Bid Security in the form of a bid bond made payable to the Board of Trustees, Michigan State University, in the amount of not less than five percent (5%) of the Base Bid, as a proposal guarantee, pledging that the Bidder will enter into a Contract with the Owner on the terms stated in its Bid, and will furnish bonds as described hereunder in Article 8 covering the faithful performance of the Contract and the payment of all obligations arising thereunder. Bidder shall attach a scanned copy of the bid bond to the bid in Unifier Bid Manager.

As an alternative to a bid bond, Bidders may provide certified check, cashiers' check, or money order made payable to the Board of Trustees, Michigan State University, in the amount of not less than five percent (5%) of the Base Bid, to be delivered to MSU Infrastructure Planning and Facilities, 1147 Chestnut Road, Room 101, East Lansing, MI 48824. The proposal guarantee of Bidders under consideration will be returned immediately after approval of contracts by the Owner; those of all others will normally be returned upon request within 48 hours after bid opening.

Should the Bidder refuse to enter into a Contract, or fail to furnish such bonds within 30 days of notification of intent to award, the amount of the Bid Security shall be forfeited to the Owner as liquidated damages, not as penalty.

4.2.2 The bonding firm must be listed on the current U.S. Department of Treasury Circular 570, rated A- or better by Best, and be licensed to do business in the State of Michigan. The bonds are to be made out to "Michigan State University, Board of Trustees."

4.2.3 The Owner will have the right to retain the Bid Security of Bidders under consideration until either (a) the Contract has been executed and bonds have been furnished, or (b) the specified time has elapsed so that Bids may be withdrawn, or (c) all Bids have been rejected.

4.3 SUBMISSION OF BIDS

4.3.1 Bids shall be completed prior to the time and date for receipt of Bids indicated in the Advertisement or Invitation to Bid, or any extension thereof made by Addendum. Bids received after the time and date for receipt of Bids will not be considered.

4.3.2 Bidder shall assume full responsibility for timely delivery at location designated for receipt of Bids.

4.3.3 Oral, telephone, paper, or faxed Bids are invalid and will not receive consideration.

4.4 MODIFICATION OR WITHDRAWAL OF BID

4.4.1 A Bid may not be modified, withdrawn, or canceled by the Bidder during the stipulated time period following the time and date designated for the receipt of Bids, and Bidder so agrees in submitting his/her Bid.

4.4.2 Prior to the time and date designated for receipt of Bids, Bids submitted early may be modified or withdrawn only by withdrawing current Bid, and resubmitting within the Bid Manager.

4.4.3 Bid security shall be in an amount sufficient for the Bid as modified or resubmitted.

4.5 BIDDER REGISTRATION

4.5.1 The Owner will only receive Bids via the Bid Manager, which requires prior registration and invitation. The Bidder is responsible to familiarize itself with this system and request access in a timely manner.

4.5.2 The Owner will endeavor to maintain a list of all interested bidders, and invite to all public bids. Bidders interested in being added to this list must register. Registration information can be found at https://ipf.msu.edu/construction/partners/prospective-partners.

4.5.3 Bidders are encouraged to continue to monitor projects via plan rooms and other advertising venues. They must express interest to bid on MSU projects by request at least 7 days prior to a bid opening. Owner takes no responsibility for inviting a bidder after that date.

ARTICLE 5

CONSIDERATION OF BIDS

5.1 OPENING OF BIDS

5.1.1 Unless stated otherwise in the Advertisement or Invitation to Bid, the properly identified Bids received on time will be opened publicly and will be read aloud. Opening will generally take place in MSU Infrastructure Planning and Facilities Building, 1147 Chestnut Road, East Lansing, Michigan 48824.

5.1.1.1 Unless stated otherwise in the Advertisement or Invitation to Bid, the Owner will endeavor to share bid results within 24 hours of opening.

5.1.1.2 The Owner will endeavor to stream the bid opening, and will share details in the bid invitation

5.2 REJECTION OF BIDS

5.2.1 The Owner shall have the right to reject any or all Bids.

5.3 ACCEPTANCE OF BID (AWARD)

5.3.1 The Owner shall have the right to waive any informality or irregularity in any Bid received.

5.3.2 If the University accepts any alternates, it will do so in the order representing the Owner's opinion of the best value to Michigan State University. The Owner shall be the sole judge of value. The low bidder will be determined on the basis of the sum of the base bid and the alternates accepted.

5.4 ACCEPTANCE OF CONTRACTOR AND SUBCONTRACTORS

5.4.1 Each portion of the Work shall be performed by an organization equipped and experienced to do the Work in each particular field, and no portion shall be reserved by the Contractor unless they are so equipped and experienced. Within 24 hours after the receipt of Bids, the successful Contractor shall submit a list of each Subcontractor proposed for each section of the Work. Subcontractors shall be satisfactory to the Owner. Unless authorized to the contrary in writing from the Owner, Subcontracts shall be awarded to the firms named in this list. Acceptance of the Bid does not imply approval of the Subcontractors subsequently named, but each Subcontractor shall be approved individually.

ARTICLE 6

QUALIFICATION OF CONTRACTORS

6.1 SUBMISSION OF QUALIFICATION STATEMENT

6.1.1 Bidders to whom award of a Contract is under consideration shall submit to the Architect upon his/her request, a properly executed Contractor's Qualification Statement, Consensus Docs 221 – Constructor's Statement of Qualifications for a Specific Project, unless such a Statement has been previously required and submitted as a prerequisite to the issuance of Bidding Documents.

6.2 NONDISCRIMINATION

6.2.1 In performing under this Contract, the Contractor agrees not to discriminate against any employee, or applicant for employment, with respect to hire, tenure, terms, conditions or privileges of employment, or any matter directly or indirectly related to employment, because of race, color, religion, national origin, age, sex, height or weight, marital status or handicap. Subcontracts with each Subcontractor will contain a provision requiring nondiscrimination in employment, as herein specified. Any breach of this covenant may be regarded as a material breach of this Contract. The foregoing is included as a part of the University's institutional Affirmative Action/Equal Opportunity commitment.

6.3 APPROVED ASBESTOS ABATEMENT CONTRACTORS

6.3.1 The Department of Environmental Health and Safety (EHS) annually prequalifies asbestos abatement contractors to perform asbestos abatement work on Campus. Asbestos abatement work shall only be performed by one of the asbestos abatement contractors on the approved list. The current list is available from the PDC Project Representative, the Environmental Coordinator for EHS, and at https://ehs.msu.edu/enviro/asbestos/index.html.

ARTICLE 7

POST-BID INFORMATION

7.1 SUBMISSIONS

7.1.1 Unless waived by the Architect, the apparent low Bidder shall, within 24 hours after receipt of bids, submit the following information to the Architect:

7.1.1.1 A designation of the Work to be performed by the Bidder with their own forces.

7.1.1.2 The proprietary names and the suppliers of principal items or systems of material and equipment proposed for the Work.

7.1.1.3 A list of names of the Subcontractors or other persons or organizations (including those who are to furnish materials or equipment fabricated to a special design) proposed for each division and/or major subdivision, for the Owner’s approval.

7.1.1.4 The names of the MBE/WBE and a description of work to be done by each, dollar value of Work and percentage of Contract price.

7.1.1.5 List of representatives authorized to perform Unifier functions on behalf of the contractor using the Unifier New Company Request, available at Unifier System Vendor Information Form.

7.1.1.6 Certificate of Insurance demonstrating compliance with project requirements.

7.1.2 At the option of the Owner, the Bidder may be required to establish to the satisfaction of the Architect and the Owner the capability, reliability, and responsibility of the proposed Contractor and Subcontractors to furnish and perform the Work.

7.1.3 Subcontractors and other persons and organizations proposed by the Bidder and accepted by the Owner and the Architect must be used on the Work for which they were proposed and accepted and shall not be changed except with the written approval of the Owner and the Architect.

ARTICLE 8

PERFORMANCE BOND AND LABOR AND MATERIAL PAYMENT BOND

8.1 OWNER'S RIGHT TO REQUIRE BONDS

8.1.1 Each Bidder under a proposal in which the base bid exceeds $50,000, shall include the premiums for furnishing a Performance Bond and also Labor Material Bond, each in the full amount of the proposal sum as specified in the Owner / Constructor Agreement.

8.1.2 The bonding firm must be listed on the current U.S. Department of Treasury Circular 570, rated A- or better by Best, and be licensed to do business in the State of Michigan. The bonds are to be made out to "Michigan State University, Board of Trustees."

8.1.3 In assuming assigned Subcontractor by the successful Bidder for general building work as specified, each assigned Subcontractor for each Subcontract shall reimburse the General Contractor his/her proportionate share of the premiums for bonds.

8.2 TIME OF DELIVERY AND FORM OF BONDS AND INSURANCE

8.2.1 The Bidder shall deliver two (2) copies of the required bonds and insurance to the Owner not later than the date of execution of the Contract.

8.2.2 The Bidder shall require the Attorney-In-Fact who executes the required bonds on behalf of the surety to affix thereto a certified and current copy of his/her Power of Attorney.

ARTICLE 9

FORM OF AGREEMENT BETWEEN OWNER AND CONTRACTOR

9.1 FORM TO BE USED

9.1.1 The Agreement for the Work will be governed by the project manual, and by the terms and conditions of ConsensusDocs 200- Standard Agreement and General Conditions Between Owner and Constructor (as modified by MSU).

9.1.2 If the project is under $250,000, an MSU Purchase Order will be used and the terms and conditions of ConsensusDocs 200- Standard Agreement and General Conditions Between Owner and Constructor (as modified by MSU), will serve as the applicable General Conditions for administration of the Work.

9.1.3 If the project is over $250,000, the ConsensusDocs 200- Standard Agreement and General Conditions Between Owner and Constructor will be used and the terms and conditions of that Agreement will be formalized through the execution of a Contract Finalization Form.

ARTICLE 10

APPLICATION FOR PAYMENT

10.1 FORM TO BE USED

10.1.1 Applications for Payment shall be submitted in Unifier in accordance with the Pay Apps (Pay Applications) business process. Refer to the MSU IPF website for more information

ARTICLE 11

ELECTRONIC TRANSACTIONS

11.1 UNIFIER

11.1.1 The Owner reserves the right to require that any or all transactions and submissions be conducted and delivered electronically through Unifier, a web-based project management software system. Unifier functions on most popular web browsers. If the owner requires the use of Unifier, the owner will provide the necessary licenses for access into Unifier and the initial training necessary to use Unifier. Access to Unifier will be password restricted, and any proposal, acceptance, quote or other information submitted through Unifier through the use of a party's password shall be deemed to be the submission of such party and any proposal, acceptance, quote or other information in the submission shall be binding on such party as if such proposal, acceptance, quote or other information was in a writing signed by such party. Owner shall not be required to verify the validity of any such submission or inquire as to the authority of the user gaining access to Unifier through the use of a party's password. The following are the minimum Unifier user software and hardware requirements. It is the responsibility of the vendor to verify compatibility of their systems with Unifier. For more information, see Unifier System Vendor Information Form.

11.2 CONTRACT EXECUTION

11.2.1 The Owner may choose to accept a scanned signed contract, provided through Unifier, as acceptance of the agreement. The Owner will rely on this document as properly signed by the Constructor.

DIVISION 1 - GENERAL REQUIREMENTS

SECTION 011000 - SUMMARY

PART 1 - GENERAL

1.1 SUMMARY OF WORK

A. Work Under This Contract

1. This Contract encompasses the furnishing of all labor, materials, services, equipment, and insurance to complete the following as shown on drawing and specified herein: Build-out of two new cryo-electron microscope rooms within the Engineering Research Complex Instrument Room. Build-out includes new structures and finishes, and mechanical, electrical, and plumbing components to support new microscope equipment. Provide modifications to adjacent support spaces and exterior elements such as loading dock and driveway.

2. Any premium time necessary to complete this project as scheduled, shall be included in the Base Bid.

3. All pertinent requirements of the Invitation to Bidders, Instructions to Bidders, and General Conditions shall form a part of these specifications and the Contractor shall consult them in detail for instructions pertaining to the work in the following divisions.

B. Work Performed Under Separate Contracts

1. The following will be provided by the Owner or by others under separate contracts:

a. Electron microscopes and related equipment.

b. Tie-back, pruning, removal and/or transplanting of existing plantings.

c. Departmental possessions - furniture, books, personal items, etc., shall be relocated by the Department or University as required.

d. Smart Ball utility locators.
e. Site lighting components – refer to Drawings.

f. As-built Site Survey

1) The Contractor shall notify the Project Representative when new underground utility installation starts, or when existing utilities are exposed, to allow the Project Representative to coordinate with IPF Facility Information Services for documentation.

2) The Project Representative shall coordinate with IPF Facility Information Services for an As-built Survey upon completion of exterior improvements and utilities.

2. Coordinate pickup of the following site-related, owner-provided materials from Beaumont Supply at 4080 Beaumont Rd., Lansing, MI 48910, phone: (517) 643-6253 (Hours of operation are May 1st – October 31st 6am-4pm Monday – Friday excluding university holidays. November 1st – up until the Thanksgiving Holiday 6am-230pm Monday -Friday and following Thanksgiving Holiday – April 30th 5am-130pm to accommodate for snow) Extended hours are available with a minimum 24-hour notice. Contractor is responsible for transporting materials to the jobsite.

a. Soil Erosion and Sedimentation Control (SESC) materials: (removed and retained by Owner at end of permit)

1) Erosion eels

b. Recycled concrete aggregate for parking bituminous pavement base (see section 321216)

c. Topsoil, final grading, fertilizing, mulching, and seeding of construction site. (see Section 312300).

d. Fence gate.

C. Pre-Ordered Products

1. The Contractor shall assume full responsibility for all pre-ordered products after their arrival at MSU. This includes transportation, handling, storage, start-up, warranty services, and installation in accordance with the General Conditions unless otherwise specified.

D. Work Sequence

1. The Substantial construction completion date for this project is as specified in the Advertisement for Bids.

2. The Contractor must coordinate interim completion dates with the Owner, including dates for work completion that support Owner-provided equipment delivery. This work includes the rear exterior drive and loading dock, which will require an interim completion date.

1.2 WORK RESTRICTIONS

A. Access Routes

1. All materials and equipment (new and demolition), including mechanical and electrical, shall be transported through a building via the designated building receiving area (usually the loading dock), and through main corridor to rooms or areas. Alternate routes may be used only with the approval of the Project Representative.

B. Owner Occupancy

1. Unless otherwise stated, University buildings will continue to function and remain occupied during the construction process.

2. On every project involving new construction, additions or alterations to existing facilities, M.S.U. requires the ability of a person with physical disabilities to independently get to, enter, and use the site, facility, building or element. In no way shall a site, building or facility be restricted to individuals with disabilities, due to alterations or construction, which would normally be made accessible to individuals with no disabilities. Alternate routes for all new and alterations of existing facilities shall incorporate the latest federal, state and local barrier free standards and include temporary access accommodations for individuals with disabilities.

C. Use of Site

1. There shall be a pre-construction site walk-thru with the Project Representative to clarify and discuss limitations and concerns prior to construction.

PART 2 - PRODUCTS
Not Used

PART 3 - EXECUTION
Not Used

END OF SECTION

SECTION 012000 - PRICE AND PAYMENT PROCEDURES

PART 1 - GENERAL

1.1 PROPOSAL QUOTATION REQUIREMENTS

A. Projects to be bid will be quoted as required by the front-end documents on the specification.

1.2 CONTRACT BREAKDOWNS

A. Within twenty-four (24) hours after receipt of Bids, the apparent Low Bidder shall submit to the Architect/Engineer, the following:

1. A Schedule of Values (SOV), indicating the cost of each specified Division and/or Major Subdivision of the Bid. The approved SOV will be used as the basis for estimating partial payments to the Contractor when allowed per the front-end documents.

a. All contracts shall assign a minimum of 1% of the contract value for final completion and project closeout. This item must be identified as a separate line item labeled *Closeout* on the SOV. Exceptions must be approved by the Construction Superintendent.

b. Due to changes to Generally Accepted Accounting Practices, environmental remediation must be separately reported in the Owner's financial statements. Accordingly, all contracts shall carry remediation costs in separate lines clearly marked *remediation*. These titles should not be used in other line descriptions.

c. Construction Management contracts shall carry separate detail lines for at least the following lines:

i. Preconstruction Services
ii. Construction phase staffing
iii. General conditions
iv. Bonds and Insurance. Note that subcontractor bonds are not required to be separately listed.
v. Fee
vi. Closeout

2. Identify a Subcontractor for each Division and/or Major Subdivision for the Owner's approval. Once approved, no Subcontractors will be changed without the Owner's written consent. The List of Subcontractors will have indicated the MBE/WBE Contractors and their percentages of the Contract Price as specified in the "Cover Letter" or "Advertisement for Bids" of this project.

3. A list of representatives authorized to perform Unifier functions on behalf of the Contractor using the Unifier System - Vendor Information available at http://ipf.msu.edu/index.cfm/capital-project-procedures/documents/unifier-system-vendor-information/.

1.3 CONTRACT MODIFICATION PROCEDURES

A. Change Management Quotation Requirements

1. Quotations for changes in the Contract will be submitted via Unifier when requested, as outlined in Section 012000-1.5.B, Change Management Procedures. This section will not prohibit the Project Representative from requesting and receiving verbal quotations. It is intended that mutual cooperation will keep any changes to an absolute minimum. The Contractor shall promptly document any verbal request by initiating a Change Management or Change Request record in Unifier. The Contractor shall not engage in added work without proper authorization by the Owner. Any added work the Contractor engages in without authorization shall be at the Contractor's risk. In no event shall the failure of the Construction Representative to initiate a change constitute authorization for the Contractor to proceed with work.

2. The Change Order Quotation Format Form is available on the MSU Capital Project Delivery Procedures website (http://procedures.ipf.msu.edu/index.cfm/capital-project-delivery-procedures/). This Form shall be forwarded to each required Subcontractor, and is recommended as an outline of the information required by this Contract.

3. The Contractor will submit quotations through Unifier, including detailed breakdowns. Upon request, originals of any documents shall be provided to the Owner. The Project Representative will receive quotations from the Contractor only. Subcontractors will submit quotations through the Contractor. All Contractors will submit quotations with information and back-up data as indicated on the quotation form.

B. Change Management Procedures

1. Change Orders shall be issued as required to alter the Contract, (i.e. change the work scope, materials, dates, etc.), in accordance with the General Conditions of the Contract, and the following procedure:

a. The Contractor or the Project Representative shall initiate a Change Request in the Unifier Project Management System. Each Change Request will consist of only one change item of work.

b. Items brought up by the Department or Contractor shall be reviewed first with the Project Representative.

c. The Architect/Engineer will review the Change Request, and with the Project Representative, will determine the need for an item to be changed in the Contract by Change Order.

d. If the Change Request is approved, the Contractor will receive a request through Unifier to proceed with the work and/or provide pricing, as applicable. Provide a quotation for the item requiring change, unless the Change Request is submitted as a lump sum with a quotation attached

e. The Contractor will submit a quotation for each Change Request item in accordance with the applicable Unifier business process. Overhead and profit shall be applied consistent with the General Conditions.

f. The Project Representative and Architect/Engineer will evaluate the quotations and accept or reject each item quoted. A Change Order will be created within the Unifier system and will be issued through the MSU Purchasing Department to change the contract amount if required.

g. The Construction Supervisor or Director of Planning, Design and Construction has approval authority for the Contract Change.

1.4 CONTRACT PAYMENT PROCEDURES

A. Payment application requirements

1. Payment applications shall be submitted in Unifier, consistent with the contract documents.

PART 2 - PRODUCTS
Not Used

PART 3 - EXECUTION
Not Used

END OF SECTION

SECTION 013000 - ADMINISTRATIVE REQUIREMENTS

PART 1 - GENERAL

1.1 PROJECT MANAGEMENT AND COORDINATION

A. Project Meetings

1. Project meetings may be called as deemed necessary by the Project Manager.

B. Project Scope Documentation

1. The Contractor shall use PlanGrid for coordination of changes in the field, punch list items, and potential use for plan review comments.

C. Project Coordination

1. The Contractor is ultimately responsible for coordination to complete all work shown on drawings and specified herein independent of the location of the work on drawings and within the specifications. The arrangement of work within the specification into Divisions and Sections shall be considered as given for convenience of reference only and shall not be held to conform to jurisdictional rules which may prevail in any particular trade. It shall be the responsibility of the Contractor to so arrange or group items of work under a particular trade to conform to the prevailing customs of that trade and best interest of the Owner. Specific items of work will be performed by specific subcontractors or workmen when so specified herein or subsequently deemed necessary by the Project Representative to produce competent results.

2. The Contractor shall lay out the work and be responsible for all lines and measurements of the work. Before ordering material or executing work the Contractor shall obtain field measurements and prepare the work to fit conditions properly.

3. The Contractor will be held responsible for any error resulting from his/her failure to verify the figures shown on the drawing before laying out the work.

4. No extra charge will be allowed on account of slight variations between field dimensions and dimensions given on the drawings.

D. Mechanical and Electrical Coordination

1. Connection to Existing Equipment

a. The Contractor shall make arrangements with Planning, Design and Construction, through the Project Representative, before connecting to existing facilities. Unless otherwise noted, if interruption of service is required it shall be done at the convenience of the Owner.

1.2 CONSTRUCTION PROGRESS DOCUMENTATION

A. Construction Schedule Development/Coordination Responsibilities.

1. The Critical Path Method (CPM) will be used to plan, schedule, execute and report status of work under this contract. It shall include and properly coordinate dates for performance of all divisions for each major portion of the Work, and including completion of off-site requirements and tasks if request by Project Representative.

a. Within fourteen (14) calendar days of the Letter of Intent or contract award, the Contractor shall develop a proposed Baseline schedule for the Work, and submit it to each subcontractor to incorporate their own work.

b. All subcontractors, both direct and indirect, shall, within seven (7) calendar days of receipt of the Contractor's Schedule, submit revisions, comments and feedback to the Contractors, which shall be incorporated into the proposed schedule.

c. Upon receipt of the schedule from the Subcontractors, the Contractor will incorporate Subcontractors information into the Baseline Construction Schedule with appropriate logic ties and Contract Milestones, and distribute to the Architect/Engineer and Owner within seven (7) calendar days. Thus the Contractor Schedule development will be completed within twenty-eight (28) calendar days from Letter of Intent or Contract, awaiting Owner approval.

d. After project schedule has been accepted by the Owner the Contractor within five days (5 days) schedule a meeting with all subcontractors to review and encourage schedule compliance.

2. **All Subcontractors shall cooperate with the General Contractor to prepare and maintain the Construction Schedule, which shall include, without limitation, the following information at the General Contractor request.**

a. Shop Drawing review and approval, product procurement, fabrication, shop inspection, and delivery dates including lead times. Note: A/E shall be given 14 days upon receipt of submittal to review and return submittal.

b. Each phase of the Work, including the Punch List, Project Closeout requirements, Contract Completion and Occupancy;

c. Milestone dates that are required by the Contract Documents and Progress Milestones. Milestones should typically be based on the critical path and not exceed one (1) month between milestones.

d. The critical path of the Work

e. Planned disruptions and shutdowns due to other operations, facilities and functions, if any.

3. Upon receipt of the proposed Construction Schedule, the Architect/Engineer (A/E) and Owner (or other designee of the Owner), shall review the Construction Schedule and submit a copy of the Construction Schedule with comments to the Contractor within seven (7) calendar days. Within five (5) calendar days of review of comments from the Owner, all requested changes shall be incorporated in to the baseline Construction Schedule and a printout and electronic copy shall be provided to the Owner. Thus, the Contractor Schedule development with Owner review and Contractor modifications/changes shall not exceed forty (40) calendar days from the Letter of Intent.

4. **No progress payments will be made to the Contractor without a Baseline Construction Schedule approved by the Owner (or other designee of the Owner).**

5. Unless otherwise specified in the Contract Documents or waived in writing by the Owner, the Contractor shall provide **monthly progress reports, at a minimum,** to the Architect/Engineer and the Owner, which shall include recommendations for adjusting the construction schedule to meet Milestone Completion dates and contract completion dates.

6. An updated construction schedule shall be submitted each month to the Project Rep. The Project Rep shall review the submittal, provide comments as necessary. No **payment will be made without an updated construction schedule approved by the Project Representative.**

7. When it is apparent to the contractor and A/E that critical path activities, scheduled Milestone completion dates, or contract completion dates will not be met, the Contractor shall submit to the Owner for review and approval, a plan to avoid or minimize any delay. Such a plan may include, without limitation, increasing the Contractor's workforce; increasing the number of working hours per shift, shifts per workday, workdays per week, the amount of construction equipment, and rescheduling of activities, or any combination thereof; to achieve maximum practical concurrency of work efforts and eliminate the cause of such delay. The Contractor agrees that such actions as described in this paragraph or other action deemed necessary by the Contractor will be taken promptly and without additional cost to the Owner.

8. Any request for time extensions or damages due to delay will only be considered where it is proven by the Contractor, using acceptable scheduling techniques, that the project's contractual intermediate milestones or contract completion dates have been directly impacted by the alleged issue causing the delay. This does not preclude the Contractor's right to finish the Project early. It does explicitly establish the condition upon which the Contractor shall be entitled to request time extensions or delay damages.

B. Construction Schedule Technical Requirements

1. The Critical Path Method (CPM) shall be used to plan, schedule, execute and report the status of work under this contract. The CPM Construction Schedule shall be developed utilizing a Scheduling Software approved by Owner. It shall include and properly coordinate dates for performance of all divisions for each major portions of the work, including completion of off-site requirements and tasks.

2. The objective of the CPM Construction Schedule is to define and plan the reasonable timing and sequencing of all work, from Letter of Intent or Notice to Proceed to Final Contract Completion (along with interim Milestone Completion dates required by the contract) without exceeding the Contract Time limits. At a minimum, CPM activities shall be used for defining the following:

   a. Permitting
   b. Submittal/procurement/approval process (including shop drawing preparation)
   c. Material and equipment fabrication and delivery
   d. Construction/Installation
   e. Trade coordination
   f. Shutdowns
   g. Owner performed work and Owner-provided items
   h. Work of Other Contractors (indirect) hired by the Owner
   i. Governing Agencies inspections
   j. Punch list
   k. Commissioning
   l. Clean-up and project close-out
      Contract Completion/Occupancy

3. The Construction Schedule level of detail shall be broken down to the extent individual activities do not combine (a) Subcontractor work; (b) distinct divisions of work; (c) work in separate facilities or areas; or (d) rough-in and finish items of work. Construction/Installation activities shall not exceed duration of fifteen (15) workdays and Owner review/approval activities are to include a reasonable time for review depending on the size and complexity of the submittal.

4. Preparation of the “Baseline” Construction Schedule shall commence following the issuance of a Letter of Intent, and shall be submitted to the Architect/Engineer and Owner (or other designee of the Owner) within twenty-eight (28) calendar days of issuance of the Letter of Intent. The Architect/Engineer and Owner will review and provide comments as it relates to the schedule. The Construction Schedule must involve input from all major subcontractors and be signed by the Contractor and all Primes/Subcontractors indicating their approval in the accuracy of the Baseline Construction Schedule and/or Schedule Updates. Submittal and approval of the Baseline Construction Schedule and/or Monthly Schedule Updates are required prior to the corresponding progress payment being released.

5. The Contractor will utilize "Retained Logic" as the method of calculating the Construction Schedule and Updated Schedules, which will be computer generated and computer drawn.

6. The Construction Schedule requirement shall include but not be limited to (a) Baseline Schedule; (b) Monthly schedule updates, (c) Weekly 2 week look-ahead schedules.

7. The Contractor shall provide the current updated Construction Schedule for review and discussion at each regular progress meeting. In addition, the Contractor shall prepare a two-week look-ahead schedule for distribution at the progress meetings. This information shall be derived directly from the current Construction Schedule. The two-week look-ahead schedule shall include all activities scheduled to commence, continue or complete in the upcoming two weeks.

8. Each monthly schedule submittal will consist of one electronic file containing current schedule files or back-up, narrative, reports and plots discussed later in this section. Each monthly schedule shall be submitted using the Unifier Transmittal process. Each schedule submittal shall be uniquely identified as to which revision and/or update and will incorporate any Owner schedule review comments from previous schedule submissions. The date of the data shall be within two (2) calendar days of the Schedule submittal date.

9. The Construction Schedule shall meet the following criteria:

    a. Activity descriptions shall be clear and concise

    b. Activities shall be coded with sufficient detail to identify the activity as to phase, type of work, responsibilities, area of work, interface with other contracts, and any other coding necessary to accurately describe or sort the work activity.

    c. Activity durations shall be sufficiently short to accurately disseminate an item of work with the maximum installation activity not to exceed fifteen (15) workdays.

    d. Architect/Engineer and Owner review and approval activities will allow for sufficient time depending on the size, quantity of and complexity of the submission(s) (14 calendar days minimum).

    e. Logic ties shall be shown on graphics at the discretion of the Owner. Logic ties shall be accurate and reasonable with no regard to preferential logic that would sequester float for any one party. Logic ties will be reasonable to the point that a true critical path is identifiable from the beginning of the project (Letter of Intent) to the Final Completion milestone. Constraint dates are to be used at a minimum with a description for their basis if used. No open-ended activities shall be allowed.

f. The Construction Schedule shall allow for and depict: recognized national holidays, proposed number of workdays per week for each activity (calendar), adherence to specific restrictions, constraints and contract completion milestones (interim and final) stipulated in the contract documents and work of separate Contractors.

g. Contractually specified interim Completion Milestone dates shall be constrained to show negative float, if the early finish date of the last activity in that phase falls after the interim Milestone Completion date.

10. For all major equipment and materials fabricated or supplied for this project, the Construction Schedule shall show a sequence of activities including:

    a. Preparation of submittal shop drawings, samples and O&M instructions.
    b. Review of shop drawings, samples and O&M instructions by the Architect/Engineer (allow reasonable time for review depending on size and complexity of the submittal, minimum 14 calendar days).
    c. Shop fabrication and delivery
    d. Erection or installation
    e. Testing of equipment and materials
    f. Required dates of completion
    g. Instruction of operating personnel

11. Baseline Construction Schedule and Periodic Schedule Monthly Update submittals shall include the following information:

    a. Report content:
        1) Activity number
        2) Activity description
        3) Activity durations in work days (not to exceed 15 workdays)
        4) Remaining durations in work days
        5) Early and late start dates (Actual dates when progressed)
        6) Early and late finish dates (Actual dates when progressed)
        7) Percent complete
        8) Total float
        9) Free float
    b. An electronic file of the schedule files with all current schedule information.

12. If a Construction Schedule revision is required as determined by the Owner, Contractor or Architect/Engineer, the Contractor must include a complete schedule submittal with reports accompanied with a detailed narrative report describing the basis for any and all changes proposed by the Contractor. The Contractor cannot make significant revision(s) to the schedule without written approval by the Owner.

13. Schedule float is not for the exclusive use of any one party and should be shared for the projects benefit. The Contractor's work shall proceed to the early start dates and the Owner shall have the right to reserve and apportion float time according to the needs of the project.

14. If any of the Project Contract Milestones fall behind more than five (5) workdays, the Contractor is required to develop a Time Recovery Plan and Schedule, which shall be monitored weekly by the Contractor. The Contractor shall detail within the next Construction Schedule submittal narrative, the reorganization means and methods instituted in the schedule recovery plan to get back to the contract completion date(s). The recovery period should be achieved within the shortest reasonable time.

    a. If the recovery plan does not achieve its goal by the next pay request period, the Contractor will be required to develop another recovery plan until the Contract Completion Milestones are back on schedule.

    b. If the recovery plan has sufficient regained compliance with the Project Milestone Dates, use of the Baseline Construction Schedule will be resumed.

15. Time Extensions/Adjustments will only be granted when the Contractor can accurately demonstrate through the use of the Construction Schedule and accepted scheduling techniques, the need for a time extension due to delays, change orders or impacts by others. Schedule fragments and/or critical path schedule analysis shall be developed and submitted with each change order or other request for time adjustment. Time extension requests shall be submitted within ten (10) days of the onset of the occurrence impacting the Construction Schedule. Failure to submit this information by the time stated above shall result in rejection of the request. Based primarily on information provided by the Contractor, the Owner will decide the extent of impact and respond within a reasonable time depending on the complexity of the analysis required.

    a. If the time extension request is approved, the impact period will then be incorporated into the Construction Schedule.

    b. If the time extension request is rejected, no change to the project schedule will be permitted.

16. The Contractor shall coordinate its work with the Owner and other Subcontractors and shall cooperate with other Subcontractors by utilizing orderly progress toward completion in accordance with the work scheduled.

1.3 MILESTONE SCHEDULE REQUIREMENTS

A. The following Milestone Schedule dates for the listed work are provided as part of the contract requirements.

MILESTONE ACTIVITY

Construction start: Week of 7/29/24
Construction end: Week of 10/28/24
MSU Occupancy start: Week of 11/4/24
MSU Occupancy end: Week of 11/18/24

1.4 SUBMITTALS

A. Submittal Schedule

1. Concurrently with the development of the Contractor's Construction Schedule, the Contractor shall prepare a complete schedule of submittals. Submit the initial Submittal Schedule along with the Construction Schedule, at, or prior to, the Pre-Construction Conference.

a. Coordinate the Submittal Schedule with the list of subcontracts, Schedule of Values, and the list of products, as well as the Contractor's Construction Schedule.

b. Prepare the schedule in chronological order. Provide the following information:
- Scheduled date for the first submittal
- Related section number or specification number
- Submittal category (Shop Drawing, Product Data, Calculations, Test Results or Samples.
- Name of the subcontractor
- Scheduled date for resubmittal
- Scheduled date for completion of the A/E's review

2. Distribution: Following the Owner's response to the initial submittal, print and distribute copies to the Project representative, A/E, Owner, subcontractors, suppliers and other parties required to comply with the submittal dates indicated. Keep copies at the Project Site at all times.

a. When revisions are made, distribute to the same parties and post at the same locations. Delete parties for distribution when they have completed their assigned portion of the Work and are no longer involved in construction activities.

3. Schedule Updating: Revise the schedule after each meeting or activity where revisions have been recognized or made. Issue the updated schedule concurrently with the report of each meeting, or as requested by the Project Representative.

B. Submittals are required for, but are not limited to, each of the following. The Contractor should refer to each of the following referenced sections for additional requirements of each submittal. Submittals listed below are for reference only, and other inspections specified but remain the responsibility of the Contractor. All submittals are to be processed electronically using Unifier.

1. GENERAL SUBMITTALS
   Section 012000 for Contract Breakdowns
   Section 013000 for Safety Documentation
   Section 017000 for FADE Log

2. AS-BUILT DRAWINGS
   As-built Drawings are required as specified in Section 017000.

3. CERTIFICATES OF INSPECTION
   Certificates of Inspection are required as specified in Section 017000.

   220500 for Plumbing Permits and Inspection
   223500 for Boiler Permits and Inspection
   260500 for Electrical Permits and Inspection
   283100 for Fire Alarm NFPA Certification
   283600 for Gas Detection and Alarm Certification

4. OPERATION AND MAINTENANCE DATA
   Operation and maintenance data is required as specified in Section 017000.

5. GUARANTEES
   Guarantees are required as specified in Section 017000.

6. SAMPLES
   Samples are required as specified in Section 013000 for the following items:

   079200 Joint Sealants
   081416 Flush Wood Doors
   088000 Glazing
   096519 Resilient Flooring
   099123 Interior Painting
   122240 Window Shades
   123600 Countertops
   323113 Chain Link Fences and Gates

7. SHOP DRAWINGS

Shop drawings are required as specified in Section 013000 for the following items:

054000 Cold-Formed Metal Framing
092116 Gypsum Board Assemblies
122400 Window Shades
123600 Countertops
212200 Clean Agent Fire Extinguishing
230913 Instrumentation and Control Devices
230923 Direct Digital Control System for HVAC
232113 Hydronic Piping
232300 Refrigerant Piping
233113 Metal Ducts (include Air Duct Accessories, 233300, Air Terminal Units, 233600, and Particulate Air Filtration, 234100)
260533 Raceway and Boxes for Electrical Systems
260923 Lighting Control Devices – Occupancy Sensors
262726 Wiring Devices
262813 Fuses
262816 Enclosed Switches and Circuit Breakers
263213 Engine Generators
265100 Interior Lighting
265200 Emergency Lighting
265600 Exterior Lighting
271700 Interior Fiber Optic Cable System
283100 Digital, Addressable Fire-Alarm System
283600 Gas Detection and Alarm
321313 Concrete Pavement
323113 Chain Link Fences and Gates

8. TEST AND BALANCE REPORTS

221119 Domestic Water Piping Specialties – vacuum breakers
226113 Compressed-Air Piping for Laboratory Facilities
230593 Testing, Adjusting and Balancing for HVAC
232113 Hydronic Piping
232300 Refrigerant Piping – tests and inspections
236200 Packaged Compressor and Condenser Units
238216 Air Coils
2605256 Grounding and Bonding for Electrical Systems
265600 Emergency Lighting
265600 Exterior Lighting
312300 Earthwork
320514 Topsoil
321216 Bituminous Pavement

C. Shop Drawings and Samples

1. The Contractor shall review, stamp with their approval, and submit via the Unifier Submittal process to the Project Representative all Shop Drawings and Samples asked for in these specifications, or deemed necessary by the Architect/Engineer.

2. Work will not begin on any item requiring Shop Drawings or samples until the Contractor receives approval in writing from the Architect/Engineer. Any material or item, ordered or fabricated prior to final approval shall be at the Contractors' risk. No changes shall be made on the approved drawings or samples without the written consent of the Architect/Engineer. Each Shop Drawing or Sample shall be properly identified as to MSU project title and number, Contractor, item, etc., with cover sheet, stamp, tag, etc., so as not to be confused with any other. The Contractor shall direct specific attention with written explanation to any deviation from what is specified or shown on the drawing.

D. Shop Drawings

1. The Shop Drawing will be identified by job name, date, Contractor name and name of person reviewing for compliance with Contract Documents. Shop Drawings are drawings, diagrams, schedules and other data specifically prepared by the Contractor to illustrate some portion of the Work for which submittals are required by the Contract Documents. The purpose of their submittal is to demonstrate the way by which the Contractor proposes to conform to the information given and the design concept expressed in the Contract Documents.

2. The Contractor shall review for compliance with the Contract Documents, approve and submit to the Owner all Shop Drawings required by the Contract Documents. Submittal shall be with reasonable promptness and in such sequence as to cause no delay in the Work or in activities of the Owner or their separate Contractors. Submittals which are not marked as reviewed for compliance with the Contract Documents and approved by the Contractor may be returned by the Owner without action.

3. By approving and submitting Shop Drawings the Contractor represents that the Contractor has determined and verified materials, field measurements and field construction criteria related thereto, or will do so, and has checked and coordinated the information contained within such submittals with the requirements of the Work and of the Contract Documents.

4. The Owner will review and approve or take other appropriate action on the Shop Drawings submitted by the Contractor only for the limited purpose of checking for conformance with information given and the design concept expressed in the Contract Documents. Review of Shop Drawings is not conducted for the purpose of determining the accuracy and completeness of other details such as dimensions and quantities, or for substantiating instructions for installation or performance of equipment or systems, all of which remain the responsibility of the Contractor as required by the Contract Documents. The Owner's review shall not constitute approval of safety precautions or, unless otherwise stated by the Owner, of any construction means, methods, techniques, sequences or procedures. The Owner's approval of a specific item shall not indicate approval of an assembly of which the item is a component.

E. Samples

1. Samples shall be submitted as directed to provide a representative sample. Samples shall be physical examples, from the actual materials, to be used whenever practical. All packing and transportation charges on samples shall be paid by the Contractor.

2. A Submittal record shall be created in Unifier for each sample, indicating the manufacturer and specifications, and informing the Owner of the status of delivery of the physical sample. The physical sample will be retained by the Owner. The Submittal record will be returned to the Contractor with a review status by the Owner.

3. Approval of Samples shall be generally for quality, color, and finish, and shall not modify the requirements of any of the Contract Documents as to dimensions or design.

1.5 SPECIAL PROCEDURES

A. Constructor Safety Requirements

1. MIOSHA regulations apply to all university projects. Each constructor is responsible for ensuring compliance with "all applicable requirements" that govern their work, including any additional regulations, interpretations, clarifications, and consensus standards incorporated therein by reference.

2. MSU-specific safety requirements are published in the Constructor Safety Requirements Manual. The most current version of this manual is available at http://www.ehs.msu.edu/contractors. Constructors will be held to the version of the manual in effect at the time of contract execution.

3. Requirements specific to work at Michigan State University generally fall into one of two categories:

   a. Administrative Requirements, such as but not limited to communication, planning, documentation, submittals, notifications, reporting, and inspections.

b. Safety Requirements unique to work at MSU, such as but not limited to Control of Hazardous Energy/Lock Out Tag Out, Confined Space, Electrical, Excavations, Fall Protection, Hot Work, etc.

4. Constructor shall submit a Site-Specific Safety Plan or work under an existing Area-Specific Safety Plan where allowed, as described in the MSU Contractor Safety Requirements Manual.

B. Hazardous Materials

1. If the Contractor suspects a material, preexisting or newly discovered, within the scope of this project to be a hazardous material such as, asbestos, lead, polychlorinated biphenyl or any other potentially hazardous material, that has not already been identified and/or in the scope of work for the Contractor to abate, notify the Project Representative immediately. Do not impact or disturb the material in question until it has been determined to either be non-hazardous, included in the original scope of work, or until other arrangements can be made with the project representative and the MSU Department of Environmental Health and Safety (EHS).

2. Due to the age of buildings on the Michigan State University campus, all coated surfaces shall be assumed to contain lead-based paint. This includes but is not limited to any type of paint, primer, coating, lacquer, or varnish on any building component. Proper precautions must be taken to ensure that workers and building occupants are not exposed to airborne lead concentrations at or above the OSHA Action Level (AL) of 30 ug/m3.

3. If work will be conducted on any coated surface at MSU, the contractor must submit to the Department of Environmental Health and Safety (EHS) and Infrastructure Planning and Facilities Project Representative current proof of appropriate detailed written lead work plan in accordance with 29 CFR § 1926.62 (Michigan Part 603). This submittal will include proof of training, written respirator program, and negative exposure assessments from projects with similar conditions at a minimum. Contractors performing work on campus must follow the provisions of the MSU Lead Management Program from EHS.

4. Any work that impacts Lead shall comply with the provisions of the MSU EHS Lead Management Plan.

5. Any work that impacts Asbestos shall comply with the provisions of the MSU EHS Asbestos Management Plan.

1.6 REQUESTS FOR INFORMATION

A. Requests for Information (RFI's) shall be processed within PlanGrid, using the RFI business process in the IPF PlanGrid Standardization Guide. Failure to complete the tasks within the Plangrid time frames shall not be a basis for a delay claim.

PART 2 – PRODUCTS
Not Used

PART 3 – EXECUTION
Not Used

END OF SECTION

SECTION 014000 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 REGULATORY REQUIREMENTS

A. Applicable Codes, Standards, and Regulations

1. The following list of codes and regulations, establish the minimum requirements applied to work done at MSU. Where the specifications or plans, exceed the applicable code, the specifications and plans shall be followed.

a. NFPA National Fire Codes.
b. NFPA National Electrical Code.
c. ICC International Building Code.
d. ICC International Plumbing Code.
e. ICC International Mechanical Code.
f. State of Michigan Elevator Safety Act - Act 227, P.A. 1967.
g. State of Michigan Boiler Act - Act 290, P.A. 1965.
h. State of Michigan Construction Code Act - Act 230, P.A. 1972, as amended.
i. State of Michigan Occupational Safety and Health Act - Act 154, P.A. 1974, as amended.
j. Americans With Disabilities Act (ADA) Public Law 101-336.
k. Regulations of Air Pollution Control Commission State of Michigan, and the Federal Clean Air Act (42 U.S.C. 1857C - 8 © (1)).
l. Soil Erosion and Sedimentation Control - Act 451 of 1994, parts 31 and 91, as amended.
m. Environmental Impact Statement Executive Order 1974-4.
n. State Fire Safety Board's New Rules for Schools, Colleges, and Universities.
o. State of Michigan Safe Drinking Water Act, P.A. 339 of 1976, and Federal Water Pollution Control Act (33 U.S.G. 1319 ©).
p. State of Michigan Energy Code (Adopting ASHRAE 90 by reference).

1.2 REFERENCES

A. Abbreviations and Symbols

1. AIA - American Institute of Architects
2. ACI - American Concrete Institute
3. AISC - American Institute of Steel Construction
4. ANSI - American National Standards Institute
5. ASTM - American Society for Testing Materials
6. BOCA - Building Officials and Code Administrators
7. LEED - Leadership in Energy and Environmental Design
7. NFPA - National Fire Protection Association
8. OSHA - Occupational Safety and Health Act
9. SMACNA - Sheet Metal and Air Conditioning Contractors National Association

10. MDOT - Michigan Department of Transportation
11. USGBC - U.S. Green Building Council

1.3 QUALITY CONTROL

A. Testing Laboratory Services

1. All work (materials and installation procedure) shall be tested and inspected by an independent testing and inspection agency, approved by the Project Representative to provide the quality control requirements in accordance with these specifications. Results of these tests and inspections when performed in accordance with these specifications will not be disputed by either party. Failure of the Contractor to provide quality control in accordance with this specification may result in the replacement of the work at the Contractor's expense.

B. Contractor’s Responsibilities

1. Submit the name of the proposed testing and inspection agency(s) to the Project Representative for review and approval prior to contracting for such services.

2. Employ and pay the cost of independent testing and inspection as required in this specification. Pay applications from the testing/inspection agency shall be reviewed by the Owner before the Contractor’s pay request for testing/inspection services is approved.

3. Advise the testing and inspection agency sufficiently in advance of the work to be inspected in the field to allow time to schedule personnel and equipment to perform the required inspections. Failure of the work to be inspected shall be the sole responsibility of the Contractor regardless of the fault of the testing and inspection agency.

4. Furnish certificates to authenticate the type and or quality of products furnished for installation as required in these specifications.

5. Shall notify the Project Representative in a timely manner when and where testing is to take place to provide sufficient time for the Project Representative to be in attendance.

C. Testing & Inspection Agency Responsibilities

1. Perform all testing and inspection of the work in accordance with these specifications.

2. Furnish qualified personnel and sufficient equipment in a timely manner when required by the Contractor and/or Project Representative to perform all testing and inspection in accordance with these specifications.

3. Provide written reports (2 copies) in a timely manner of the work tested and inspected. The reports shall include complete material test results and for in-place material, a sketch showing the exact location where the test was taken on the project site.

4. The inspection and testing agency and its representatives are not authorized to revoke, alter, relax, enlarge or release any requirements of the Contract Documents, nor to approve or accept any portion of the work.

5. Work will be checked by representatives of the testing agencies as it progresses, but failure to detect any defective work or product will not in any way prevent later rejection when such defect is discovered, nor will it obligate the Owner to final acceptance. When it appears that the work or product furnished is in non-conformance with the Contract Documents, the representative of the testing agency will direct the attention of the Project Representative and Contractor to such non-conformance.

6. Quality control testing items shall include the following:

    a. Soil densities
    b. Concrete testing
    c. Asphalt field testing (density and yield)
    d. Bituminous mix design approval and batch plant verification
    e. Asphalt plant mix verification
    f. Verify pavement sections
    g. Determine need for and extent of sub-grade undercutting and testing

D. Authority of the Project Representative

1. May order additional tests and inspection beyond those required, if in their opinion, the subject work may not meet specification. The costs for these tests and inspections shall be borne by the Contractor.

2. May terminate the testing and inspection agency. The Contractor shall then furnish to the Project Representative the name of an additional agency for approval.

3. May perform quality control tests and inspections.

PART 2 - PRODUCTS
Not Used

PART 3 - EXECUTION
Not Used

END OF SECTION

SECTION 015000 - TEMPORARY FACILITIES AND CONTROLS

PART 1- GENERAL

1.1 TEMPORARY UTILITIES

A. General

1. The Contractor for the general construction work shall be responsible for all items specified in Section 015000. The Contractor shall install and maintain all items until project is finished and shall remove same and restore areas to their original conditions.

B. Temporary Electricity

1. The Contractor may use any permanent electrical outlets in the construction area.

2. Construction lighting shall be turned off during unoccupied periods, with the exception of lighting required for safety reasons such as path of egress.

3. Temporary service for heavy loads, or where no other service is available, will be provided by the general Contractor at the Contractor's expense. Power for temporary service connected to public utility company lines, (before an MSU service meter) will be paid for by the Contractor. Power for temporary service connected to the MSU power system, or after an MSU service meter, will be furnished by the Owner at no charge.

4. The contractor shall install temporary lighting within the construction area consistent with MIOSHA requirements.

C. Temporary Heat

1. All equipment and labor for temporary heat shall be furnished by the Contractor. Use of University utilities for temporary heat will be at the discretion of the Owner. The cost of natural gas or steam for heating new structures or other applications requiring temporary heat will be paid by the Contractor.

D. Temporary Telephone Service

1. If there is no University phone at the immediate work site, the Contractor shall provide a temporary job site telephone and/or provide the Job Superintendent with a phone activated paging device or cell phone.

E. Temporary Water

1. Each Contractor may use water for construction purposes from the nearest University source.

F. Temporary Sanitary Facilities

1. A toilet in the work area may be used by the Contractor's employees.

2. Where there is no toilet in the work area, an approved chemical type portable toilet will be provided by the Contractor.

1.2 VEHICULAR ACCESS AND PARKING

A. Parking Regulations

1. Unless otherwise directed, all non-University personnel working on the Campus of Michigan State University are required to park as Visitors. Between 7:00 a.m. and 6:00 p.m., Monday through Friday, Visitors may park only in metered parking spaces or gate controlled parking lots.

2. Commercial permits are available from the Department of Police and Public Safety (355-8440), which will allow parking in specific areas. The cost of a commercial permit is the responsibility of the Contractor.

3. Permits for one day parking in areas reserved for university employees are available to Contractors or their personnel from the Department of Police and Public Safety at the current rate, with a signed note from the Project Representative.

4. Parking permits are not required for vehicles south of Mount Hope Road.

5. Remote parking for Contractor personnel is available in parking lot 97 and cost to be verified by contractor with DPS. Due to the limited number of faculty/staff parking spaces in the vicinity of the construction site, no general commercial permits will be issued.

1.3 TEMPORARY BARRIERS AND ENCLOSURES

A. General

1. The Contractor shall provide, install, and maintain necessary temporary barriers, warning signs, and other safety measures to protect the public, property, and plant growth.

2. The Contractor will be required to work within limitations imposed by the University Police and Public Safety Department with respect to vehicular and pedestrian traffic. When approved by the Owner, if it becomes necessary to occupy a traffic lane for **ANY** length of time, proper directional signs, flashers and barricades shall be provided at the Contractor's expense in accordance with the most recent edition of the Michigan Manual of Uniform Traffic Control Devices. The Contractor will replace if damaged or stolen, all barricades, flares, and night protection at Contractor’s expense, all being considered as incidental to the work.

B. Dust Control

1. Temporary Partitions

a. The Contractor shall construct necessary temporary partitions to isolate the new work from the existing building.

b. Unless noted otherwise, construct partitions of 2” x 4” wood studs, 16” on center and heavy mil, fire retardant plastic sheeting securely attached so as to keep dust, dirt, and debris from spreading beyond the work area.

2. Return Air Openings

a. The Contractor shall block all return air openings in the work area so that dust will not carry into other areas of the building.

3. Site Dust

a. The General Contractor shall be responsible for eliminating airborne dust in the work area and staging area by application of appropriate mitigation measures, as approved by the Owner.

C. Security Measures

1. Temporary & Access Keying

a. The MSU Infrastructure Planning and Facilities Key Shop will furnish construction keys, and furnish and install construction cores for use during construction as deemed necessary by the Project Representative. The Contractor may pick up the construction keys at the Key Shop with the form, "Authorization for Construction Cores and Keys," completed and authorized by the Project Representative.

b. All construction keys and facility keys issued to a Contractor for a particular project will be returned to the Project Representative before final payment will be processed. If keys are not returned, the Contractor may be held responsible to pay for re-keying any and all affected facilities.

2. Campus Security and Access Control System

a. When deemed necessary by the Project Representative, temporary security access cards will be issued to the Contractor for building exterior doors, rooms, and/or spaces that are secured by the Campus Security and Access Control System.

b. On construction projects where the security system is active and armed during construction the Contractor will be assessed a false alarm fee for any unauthorized entry of a secure space and/or setting off an alarm by propping open secured doors/windows, cutting into the security wiring, removing security devices, or any other action causing an alarm.

c. The false alarm fees shall be as follows:

First occurrence	No assessed fee
Second occurrence	$500
Third and subsequent occurrences	$1,000 each

d. The breaches of security and associated fees shall be assessed by project to the Contractor, not by sub-contractor, vendor, supplier, etc.

D. Campus Woody Plant Protection

1. Coordinate all plant protection and site work limits with the Project Representative. SITE WORK CANNOT COMMENCE WITHOUT A PRE-CONSTRUCTION WALK-THROUGH.

   All Contractor employees engaged on the project site shall attend, or are expected to have attended, the Contractor Woody Plant Protection Seminar, hosted by MSU's Landscape Services (formerly Grounds Maintenance) Division. This seminar will be presented on an annual basis at a minimum. Coordinate with the Project Representative for times and locations of the seminar(s).

2. Work by Owner

   a. Tie-back of existing plantings. Pruning, thinning, and sealing of existing plantings. Root pruning and root protection of exposed roots. Watering of existing trees under stress. Salvaging of existing small trees, shrubs, and other plant growth that the Owner wishes to retain.

3. Protection of Plantings

   a. Protect existing trees and other vegetation indicated to remain in place. Prohibited practices include breaking of branches, scraping of bark, or unauthorized cutting; nailing or bolting into trees or plants; use of trees or plants as temporary support (i.e. for cables); unauthorized filling, excavating, trenching or auguring within the root zone; compaction/driving over the root zone; (see definitions below), storage of any materials or vehicles within the root zone; dumping of construction waste or materials (including liquids); unauthorized removal or relocation of woody plants; removal of tree protection barricades or construction fencing prior to completion of project.

b. Compaction within the root zone is the increasing of the soil density caused by heavy equipment or concentrated foot traffic which significantly alters the soil conditions from that which was present prior to construction.

c. The root zone of a tree is one and a half the distance of plant crown drip line outward from the stem, along undisturbed grade. Should placement of concrete be specified or authorized by the Owner within the root zone, a sulfur application will be applied by the Owner. The Contractor shall notify the Owner at least 48 hours prior to pouring concrete. Trees to receive sulfur shall be identified by Owner.

d. Tree protection barricades shall be wood rail fencing constructed of 4" x 4" x 11' posts, at 8' maximum o.c. and two 2" x 6" wood rails, lined with snow fence (or similar approved construction barrier fencing) which meets existing grade. Standard fence height shall be 8'; for variations see site drawings. Failure to install barricades as directed may halt work. Plant damage occurring within installed barricades does not absolve the Contractor from damage assessment.

e. All tree protection shall be installed prior to the beginning of construction and continually maintained. Tree protection shall not come in contact with anything except the construction fence, when shown on the drawings.

4. Damage

a. Damage to campus woody plants shall include any of the items indicated in paragraph 2.a above as determined solely by the Owner. The Owner shall evaluate damage and establish proportional fines up to 100% of the value shown below, regardless of the current disposition of the plant.

b. 100% Value Schedule for Campus Trees

1" - 3" caliper	$200/inch
3" - 6" DBH	$290/inch
6" - 9" DBH	$380/inch
9" - 12" DBH	$480/inch
12" - 15" DBH	$670/inch
15" DBH or greater	$960/inch

c. DBH is the tree trunk diameter at breast height.

d. Replacement value for shrubs, vines, and perennials shall be assessed at three times the current market cost of the plant.

e. Alternatives to the above protective measures, or any variations, must be approved by the staff Landscape Architect and the Project Representative. (Measures may include: thinning and root pruning, fertilization, aeration, boring & jacking, hand excavation, supervision by campus arborist, seasonal schedule recommendations.) Alternatives would be based on the specific requirements of the plant species in question, as determined by the staff Landscape Architect.

1.4 TEMPORARY CONTROLS

A. Soil Erosion and Sediment Control (SESC)

1. The Contractor shall comply with all Contract Documents, approved SESC plans, permit conditions and with Parts 31 and 91 of Public Act 451 of 1994. The Owner shall obtain a Soil Erosion and Sedimentation Control (SESC) permit from the appropriate Municipal (MEA) or County (CEA) Enforcing Agency. Permit Fees and MEA/CEA routine inspections will be paid for by the Owner.

2. Prior to beginning any earth change, the Contractor shall retain a DEQ Certified Storm Water Operator (CSWO) to provide the required SESC reports (which include the weekly and storm event reports as well as all follow up reports for both violations and storm event corrections) on the standard DEQ form. The Contractor shall provide the reports to the Owner on a weekly basis, and retain those reports for 3 years.

3. Prior to beginning any earth change, and during the life of the contract, the Contractor shall install and maintain all temporary SESC measures as shown on the Contract Documents, SESC plans, and as directed by the Owner, CSWO, DEQ, or MEA/CEA, until MSU officially takes over responsibility for the site.

4. Immediately prior to MSU taking responsibility for the site, the Contractor:
   a. Will be required to clean all catch basins affected by the construction, both within the Contract Limits and all surrounding roads and lawn areas when soil may have spread as the result of construction activities.
   b. Shall put all temporary SESC measures in satisfactory condition as determined by the CSWO.

5. All temporary SESC measures will remain in place and will become the property of the Owner when responsibility for maintaining the SESC measures becomes the Owner's responsibility.

6. The Contractor shall conduct all excavation, filling, grading and clean-up operations in a manner such that sediment generated by wind or water is not discharged off site or into any storm sewer, drainage ditch, river, lake, air or underground utility system. Stage the work per plan to minimize the area of exposed soil, thereby reducing the opportunity for soil erosion.

7. Water from trenches and other excavation shall be passed through an approved filtration bag to remove sediments from the water before it is released into the storm water drainage system.

8. If sediment extends beyond the project limits, the Contractor shall be responsible for cleanup and restoration of all surfaces and utility systems to the condition that existed prior to the Contract award.

9. All SESC measures shall be maintained daily.

10. Should violations (irrespective of a fine being assessed) be identified by the Owner, CSWO, MEA/CEA or DEQ, they shall be corrected within 24 hours of notification. The correction(s) shall be approved by the Owner, CSWO, MEA/CEA or DEQ. All subsequent inspections performed by the Owner, CSWO, MEA/CEA or DEQ as a result of the violation (and any other associated costs) will be paid by the Contractor. If identified violations are not corrected within 24 hours of written notice, the Owner shall have the right to make necessary repairs at the Contractor's expense, without being required to provide further notice to Contractor.

11. Fines assessed as a result of the violation for non-compliance of the SESC provisions, will be paid by the Contractor. If a "Stop Work" order for non-compliance is issued, a time extension request for that time period will **not** be granted. (Fines could be assessed up to and including $25,000/DAY for each violation.)

12. Only one Seven Day Notice will be issued for violations of the SESC provisions. Should subsequent violations be identified, the contractor will be expected to make the satisfactory correction within 24 hours of notification. Should the corrections not be made, the Owner, without further notice to the Contractor, will correct the violation. The cost of the corrective action will be charged to the Contractor.

1.5 CONSTRUCTION DEBRIS CONTROL

A. The Contractor shall provide and administer a system for disposal of construction debris, and shall be responsible for seeing that the site and the new building are at all times free of accumulated debris caused by the construction. For purposes of this paragraph, debris shall include ALL materials used in construction including construction roads and pads. Special attention should be given to materials that could leach into the ground, including but not limited to lime based materials, all chemicals, and any liquids except clean water.

B. The Contractor shall comply with LEED Materials & Resources Credit 2, including documentation of the Construction Waste materials recycled, reused and sent to the landfill, using the Construction Waste Management form and process provided by the Owner in Unifier. This form shall be submitted monthly, and will be generated from completed payment applications. Negative reports are required.

C. This shall include, but not be limited to, rubbish containers conveniently located throughout the site for the daily disposal of debris directly into them from each work location. Debris shall not be allowed to accumulate on the ground through-out the site overnight.

D. All combustible debris shall be removed to a solid waste disposal site properly licensed under Act 87 of the Public Acts of 1965 of the State of Michigan.

E. No burning of debris will be permitted on the Project site or elsewhere on the Owner's property.

F. Should the Contractor not execute the work required in this section, the Owner reserves the right to perform the work by other forces and deduct the cost from the contract price.

1.6 CONFINED SPACES

A. The workplace may contain permit confined spaces and entry is allowed only through compliance with a confined space program as defined by 29 CFR 1910.146. The contractor is responsible for assessing real or potential atmospheric hazards and other serious safety and health hazards in the confined space. MSU will make available records of known confined space hazards. The contractor shall provide all necessary equipment for confined space entry. If MSU personnel will be working in or near confined spaces occupied by the contractor, the contractor is required to coordinate activities with the Project Representative. The contractor will inform the Project Representative of procedures followed and hazards confronted or created during entry operations.

1.7 LOCK-OUT/TAG-OUT PROCEDURE

A. The Contractor shall conform to Michigan State University Infrastructure Planning and Facilities lock-out/tag-out procedure. Copies are available from Planning, Design and Construction, Infrastructure Planning and Facilities Building, Michigan State University.

1.8 FM RED TAG PERMIT MONITORING SYSTEM

A. When working on fire protection sprinkler systems the Contractor shall conform to the Factory Mutual Red Tag Permit Monitoring System modified by notifying the Project Representative in lieu of the Emergency Organization, Public Fire Department, and Factory Mutual. Documentation is available from Factory Mutual, (781) 255-4359.

1.9 FM HOT WORK PERMIT SYSTEM

A. For all hot work operations, the Contractor shall conform to the Factory Mutual Hot Work Permit System modified by notifying the Project Representative in lieu of the Fire Safety Supervisor and Factory Mutual. Documentation is available from Factory Mutual, (781) 255-4359.

1.10 HAZARDOUS SUBSTANCE SPILLS

A. Releases of hazardous substances that pose a significant threat to health and safety, or that, by their very nature, require more than a routine response, are emergency situations. If a release of an emergency nature occurs, call 911 immediately. Provide all applicable information and stay on the phone until told to hang up. If a non-emergency release of a hazardous substance occurs, contact the MSU Infrastructure Planning and Facilities Project Representative immediately.

1.12 CRANE HOISTING

A. Crane hoisting of equipment or materials over occupied spaces shall be performed at the convenience of the Owner, with arrangements made by the Project Representative.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION (Not Used)

END OF SECTION

SECTION 016000 - PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 PRODUCT STORAGE AND HANDLING REQUIREMENTS

A. Storage and Protection

1. The Contractor shall be responsible for work, material, and equipment until finally inspected, tested, and accepted. The project shall be protected against theft, injury, and damage. Material and equipment received on the site shall be carefully stored until installation.

B. Staging Area

1. Should the Contractor require exterior staging or on-site storage of materials - the location of this area must be agreed upon prior to actual use of the space by the Project Representative and the Contractor. The area will not be within the drip-line of any tree or in plant beds, as per Section 015000.1.3.D.3.

2. If this exterior area is outside the fenced project site, the area shall be enclosed with a minimum 4' high welded wire fence, with metal fence T-posts not exceeding 8' on center. Fence fabric shall be supported by either a top bar or a tension cable.

3. The Contractor shall be responsible for the cost of placing and removing the fence.

4. Each designated area shall have only one access route from the road or drive.

5. The area is not to be used for employee parking, but may be utilized by the Contractors' vehicles and equipment necessary to service the project.

6. Any areas damaged as a result of the staging operation shall be repaired by the Contractor, at no additional cost to the Owner.

PART 2 - PRODUCTS
Not Used

PART 3 - EXECUTION
Not Used

END OF SECTION

SECTION 017000 - EXECUTION REQUIREMENTS

PART 1- GENERAL

1.1 EXAMINATION

A. Pre-Bid Site Inspection

1. Each Bidder shall be held to have visited the site of the proposed work before submitting their proposal and to have familiarized themselves with all existing conditions affecting the execution of the work in this project. No allowance or extra consideration on behalf of the Contractor or Subcontractor will subsequently be made by reason of failure to observe the site conditions.

1.2 PREPARATION

A. Protection of Work and Property

1. Contractor shall protect existing and new work as required by this construction or as requested by the Project Representative.

2. Interior Protection

a. This will include, but not be limited to the wall, floor, and ceiling finishes to remain at the construction site, along the access route to the site, existing elevators, and other areas such as roofs and mechanical rooms where related work is specified or required.

3. Exterior Protection

a. The Contractor shall be responsible for any damage to existing facilities, including but not limited to the following: buildings, trees and shrubs, walks, roads, utility systems, terraces and steps, lights, and unreasonable turf damage as determined by the Project Representative. Damage shall be repaired by the Contractor in accordance with MSU's Construction Standards at no cost to the Owner.

b. No crawler cranes, bulldozers, or other equipment, fitted and running on steel treads, shall be permitted to traverse any walk, road, street, or other thoroughfare on the Campus of Michigan State University. Where it is necessary to unload such equipment on these thoroughfares, and when approved by the Project Representative, planking shall be provided to protect same. If this is not done, and damage is observed, the cost of replacing shall be the burden of the Contractor causing such damage.

c. Staging zones for materials and equipment shall be coordinated with Project Representative. They are to be placed on paved areas where possible. Set-up and storage areas shall be fenced with minimum 6-foot high pedestal-type chain link fencing. Locations shall be reviewed with the Department of Police and Public Safety and approved by the Project Representative.

d. Crane hoist dates shall be coordinated with Project Representative for sufficient notice to building users. Project Representative shall direct the notice to the building users and coordinate with DPPS.

e. Owner may provide temporary access-ways in turf or root zone areas, as determined in pre-construction walk-through. For heavy equipment on turf areas, Alturna mats or approved equal, must be utilized for travel and set-up zones.

f. All electric, telephone, and steam vaults and water valves shall be protected and remain accessible at all times. Heavy equipment shall not be run over the top of vaults or valve boxes, nor shall materials be stored over them.

g. Contractor shall provide lighted barricades if building entrances or pedestrian walks are closed after work hours or on the weekends.

h. Tree pruning, plant tie-back, and vine removal shall be done by the Owner, as coordinated with the Project Representative, and as noted in Section 015000.1.3.D.2.a. Trees or other plant material shall not be used as anchor points for any lines or equipment.

i. Plant protection as directed by the Project representative:

a. Minor work: Plants adjacent to, or below work zones are to be washed off daily. In no case shall masonry dust or other construction debris remain on plants for more than 24 hours.
b. Major work: Plants adjacent to, or below work zones are to be covered with breathable woven mesh tarp. Tarp shall be removed at the end of each day and debris disposed of. Debris and dust shall not be absorbed into soil.

B. Field Engineering

1. Quality Assurance

a. Surveyor

1. Engage a Registered Land Surveyor, registered in Michigan, to perform ALL project surveying, including construction layout, as outlined in Section 017000-1.2.B, "Field Engineering."

2. Submittals

    a. Project Record Documents

        1. Upon completion of Work requiring Field Engineering, submit a record of Work performed and record survey data as required in Section 017000-1.2.B.5.

        2. Upon completion of Work requiring Field Engineering, submit a certificate signed by the Registered Land Surveyor, certifying the location and elevation of improvements comply with the Contract Documents.

3. Control Points

    a. The Owner will identify existing control points and property line corner stakes.

    b. Verify layout information shown on the Drawings in relation to the property survey and existing benchmarks before proceeding to lay out the Work. Locate and protect existing benchmarks and control points. Preserve permanent reference points during construction.

    c. If a discrepancy between the contract drawings and the existing site is found, contact the Project Representative for a resolution BEFORE any actual layout of the work is begun.

    d. Do not change or relocate benchmarks or control points without prior written approval. Promptly report lost or destroyed reference points, or requirements to relocate reference points because of necessary changes in grades or locations.

    e. Promptly replace lost or destroyed control points. Base replacements on the original survey control points.

    f. Establish and maintain a minimum of two permanent benchmarks on the site, referenced to data established by survey control points.

    g. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.

    h. The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning site work, investigate and verify the existence and location of underground utilities and other construction.

    i. Prior to construction, verify the location and invert elevation at points of connection to existing utilities.

4. Benchmarks and Markers

    a. Working from lines and levels established by the property survey, establish benchmarks and markers to set lines and levels at each story of construction and elsewhere as needed to properly locate each element of the Project. Calculate and measure required dimensions within indicated or recognized tolerances. Do no scale Drawings to determine dimensions.

    b. Advise entities engaged in construction activities of marked lines and levels provided for their use.

    c. As construction proceeds, check every major element for line, level, and plumb.

5. Registered Land Surveyor's Log

    a. Maintain a surveyor's log of control and other survey Work. Make this log available for reference.

    b. Record deviations from required lines and levels, and **immediately** advise the Project Representative when deviations that exceed indicated or recognized tolerances are detected. On Project Record Drawings, record deviations that are accepted and not corrected.

    c. On completion of foundation walls, major site improvements, and other Work requiring field engineering, submit this log and associated Project Drawings to the Project Representative.

6. Existing Utilities

    a. Furnish information necessary to adjust, move or relocate existing structures, utility poles, lines, services or other appurtenances located in or affected by construction.

7. Site Improvements

    a. Locate and layout all site improvements including, but not limited to, pavements, structures, earthwork and utility locations and grades.

8. Structure Lines and Levels

    a. Locate and layout batter boards for structures, building foundations, column grids and locations, floor levels and control lines and levels required for mechanical and electrical Work.

1.3 EXECUTION

A. Cutting and Patching – Concrete and Masonry

1. The Contractor shall be responsible for any cutting, fitting, and patching that may be required to complete this project, except for core drilling required for mechanical and electrical installations, which shall be the responsibility of the Mechanical or Electrical Contractor.

2. The Contractor shall not endanger any work of any other Contractors by cutting, excavating, or otherwise altering any other work and shall not cut or alter the work of any other Contractor except with the written consent of the Architect/Engineer.

3. No cutting of structural members of the building, likely to impair its strength, shall be done without written approval from the Architect/Engineer.

4. To avoid damage to hidden utilities and structural re-enforcement any cutting or core drilling over one inch in diameter, through concrete floors and slabs will be x-rayed/scanned by the contractor prior to cutting.

    a. A qualified engineer will conduct an on-site assessment before any cutting or drilling of a pre-tensioned or post-tensioned component or other structural component of a building or structure commences. The assessment will be documented and provided to the person contracted to carry out the work.

    b. If any load bearing member is cut, cored or removed all the requirements of 29 CFR 1926 Subpart T (LARA Part 20) shall apply. This will require notifications to the DEQ 10 working days before cutting begins. Emergency notifications are possible under specific conditions.

    c. The responsible person for the project shall ensure substantial compliance with the requirements for exposure to Silica Dust. Substantial compliance will also be required for all other construction safety standards and published by the State of Michigan or Federal OSHA.

    d. Work shall be conducted outside of the regular hours to avoid disturbing the building occupants. An exception to this rule will be granted only by the project manager and shall be in writing.

e. The MSU project representative or employee shall be responsible for locating all utilities in the area to be cut. This part of the job is mandatory and shall be given appropriate attention. Minimally the responsible person shall review all available prints and consider structural scanning. The MSU representative or employee shall take necessary steps to isolate and lock out any energy sources that may be jeopardized by the cut to protect worker safety and avoid equipment damage. In some cases, utilities will need to be cut and relocated to conduct the work. The responsible person shall take steps to notify repair persons in advance of the anticipated timing and scope of the repair project or the need for temporary services.

f. Responsible person shall inspect the area to ensure that no damage has occurred and that the area is cleaned to an acceptable level.

5. Cutting and Patching for Mechanical Work

a. The Mechanical Contractor shall be responsible for any core drilling required to complete their work.

b. The Mechanical Contractor shall be responsible for the accurate location of all openings necessary for the installation of the mechanical work. Any additional openings required to move their work due to an error in the initial layout and the repair of inaccurate openings, shall be made at the expense of the Mechanical Contractor.

6. Cutting and Patching for Electrical Work

a. The Electrical Contractor shall be responsible for any core drilling required to complete their work.

b. The Electrical Contractor shall be responsible for the accurate location of all openings necessary for the installation of the electrical work. Any additional openings required to move their work due to an error in the initial layout and the repair of inaccurate openings, shall be done at the expense of the Electrical Contractor.

B. Salvaging of Materials

1. Materials or equipment shown on drawing or specified herein to be removed, which are not to be reused or salvaged, shall become the property of the Contractor and will be removed from University property and disposed of legally.

2. Deliver all fire alarm equipment removed from the job to the IPF Storage Building 210, 1457 Recycling Drive, East Lansing, MI.

3. Deliver all Best key cylinders to be removed from the job to the Key Shop in the Infrastructure Planning and Facilities Building, 1147 Chestnut Road, East Lansing, MI.

1.4 CLEANING UP

A. Cleaning up shall be in accordance with the General Conditions of the Contract.

B. No rubble, dust, or debris shall be allowed to accumulate or be transported throughout the building.

C. A thorough final cleaning of all of the adjacent streets, as specified by the Project Representative, will be required before final payment is made.

D. If the Contractor fails to clean up, the Owner may do so and the cost thereof shall be charged to the Contractor.

1.5 STARTING AND ADJUSTING

A. Refer to each Division for requirements.

1.6 CLOSEOUT PROCEDURES

A. In general, one or more walk-throughs will be performed with the Contractor and punch lists developed of items to be completed before the project can be closed out.

1.7 CLOSEOUT SUBMITTALS AND PROJECT DELIVERABLES

A. Operation and Maintenance Data

1. The Contractor shall provide operation and maintenance data as required in this specification, and submit the required information through use of the Unifier and PlanGrid systems.

2. Submittals for equipment and systems shall contain the manufacturer's information on installation, balancing, operating, maintenance, lubrication, and repair instructions and parts list for each component.

3. Please refer to MSU Document Submittal Standards and PlanGrid Standardization Guide.

B. As-Built Drawings

1. Submission of all As-built Drawings called for in this specification shall precede request for final payment.

2. The Contractor shall submit As-built Drawings in electronic (.pdf) format, that is not password protected, indicating any deviations from the Contract Drawings, including contract Change Orders. Upon request of the Owner, printed copies of the As-Built drawings shall be provided as well.

3. Provide any Building Information Model (BIM) data developed for this Project to the Project Representative.

4. Please refer to MSU Document Submittal Standards

C. Facility Asset Data Exchange (FADE) Log

1. The Constructor shall furnish all information as indicated on the FADE log spreadsheet. The University's FADE procedure and requirements for asset tracking and populating the log can be found at the following web addresses:

   FADE process during design phase:
   https://us.promapp.com/msu/Process/Minimode/Permalink/BrVwOrmhTRjBaJ5QaaOZKI

   FADE process during construction:
   https://us.promapp.com/msu/Process/Minimode/Permalink/BDKsT36upoGpxJeNiakDkW

   Should the Owner change the FADE process change in form or content, the Constructor is not relieved of fully executing the work required to compile the information and complete the Log.

D. Construction Safety Documentation

1. The Contractor shall provide written documentation of the following site safety information, as it pertains to the project only:

   a. List of all lost time accidents.
   b. Reportable incident rate (total hours worked).
   c. Details of many MIOSHA site visits, including resulting citations, violations, or actions.

E. Certificates of Inspection

1. The Contractor shall provide a copy of all Certificates of Inspection called for in this specification. Refer to Section 013000 Part 1.4.B.

F. Construction Waste Management – LEED Documentation

1. The Contractor shall provide written documentation of the Construction Waste Management program, as required for LEED Materials & Resources Credit 2. A form for this purpose is provided within this specification. Refer to Section 024200, Construction Waste Management.

G. Warranty

1. The Contractor shall provide a written guarantee stating that all work performed and material furnished is free from all defects in workmanship, and material for a period of one year, unless noted otherwise, after the equipment has been accepted by the Owner. Final payment or Certificate of Substantial Completion, whichever is issued first, shall constitute Owner acceptance.

2. Additional warranties are required for site concrete pavement (Section 321313), curb/gutter (Section 321613), bituminous pavement (Section 321216), and specific mechanical equipment (Division 23)

H. Final payment

A. The contractor shall provide a sworn statement with final payment. The statement shall detail all subcontractors paid on the project and other information detailed in the link below:

https://api.gis.msu.edu/edms/file/{C500C6DD-E852-11ED-0000-76DDD13A85C5}

PART 2 - PRODUCTS
Not Used

PART 3 - EXECUTION
Not Used

END OF SECTION

SECTION 019113 - GENERAL COMMISSIONING REQUIREMENTS

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.

B. OPR and BoD documentation are included by reference for information only.

1.2 SUMMARY

A. Section includes general requirements that apply to implementation of commissioning without regard to specific systems, assemblies, or components.

B. Owner intends to self-perform commissioning and act as the Commissioning Authority. Contractor responsibilities remain as indicated herein and in related Commissioning Specification Sections.

C. Related Sections:

1. Division 22 Section "Commissioning of Plumbing" for commissioning process activities for plumbing systems, assemblies, equipment, and components.
2. Division 23 Section "Commissioning of HVAC" for commissioning process activities for HVAC&R systems, assemblies, equipment, and components.
3. Division 26 Section "Commissioning of Electrical Systems" for commissioning process activities for electrical systems, assemblies, equipment, and components.
4. Division 27 Section "Commissioning of Communications" for commissioning process activities for communications systems, assemblies, equipment, and components.
5. Division 28 Section "Commissioning of Electronic Safety and Security" for commissioning process activities for electronic safety and security systems, assemblies, equipment, and components.

1.3 DEFINITIONS

A. BoD: Basis of Design. A document that records concepts, calculations, decisions, and product selections used to meet the OPR and to satisfy applicable regulatory requirements, standards, and guidelines. The document includes both narrative descriptions and lists of individual items that support the design process.

B. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.

C. CxR: Commissioning Representatives of the contractors, sub-contractors, manufacturers, and suppliers.

D. CxM: Commissioning Manager. The commissioning representative of the CM, appointed by the CM to manage and lead the commissioning effort on behalf of the CM.

E. OPR: Owner's Project Requirements. A document that details the functional requirements of a project and the expectations of how it will be used and operated. These include Project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information.

F. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.4 ABBREVIATIONS

A. CM: Construction Manager.

B. Cx: Commissioning.

C. CxA: Commissioning Authority.

D. CxM: Commissioning Manager.

E. CxR: Commissioning Representatives.

F. FPT: Functional Performance Testing.

G. GC: General Contractor.

H. PIV: Pre-installation Verification.

I. PSV: Pre-startup Verification.

J. STV: Startup Testing and Verification.

1.5 COMMISSIONING APPROACH

A. Commissioning process activities shall be completed, by the MSU commissioning team, in accordance with LEED-NC 3. Systems to be commissioned include:

1. HVAC&R systems and associated control systems.
2. Lighting and daylighting controls.
3. Domestic hot water systems.
4. Oxygen detection systems.

B. Include a series of checks, tests, and operational procedures applied in specific sequences to each system or equipment component to be commissioned.

C. Commissioning representatives of the sub-contractors, manufacturers, and suppliers shall perform the procedures, under the direction of the GC, utilizing members of the construction staff and representatives of the equipment and system manufacturers who are fully knowledgeable of the equipment and systems installation and operation.

D. Before the start of system installation, all contractors, sub-contractors, manufacturers, and suppliers providing labor or materials for items specified to be commissioned shall designate specific individuals as commissioning representatives (CxR) to be associated with the commissioning work. The CxM shall provide a complete listing of those designated CxRs. The commissioning representatives shall participate in the commissioning process as team members, providing commissioning testing services, equipment operation, adjustments, and corrections if necessary. All CxRs shall be selected as individuals having sufficient authority to direct their respective staff to provide the services required, accept and provide minor changes to the work on behalf of the sub-contractors or various organizations involved, and to speak on behalf of their organizations in all commissioning related contractual matters.

E. With exception to the pre-installation verification (PIV) phase all commissioning procedures and completion of Cx documents are to be carried out in collaboration between the CxA and CxRs. The PIV will be carried out and documented exclusively by the CxRs.

F. Where vibration testing and analysis, acoustic testing and analysis, fume hood testing, biological safety cabinet testing and certification, HVAC systems testing, adjusting and balancing, detailed mechanical alignment by laser systems, or electrical systems testing is required, these services shall be provided by testing agents skilled in the provision of the services specified to perform the work.

1.6 COMMISSIONING TEAM

A. The Commissioning Team consists of the CxA, CxM, AExA and CxR(s).

B. Members Appointed by Contractor(s):

1. CxM & CxR: Individuals, each having the authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated action. The commissioning team shall consist of, but not be limited to, representatives of each Contractor, including Project superintendent and subcontractors, installers, suppliers, and specialists deemed appropriate by the CxA.

C. Members Appointed by Owner:

1. CxA: The designated person, company, or entity that plans, schedules, and coordinates the commissioning team to implement the commissioning process. Owner will engage the CxA under a separate contract.
2. Representatives of the facility user and operation and maintenance personnel.
3. AExA: Architect and engineering design professionals.

1.7 OWNER'S RESPONSIBILITIES

A. Provide the OPR documentation to the CxA for information and use.

B. Assign operation and maintenance personnel and schedule them to participate in commissioning team activities.

C. Provide the BoD documentation, prepared by Architect and approved by Owner, to the CxA for use in developing the commissioning plan, systems manual, and operation and maintenance training plan.

1.8 CONTRACTOR'S RESPONSIBILITIES

A. Each Contractor shall assign representatives with expertise and authority to act on its behalf and shall schedule them to participate in and perform commissioning process activities including, but not limited to, the following:

1. Evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, recommend corrective action.
2. Cooperate with the CxA for resolution of issues recorded in the Issues Log.
3. Attend commissioning team meetings held on a variable basis.
4. Integrate and coordinate commissioning process activities with construction schedule.
5. Review and accept construction checklists provided by the CxA.
6. Complete paper construction checklists as Work is completed and provide to the Commissioning Authority on a weekly basis.
7. Review and accept commissioning process test procedures provided by the Commissioning Authority.
8. Complete commissioning process test procedures.
9. Provide comprehensive set of equipment submittals for review by CxA.
10. Provide control device submittals, sequence of operation descriptions and all control drawings for review by CxA.
11. Aid in the completion of pre-installation verification checklists.
12. Aid in the completion of pre-startup verification checklist procedures.
13. Aid in and the support the CxA as required to complete startup testing and verification checklist procedures (includes startup of all equipment).
14. Carry out functional performance testing procedures as directed by CxA.
15. Provide final control drawings and comprehensive operation and maintenance documentation for review by CxA.
16. Provide comprehensive operation and maintenance documentation for review by CxA.
17. Provide Owner training as required by the CxA.

1.9 CxA'S RESPONSIBILITIES

A. Organize and lead the commissioning team.

B. Provide commissioning plan.

C. Review and provide comment on submittals from Contractor for compliance with the OPR, BoD, and Contract Documents.

D. Convene commissioning team meetings.

E. Provide Project-specific construction checklists and commissioning process test procedures with exception of PIV carried out by respective contractor.

F. Verify the execution of commissioning process activities using random sampling. The sampling rate is 20%. A 100% verification shall be carried out for the PSV, STV and FPT phases. Verification will include, but is not limited to, equipment submittals, construction checklists, training, operating and maintenance data, tests, and test reports to verify compliance with the OPR. When a random sample does not meet the requirement, the CxA will report the failure in the Issues Log.

G. Verify 20% of all readings on both air and hydronic systems. When a random sample does not meet the requirement, the CxA will report the failure in the Issues Log.

H. Prepare and maintain the Issues Log for each phase of the commissioning process; address all noted issues through resolution.

I. Prepare and maintain testing and verification checklists and completed construction checklist log.

J. Witness systems, assemblies, equipment, and component startup.

K. Perform systems, assemblies, equipment, and component functional performance testing activities with the control contractor.

L. Compile test data, inspection reports, and certificates; include them in the systems manual and commissioning process report.

1.10 COMMISSIONING PLAN

A. Prior to the start of construction of any system required to be provided with commissioning services, the CxA shall assemble and make available the commissioning plan. This will be developed based on all project documentation and through input provided by the CxM and CxRs. All information, procedures, forms, drawings, and system descriptions will be made available for utilization by the GC and CxRs for carrying out the requirements of the commissioning process.

B. The commissioning plan shall detail the overall approach to commissioning, team organization, sequence and scheduling of activities, checks, tests, and procedures to be employed, coordination and methods of team communication and record keeping, and construction activities required in other sections of the project specifications.

C. The completed and approved commissioning plan and all subsequent revisions to the plan shall be made available to the GC and CxRs in hard copy and in electronic media form.

D. Detailed project scheduling information may be provided in the computer program and format preferred by the GC or may be provided as hard copy only if a computerized scheduling program is not utilized by the GC.

E. The CxA shall complete all sections of the Plan, providing sufficient detail and expanded information as required to fully complete all required commissioning work.

1.11 COMMISSIONING PROCEDURES

A. The CxM and CxRs shall fully review all commissioning checks, tests, and procedures, and related sequencing requirements provided by the CxA and become thoroughly knowledgeable of all commissioning procedure requirements. The CxRs shall thoroughly review all procedures with the respective equipment manufacturers to determine that the procedures can be provided in a manner which fully protects the equipment, the construction staff, the commissioning team members, and which maintains full equipment warrantees and guarantees.

B. The CxRs shall review and identify any modifications necessary for the following items:

1. To adequately reflect the requirements for job-site safety and adequate protection of the systems and equipment.
2. To coordinate all scheduling and sequencing requirements.
3. To adequately reflect the actual conditions, equipment, and systems as installed.
4. To fully demonstrate that the equipment or system is adequately installed and fully functional.
5. To provide a fully coordinated construction and commissioning effort and to provide the commissioning sequencing requirements.

C. The CxA shall provide sufficient procedure forms as necessary to provide sufficient space to record all required information for each component item and system included in the procedure. All procedure forms shall clearly indicate equipment identification numbers and descriptions coordinated with the Owner’s identification system. All procedure tasks or elements shall have provision within the forms to include the procedure results directly within the computer program electronic file copy without modification of the forms or data sheets.

D. Modifications and additions to the commissioning procedures shall be fully annotated to indicate the specific changes and the reasons for each change. Additions and modifications to the commissioning procedures shall be subject to review and approval by the CxA.

E. All commissioning procedures shall include a specific team listing of all individuals participating in each procedure and their respective organizations or roles. Provide space for each participant to sign as verification of attendance only. Signatures provided by participants, including the CxM, CxA, and AExA shall not constitute acceptance of the procedure, equipment, or system.

F. The GC or CM shall submit all proposed commissioning procedural changes from CxRs to the CxA for review and approval. Procedures shall not be scheduled for completion prior to obtaining satisfactory review and approval by the CxA.

G. The CxM or designated assistant shall provide field record keeping of all procedure results. All field data, notes, and comments, shall be neatly hand labeled in the respective procedure forms during each procedure. The CxM shall maintain a master file of all completed procedure originals and submit a copy to the CxA for implementation into the Final Commissioning Report. The CxM shall transfer all field procedure results, comments, and annotations to the computerized file copy of the procedure. Signature spaces shall be annotated as “yes” or “no” as verification of attendance in the computerized file copies.

1.12 COMMISSIONING DOCUMENTATION

A. MSU Physical Plant/Commissioning Services will provide all required field checklist documentation to CM or GC, and CxA.

B. CM/GC and CxA shall prepare an index to include storage location of each document.

C. CxRs shall complete all checklist items during each phase of commissioning process for each system and/or each piece of equipement as indicated by MSU Commissioning Services.

D. CM/GC and CxA shall verify the completion and accuracy of field checklist documentation on a basis of 20% for each system to be commissioned.

E. CxA shall document corrective action taken for systems and equipment that fail tests. Include required modifications to systems and equipment and revisions to test procedures, if any. Retest systems and equipment requiring corrective action and document re-test results.

F. CxA shall document results of the commissioning process including unresolved issues and performance of systems, subsystems and equipment.

G. CxA shall gather required information and compile final commissioning report.

1.13 SUBMITTALS

A. CxA shall submit sample checklists and forms to CxM for review and comment. Submit (2) copies of each checklist and report form.

1.14 COORDINATION

A. Coordination Meetings: CxA shall conduct two pre-construction coordination meetings and three to five additional meetings as required upon near completion of the mechanical system.

1.15 PROJECT COMMISSIONING REPORT

A. Prior to final acceptance of the commissioning process, and as a condition of final acceptance of the work, the CxA shall compile the detailed Project Commissioning Report.

B. The Project Commissioning Report shall detail the overall approach to commissioning, team organization, sequence and scheduling of activities, checks, tests, procedures employed, and methods of team communication and record keeping. The project commissioning report shall include a dedicated section that includes one copy of this commissioning specification section.

C. The Project Commissioning Report shall include all commissioning procedure results, test data, system or equipment descriptions, adjustments and set-up data, and the procedure descriptions and results of special testing, alignments and calibrations. The record shall contain all special reports, all certified final system adjusting and balancing reports, approved operations and maintenance manuals, certifications, and meeting minutes.

D. Contractors, sub-contractors, manufacturers, and suppliers shall provide all test data, reports, and information to the CxA in a timely manner for incorporation and inclusion in the Project Commissioning Report.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 PRE-COMMISSIONING WORK SESSION

A. The CxA shall chair and the CxM shall schedule a pre-commissioning work session to kick-off the project commissioning and to review the development of the commissioning plan. The work session shall be held soon after award of contract, prior to the installation of any of the systems that are to be provided with commissioning services, and prior to the initial submittal of the commissioning plan.

B. The work session shall be held at the GC's on-site construction office. The CxM, CxA, AExA, the GC's project manager, GC's designated construction superintendent, and the A/E's principle construction administration representative shall be scheduled for attendance, at a minimum. Sub-contractor representatives involved in the commissioning process may be scheduled for attendance at the direction of the CxM.

C. The CxA shall present an overview of the commissioning process. The CxM shall present and review the status and development of the updated commissioning plan and shall review all requirements of the plan in detail. The review shall include the CxA's approach to management and administration of the commissioning process, reporting lines and communications, record keeping, construction integration and coordination, commissioning procedures, scheduling, sequencing, and plan format.

D. Provide meeting date notification to the required participants a minimum of four weeks prior to the session. The meeting notification shall include a detailed agenda.

E. The CxA shall record participant comments and distribute minutes of the session to all parties involved.

3.2 PRE-COMMISSIONING SCHEDULING AND SEQUENCING WORK SESSION

A. The CxM shall schedule and chair a pre-commissioning scheduling and sequencing work session to review the CxM's initial commissioning schedule and interactively develop it further, integrating it with the construction schedule. The work session shall be held before the start of installation of any systems or equipment for which commissioning services are required and during the same time frame that the construction schedule is being developed.

B. The CxM, CxRs, CxA, AExA, GC's project manager, GC's field superintendent, GC's scheduler, and A/E's principle construction administration representative shall be scheduled to attend the work session, at a minimum.

C. The CxM shall present and review the schedule for commissioning work and the sequenced order in which work shall proceed.

D. Provide meeting date notification to the required participants at the Pre-Commissioning Work Session, a minimum of two weeks prior to the session. The meeting notification shall include a detailed agenda.

E. The CxM shall record and distribute meeting minutes, including the resulting updated commissioning schedule, to all parties involved.

F. The CxA shall finalize the commissioning plan immediately following this meeting to reflect the actual construction schedule.

3.3 COMMISSIONING PROGRESS AND COORDINATION MEETINGS

A. The CxM shall convene and chair three to five scheduled on-site, commissioning review, progress, and coordination meetings. The meetings shall include the CxM, all CxRs, the CxA, and associated special testing agents, outside agents, or manufacturer's representatives as appropriate.

B. The meetings shall be initiated immediately prior to the initiation of the pre-startup verification process and shall be held at least monthly during the remaining construction duration.

C. The CxA shall record and distribute meeting minutes to all parties.

3.4 CHANGES TO THE WORK

A. Changes to the work shall be as directed by Change Order, Construction Change Directive, or Change Authorization as defined in Section 00800, Supplementary General Conditions, Article 7: Changes in the Work.

B. The CxA shall have authority to issue Orders for Minor Change, on behalf of the Owner and with the approval of the A/E, on-site, in conjunction with the commissioning activities. Such directions to the contractor will be provided in writing and will be signed and dated by the CxA.

C. The CxM shall have authority to accept Orders for Minor Change as directed by the CxA on behalf of the CM. The CxM, if in agreement with the Order for Minor Change, shall sign and date the Order and provide one copy to the CxA for record purposes.

D. All changes to the work shall be attached to the related procedures and shall be included as attachments to the submittals and to the final Project Commissioning Record.

E. If, in the opinion of the CxA, Change Orders or Construction Change Directives are required or if other special provisions are necessary to resolve a commissioning, construction or performance issue, the issue and recommendations will be documented by the CxA and submitted to the A/E's construction administration staff for disposition. If the continuation of a commissioning procedure is affected by the issue, the procedure will be continued to the extent possible or as determined appropriate by the CxA. The CxA shall have full authority to stop or postpone any procedure pending disposition of commissioning, construction, or performance issues.

3.5 FINAL ACCEPTANCE

A. Final acceptance will be contingent upon satisfactory completion of all commissioning tasks and submittals, with final review and recommendation of acceptance to the Owner by the Commissioning Authority.

END OF SECTION 019113

SECTION 024119 – SELECTIVE DEMOLITION

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 modification, alteration, conversion, and renovation of existing structures:
   1. Be aware of the many incidental items which exist which must be demolished, relocated, or replaced in order to accomplish the remodeling work of trades.
   2. Include the price of such demolition, relocating, and replacement in the base Bid.
   3. These incidental items may or may not be indicated in the Contract Documents.
   4. Contractor and Subcontractors performing remodeling work are expected to be familiar with the unknown nature of existing utilities serving an area to be remodeled and shall calculate the base Bid to include the demolition, removal, relocation, and replacement of these utilities.

1.3 REFERENCES

A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the pertinent provisions of the following:
   1. American National Standards Institute: ANSI A10.6 - Safety Requirements for Demolition Operations.
   2. ASTM: D1557 - Laboratory Compaction Characteristics of Soil Using Modified Effort.
   3. EPA: Rule 406(b) of the Toxic Substances Control Act of 1992.
   4. NFPA: NFPA 241 - Standard for Safeguarding Construction, Alteration, and Demolition Operations.

1.4 DEFINITIONS

A. Terms:
   1. Abandon:
      a. Remove an item to the extent that it is not visible and does not interfere with new construction.
      b. Portions of the abandoned item may be left in place.
      c. No abandoned items shall be left below new footings.
   2. Demolish:
      a. Remove existing items from their present location in the Project area and haul to an area outside of the Project area.
      b. Remove utilities serving these items.
   3. Relocate:
      a. Move existing items from their present location to another location in the Project area.
      b. Extend utilities serving the present location to the new location.

4. Remove:
    a. Except for items indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, demolished materials shall become Contractor's property.
    b. Remove existing items from their present location in the Project area and haul to an area outside of the Project area.
    c. Remove utilities serving these items.
5. Replace:
    a. Remove existing items from their present location in the Project area, haul them to an area outside of the Project area, and furnish and install new items in the same or another location.
    b. Extend utilities serving the present location to the new location.
6. Reuse: Move existing items from their present location to another location in the Project area. Extend utilities serving the present location to the new location.
7. Salvage: Precise and careful deconstruction, removal, and reclamation of existing item without damage for reuse within this project or for Owner's storage.

1.5 DIVISION OF WORK

A. Work: In accordance with the General Conditions, Contractor is responsible for dividing the Work among the Subcontractors and Suppliers and for delineating the work to be performed by specific trades. The following are suggestions as to how the Work may be divided. This is not a complete list of the work:
    1. Contractor:
        a. Cut and patch walls, floors, and ceilings to allow for recessed utilities and ductwork.
        b. Remove and reinstall existing suspended ceilings to allow for above ceiling construction.
        c. Replace damaged units.
        d. Install new ceilings as indicated on the Drawings.
        e. Place sleeves in new concrete structures.
        f. Patch roof at new penetration and curbs and where existing penetrations and curbs are removed.
        g. Furnish and install new structural steel where required for reinforcement at floor, wall, and roof openings.
        h. Install fire stop and smoke stop systems at penetrations for ratings indicated in accordance with local building codes.
    2. Mechanical, Electrical, and Fire Protection Subcontractors:
        a. Furnish sleeves for use in new concrete construction.
        b. Install fire stop and smoke stop systems at utility penetrations in accordance with local building codes.
        c. Furnish and install sleeves in gypsum board and masonry construction.
        d. Core drill existing concrete for new utilities and sleeves after obtaining Engineer's review of locations.
        e. Remove and reinstall existing fire protection heads to allow for ceiling removal and installation.
        f. Furnish new heads, piping, and connections as required for completion of the Work.
    3. Miscellaneous:
        a. Each trade shall be financially responsible for cutting and patching for sleeves, penetrations, and installation of isolated components as necessary for its work unless herein specifically stated to the contrary.

b. On renovation projects, cut and patch walls, floors, and ceilings to allow for continuous runs of recessed utilities and ductwork.
c. Patching shall be done by the trade whose work is damaged.
d. Costs caused by defective or ill-timed work shall be borne by the party responsible.
e. Each trade shall do fitting of its own work as required to make its several components fit together or to receive the work of other trades.

1.6 SUBMITTALS

A. Predemolition Photographs and Audio-video:
1. Submit showing existing conditions of construction to remain that could be misconstrued as damage caused by construction activities.
2. Including building and Site, as well as interior and exterior finishes.
3. Submit prior to commencing Work.

1.7 QUALITY ASSURANCE

A. Qualifications: Engage an experienced firm that has specialized in demolition work similar to material and extent indicated for this Project.

B. Regulatory Requirements:
1. Comply with governing EPA notification regulations before beginning selective demolition.
2. Comply with hauling and disposal regulations of authorities having jurisdiction.
3. Comply with ANSI A10.6 and NFPA 241.
4. Comply with 29 CFR 1926.62-(OSHA Paint Standard).

C. Pre-Demolition Conference:
1. Conduct pre-demolition conference at Site in accordance with Division 01 Section “Project Meetings.”
2. Review methods and procedures related to selective demolition including, but not limited to, the following:
a. Inspect and discuss condition of construction to be selectively demolished.
b. Review structural load limitations of existing structure.
c. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and to avoid delays.
d. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.

1.8 PROJECT CONDITIONS

A. Owner Occupancy:
1. Owner will occupy portions of building immediately adjacent to selective demolition area.
2. Conduct selective demolition so Owner’s operations will not be disrupted.
3. Provide not less than 72 hours notice to Owner of activities that will affect Owner’s operations.

B. Access:
   1. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities.
   2. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from authorities having jurisdiction.

C. Conditions:
   1. Owner and Engineer assume no responsibility for condition of areas to be selectively demolished.
   2. Conditions existing at time of inspection for bidding purposes will be maintained by Owner as far as practicable.
   3. Before selective demolition begins, Owner/Construction Manager will remove the following items:
      a. All Books, Shelving, and Loose Furniture.

D. Storage or sale of removed items or materials on Site will not be permitted.

E. Maintenance of Utilities:
   1. Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
   2. Maintain fire-protection facilities in service during selective demolition operations.

F. Unknown Hazardous Materials:
   1. It is not expected that hazardous materials will be encountered in the Work.
   2. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Engineer and Owner in accordance with the General Conditions.
   3. Hazardous materials will be removed by Owner under a separate contract.

G. Lead Paint: Remove and remediate existing lead paint as required to comply with all codes and requirements while performing the requirements of the Work. Either remove lead paint completely or partially as required to achieve this.

1.9 WARRANTIES

A. Existing Warranties:
   1. 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.
   2. If possible, retain original installer or fabricator to patch exposed work that is damaged during selective demolition.
   3. If it is not possible to engage original installer or fabricator, engage another recognized, experienced, and specialized firm.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General:
   1. Materials and workmanship shall conform to the requirements of other Sections of the Specifications.
   2. Where no materials are specified in these specifications, use materials of an equivalent type, quality, and size to match those existing in other areas of the facility.
   3. If none exist, use materials and workmanship recognized as of the highest quality in the industry.
   4. Obtain Engineer's review of such material and workmanship.

B. Piping: Existing piping which is removed from its present location shall not be reused where new piping is required unless specifically noted on the Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped.

B. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.

C. Inventory and record the condition of items to be removed and reinstalled, and of items to be removed and salvaged.

D. Conflicts:
   1. 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.
   2. Promptly submit written report to Engineer.

E. Survey, or engage a competent person to survey condition of the building, in accordance with requirements of OSHA, to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of the structure or adjacent structures during selective demolition operations.

F. Perform additional surveys as the work progresses to detect hazards resulting from operations to date.

3.2 UTILITY SERVICES

A. Maintain existing services indicated to remain and protect them against damage during selective demolition operations.

B. Interruptions:
   1. Do not interrupt existing utilities serving occupied or operating facilities unless authorized in writing by Owner and other authorities having jurisdiction.
   2. Provide temporary services during interruptions to existing utilities, as acceptable to Owner and to authorities having jurisdiction.
   3. Provide at least 72 hours notice to Owner if shutdown of service is required during changeover.

C. Utility Requirements:
   1. Locate, identify, disconnect, and seal or cap off indicated utilities serving areas to be selectively demolished.
   2. Owner will arrange to shut off indicated utilities when requested by Contractor.
   3. Arrange to shut off indicated utilities with utility companies.
   4. If utility services are required to be removed, relocated, or abandoned, before proceeding with selective demolition, provide temporary utilities that bypass areas of selective demolition and that maintain continuity of service to other parts of building.
   5. Cut off pipe or conduit in walls or partitions to be removed.
   6. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing.

3.3 PREPARATION

A. Site Access and Temporary Controls:
   1. Conduct selective demolition and debris removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
   2. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and other authorities having jurisdiction.
   3. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.
   4. Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction.
   5. Protect existing Site improvements, appurtenances, and landscape features to remain.
   6. Erect a plainly visible fence around drip line of individual trees or around perimeter drip line or groups of trees to remain.

B. Temporary Facilities:
   1. Protection:
      a. Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
      b. Provide protection to ensure safe passage of people around selective demolition area, and to and from occupied portion of building.
      c. Weather Protection:
         1) Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
         2) Where heating or cooling is needed and permanent enclosure is not complete, provide insulated temporary enclosures.
         3) Coordinate enclosures with ventilating and material drying or curing requirements to avoid dangerous conditions and effects.

d. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
e. Cover and protect furniture, furnishings, and equipment that have not been removed.

2. Shoring and Bracing:
a. Provide and maintain shoring, bracing, or structural support to preserve stability and prevent movement, settlement, or collapse of construction to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
b. Strengthen or add new supports when required during progress of selected demolition.

3.4 POLLUTION CONTROLS

A. Dust Control:
1. Use water mist, temporary closures, and other suitable methods to limit spread of dust and dirt.
2. Do not use water when it may damage existing construction or create hazardous or objectionable conditions, such as ice, flooding, and pollution.
3. Wet mop floors to eliminate trackable dirt and wipe down walls and doors of demolition enclosure.
4. Vacuum carpeted areas.
5. Comply with governing environmental protection regulations.

B. Disposal:
1. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
2. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.

3.5 GENERAL

A. Demolish and remove existing construction only to the extent required by new construction and as indicated.

B. Methods:
1. Use methods required to complete the work within limitations of governing regulations.
2. Level by Level:
a. Proceed with selective demolition systematically, from higher to lower level.
b. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
3. Cutting Openings:
a. Neatly cut openings and holes plumb, square, and true to dimensions required.
b. Use cutting methods least likely to damage construction to remain or to adjoining construction.
c. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces.
d. Temporarily cover openings to remain.
4. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.

5. Flame Cutting:
    a. Do not use cutting torches until work area is cleared of flammable materials.
    b. At concealed spaces, such as duct and pipe chases, verify condition and contents of hidden space before starting flame-cutting operations.
    c. Maintain fire watch and portable fire suppression devices during flame-cutting operations.
    d. Maintain adequate ventilation when using cutting torches.
6. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials, and promptly and legally dispose of off Site.
7. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
8. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
9. Dispose of demolished items and materials promptly.
10. Return elements of construction and surfaces that are to remain to condition existing before selective demolition operations began.

C. Existing Facilities: Comply with Owner's requirements for using and protecting elevators, stairs, walkways, loading docks, building entries, and other building facilities during the selective demolition operations.

D. Removed and Salvaged Items:
1. Clean salvaged items.
2. Pack or crate items after cleaning and identify contents of containers.
3. Store items in a secure area until delivery to Owner.
4. Transport items to Owner's storage area as designated by Owner.
5. Protect items from damage during transport and storage.

E. Removed and Reinstalled Items:
1. Clean and repair items to functional condition adequate for intended reuse.
2. Paint equipment to match new equipment.
3. Pack or crate items after cleaning and repairing, and identify contents of containers.
4. Protect items from damage during transport and storage.
5. Reinstall items in locations indicated.
6. Comply with requirements for new materials and equipment.
7. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

F. Existing Items to Remain:
1. Protect construction indicated to remain against damage and soiling during selective demolition.
2. Protect existing floor and walls to remain from scratches, spills, staining, dents, and damage with protection board or plastic sheeting.
3. Protect existing stair treads, risers, and nosing to remain from scratches, spills, staining, dents, and damages with heavy duty protection board.
4. When permitted by Engineer, items may be removed to a suitable, protected storage location and cleaned and reinstalled in their original locations after selective demolition operations are complete.

3.6 DEMOLITION

A. Structures:
   1. Cut, repair, reuse, excavate, demolish or otherwise remove parts of the existing structures or appurtenances, as indicated on the Drawings, herein specified and necessary to permit completion of the Work.
   2. Dispose of demolished materials in an approved manner.
   3. Include necessary cutting, bending, and welding of reinforcing steel, structural steel, or miscellaneous metal work found embedded in the existing structures.
   4. When removing materials or portions of existing structures, shore up, underpin, and protect adjacent structures.
   5. Concrete:
      a. Demolish in small sections.
      b. Cut concrete to a depth of at least 3/4-inch at junctures with construction to remain, using a power driven saw.
      c. Dislodge concrete from reinforcement to remain at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete indicated.
      d. Neatly trim openings to dimensions indicated.
   6. Engineer's review of cutting: No existing structure, equipment or appurtenance shall be shifted, cut, removed or otherwise altered without obtaining review of Engineer.

B. Equipment:
   1. Dismantle, remove, and relocate existing equipment, piping, and other appurtenances required for the completion of the Work.
   2. Cut existing pipelines for the purpose of making connections thereto.
   3. Cut off anchor bolts for equipment and structural steel indicated to be removed 1-inch below the concrete surface.
   4. Patch remaining concrete surface to smooth even finish.
   5. Remove air conditioning equipment without releasing refrigerants, if applicable.

C. Piping, Fire Protection, and Electrical Components:
   1. When a new connection is made to an existing pipeline, install additional new piping, extending to and including the most convenient new valve.
   2. Piping, conduit, and wiring indicated or required to be demolished shall be done so to the nearest reasonable connection outside of the Project area or as directed by Engineer.
   3. Where necessary or required for the purpose of making connections, cut existing pipelines in a manner to provide an approved joint.
   4. Weld beads, flanges, and provide Dresser couplings on existing and new piping.
   5. Remove and reinstall existing fire protection heads to allow for new construction.
   6. Comply with applicable fire protection codes.
   7. Furnish new heads, piping, and connections as required for completion of the Work.
   8. Remove junction boxes and electrical outlets which will no longer be in use.
   9. At existing walls which are made thicker, extend piping and wiring to accommodate additional wall thickness.
   10. Remove and reinstall fixtures and electrical outlets, switches, etc.

D. Ductwork:
   1. Remove portions of existing ductwork systems to the nearest branch outside the project area, except as indicated otherwise on drawings.
   2. Remove existing ductwork in a manner to minimize dispersion of dust in the duct system.
   3. Repair and replace existing insulation and duct liner disturbed by this Work to provide a continuous smooth surface.
   4. New connections to existing ductwork shall comply with the requirements of Division 23 Section “Metal Ducts.”

E. Conceal Utilities: Recess new piping, conduit, and other utilities into floors, wires, and ceilings in finished areas.

F. Ownership of Salvaged Materials:
   1. Materials and equipment removed shall remain the property of Owner at Owner's option.
   2. Items not salvageable, as determined by Engineer and Owner, and items Owner elects not to keep shall become the property of Contractor to be properly disposed of off the Site.
   3. Salvaged equipment shall be thoroughly cleaned, lubricated, and greased for protection during prolonged storage.

G. Nonshrink Grout: Use nonshrink grout for setting wall castings, sleeves, leveling pump bases, doweling anchors into existing concrete and elsewhere as indicated.

H. Protect Facility from Water Damage: Provide flumes, hoses, piping, suitable plugs, bulkheads, or other means to divert or hold back the flow of wastewater, water, or other liquids, as required for proper performance of the Work.

I. Blasting: Not permitted.

J. Sleeves:
   1. Subcontractors for mechanical, electrical, and other trades shall furnish sleeves and inserts for pipes, conduits, and similar items in forms, walls, partitions, and floors.
   2. Perform work in cooperation with Contractor.
   3. Place items in ample time so as not to delay operations.
   4. Do not place sleeves so they pass through beams, girders, and similar construction.

K. Miscellaneous: At existing walls which are made thicker, reinstall fire extinguisher cabinets, clocks, thermostats, and other wall hung items in new wall to accommodate additional wall thickness.

3.7 PATCHING AND REFINISHING

A. Promptly repair damage to adjacent construction caused by selective demolition operations.

B. Patching:
   1. Patch and repair existing surfaces from which items have been removed leaving holes, fasteners, and surface blemishes exposed to view.
   2. Where repairs to existing surfaces are required, patch to produce surfaces suitable for new materials.

3. Completely fill holes and depressions in existing masonry walls that are to remain with an approved masonry patching material applied according to Manufacturer's written recommendations.
4. Comply with Division 01 Section "Cutting and Patching."

C. Refinishing:
1. Prepare existing surfaces for finishes by scraping, sanding, filling, acid etching, and sand blasting to ensure bonding and a smooth finish.
2. Refinish entire surfaces as necessary to provide an even finish.
3. Refinish continuous surfaces to the nearest intersection and entirely finish assemblies.
4. Restore exposed finishes of patched areas and extend restoration into adjoining construction in a manner that eliminates evidence of patching and refinishing.
5. Refinish entire surfaces if necessary to remediate existing lead painted surfaces.

D. Floors and Walls:
1. Where floors or partitions that are demolished extend one finished area into another, patch and repair floor and wall surfaces in the new space.
2. Provide an even surface of uniform finish, color, texture, and appearance.
3. Remove existing floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
4. Patch with durable seams that are as invisible as possible.
5. Provide materials and comply with installation requirements specified in other Sections of these Specifications.
6. Where patching occurs in a painted surface, apply primer and intermediate coats over the patch and apply final coat over entire unbroken surface containing patch.
7. Provide additional coats until patch blends with adjacent surfaces.
8. Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.

E. Ceilings: Patch, repair, or rehang existing materials as necessary to provide even plane surface of uniform appearance.

3.8 CLEANING

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations.

B. Return adjacent areas to conditions existing before selective demolition operations began.

END OF SECTION 024119

SECTION 024200– CONSTRUCTION WASTE MANAGEMENT

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 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.

B. Related sections include the following:

1. Division 01 Section “General Requirements – Temporary Facilities and Controls.”

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 and clearing debris including soil, vegetation, and rocks are not to be included.

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: Collect, reprocess and reuse of materials diverted or recovered from solid waste stream.

E. Salvage: Recovery of demolition or construction materials from existing buildings or construction sites and subsequent sale or reuse in another facility.

F. Salvage and Reuse: Recovery of demolition or construction materials from existing buildings or construction sites and subsequent incorporation into the Work.

1.4 PERFORMANCE GOALS

A. General: Develop waste management plan that results in end-of-Project rates for salvage/recycling of 50 (75) percent by weight of total waste generated by the Work.

1.5 SUBMITTALS

A. Waste Management Plan: Submit 3 copies of plan within 14 days of date established for commencement of the Work

B. Waste Reduction Progress Reports: Concurrent with each Application for Payment, submit 2 copies of report. Include separate reports for demolition and construction waste. Include the following information:

1. Material category.
2. Generation point of waste.
3. Total quantity of waste in tons.
4. Quantity of waste salvaged, both estimated and actual in tons or cubic yards.
5. Quantity of waste recycled, both estimated and actual in tons or cubic yards.
6. Total quantity of waste recovered (salvaged plus recycled) in tons or cubic yards.
7. Total quantity of waste recovered (salvaged plus recycled) as a percentage of total waste.

C. Waste Reduction Calculations: Before request for Substantial Completion, submit 2 copies of calculated end-of-Project rates for salvage, recycling, and disposal as a percentage of total waste generated by the Work.

D. Records of Donations: Indicate receipt and acceptance of salvageable waste donated to individuals and organizations. Indicate whether organization is tax exempt.

E. Records of Sales: Indicate receipt and acceptance of salvageable waste sold to individuals and organizations. Indicate whether organization is tax exempt.

F. 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.

G. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licenses to accept them. Include manifests, weight tickets, receipts, and invoices.

1.6 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. 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.

1.7 WASTE MANAGEMENT PLAN

A. General: Develop plan consisting of waste identification, waste reduction plan, and cost/revenue analysis. Include separate sections in plan for 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 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 for 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 on Project site where materials separation will be located.

D. Plan for and describe the means for securing waste containers from unauthorized users.

E. 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 waste management plan as approved by Owner. 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 Division 01 Section "Temporary Facilities and Controls" for operation, termination, and removal requirements.
2. Observe and follow site measures that prevent cross-contamination of waste. Cross-contamination could render some portion of waste to be non-recyclable, and the exemplary performance credit of diverting 95% of waste from landfill.

B. Waste Management Coordinator: Engage a waste management coordinator to be responsible for implementing, monitoring, and reporting status of waste management work plan. Coordinator shall be present at Project site full time for duration of Project. The Construction Superintendent may perform the role of the Waste Management Coordinator.

C. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work occurring at the Project site.

1. Distribute waste management plan to everyone concerned within three days of submittal return.
2. Distribute waste management plan to entities upon execution of their contracts. Review plan procedures and locations established for salvage, recycling, and disposal.

D. 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:

1. Clean salvaged items.
2. Pack or crate items after cleaning. Identify contents of containers.
3. Store items in a secure area until installation.
4. Protect items from damage during transport and storage.

5. Install salvaged items to comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make items functional for use indicated.

B. Salvaged Items for Sale and Donation: Not permitted on Project site.

C. Salvaged Items for Owner's Use:

1. Clean salvaged items.
2. Pack or crate items after cleaning. Identify contents of containers.
3. Store items in a secure area until delivery to Owner.
4. Transport items to Owner's storage area off-site designated by Owner.
5. Protect items from damage during transport and storage.

D. Doors and Hardware: Brace open end of door frames. Except for removing door closes, leave door hardware attached to doors.

3.3 RECYCLING DEMOLITION AND CONTRUCTION WASTE, GENERAL

A. General:

1. Recycle paper and beverage containers used by on-site workers.
2. Concrete, masonry, or asphalt crushed and reused are to be identified and include in calculations.
3. Exclude hazardous waste from calculations.

B. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall accrue to Contractor.

C. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical.

1. Provide appropriately marked containers or bins for controlling recyclable waste until they are 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 off Owner's property and transport to recycling receiver or processor.

3.4 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. Site-Clearing Wastes: Chip brush, branches, and trees on-site.

1. Transport chipped organic waste as organic mulch to a location (for placing in a pile) as designed by MSU on campus.

C. 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.

    a. Transport clean sawdust as organic mulch to a location (for placing in a pile) as designed by MSU on campus.

D. Gypsum Board: Stack large clean pieces on wood pallets 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.

    a. Transport clean ground gypsum board as inorganic soil amendment.to a location (for placing in a pile) as designed by MSU on campus.

E. Metals: Separate metal by type or to meet requirements of recycling receiver or processor.

3.5 DISPOSAL OF WASTE

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

1. Except as otherwise specified, do not allow excessive on-site accumulation of waste materials.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
3. Coordinate with each product manufacturer for take-back programs. Set aside scrap to be returned to manufacturer for recycling into new product.

B. Burning: Do not burn waste materials.

C. Disposal: Transport waste materials off Owner's property and legally dispose of them.

END OF SECTION 024200

SECTION 05 40 00 - COLD-FORMED METAL FRAMING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Formed steel stud exterior wall and interior wall framing.

B. Formed steel joist and purlin framing and bridging.

1.2 RELATED REQUIREMENTS

A. Section 09 21 16 - Gypsum Board Assemblies: Lightweight, non-load bearing metal stud framing and gypsum-based sheathing.

1.3 REFERENCE STANDARDS

A. AISI S100-12 - North American Specification for the Design of Cold-Formed Steel Structural Members; American Iron and Steel Institute; 2012.

B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.

C. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.

D. ASTM C955 - Standard Specification for Cold-Formed Steel Structural Framing Members; 2018.

E. ASTM C1007 - Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories; 2020.

F. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2020, with Errata (2023).

G. SSPC-Paint 20 - Zinc-Rich Coating (Type I - Inorganic, and Type II - Organic); 2019.

1.4 SUBMITTALS

A. Product Data: Provide data on standard framing members; describe materials and finish, product criteria, and limitations.

B. Product Data: Provide manufacturer's data on factory-made framing connectors, showing compliance with requirements.

C. Shop Drawings: Indicate component details, framed openings, bearing, anchorage, loading, welds, and type and location of fasteners, and accessories or items required of related work.
   1. Indicate stud and ceiling joist layout.
   2. Design data:
      a. Shop drawings signed and sealed by a professional structural engineer.
   3. Calculations for loadings and stresses of specially fabricated framing, signed and sealed by a professional structural engineer.

D. Designer's Qualification Statement.

E. Manufacturer's Qualification Statement.

1.5 QUALITY ASSURANCE

A. Designer Qualifications: Design framing system under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed in the State in which the Project is located.

B. Manufacturer Qualifications: Company specializing in manufacturing the types of products specified in this section, and with minimum three years of documented experience.

C. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Metal Framing:
   1. ClarkDietrich.
   2. Metal-Lite.
   3. SCAFCO Corporation.
   4. Steel Construction Systems.
   5. The Steel Network, Inc.

B. Framing Connectors and Accessories:
   1. Same manufacturer as metal framing.

2.2 FRAMING SYSTEM

A. Provide primary and secondary framing members, bridging, bracing, plates, gussets, clips, fittings, reinforcement, and fastenings as required to provide a complete framing system.

B. Design Requirements: Provide completed framing system having the following characteristics:
   1. Design: Calculate structural characteristics of cold-formed steel framing members according to AISI S100-12.

2. Structural Performance: Design, engineer, fabricate, and erect to withstand specified design loads for project conditions within required limits.
3. Design Loads: In accordance with applicable codes.
   a. Ceiling Live Loads:
      1) Minimum Uniformly Distributed: 40 psf.
      2) Minimum Concentrated: 500 lbs.
4. Live load deflection meeting the following, unless otherwise indicated:
   a. Floors: Maximum vertical deflection under live load of 1/480 of span.
   b. Ceilings: Maximum vertical deflection under live load of 1/240 of span.
5. Able to tolerate movement of components without damage, failure of joint seals, undue stress on fasteners, or other detrimental effects when subject to seasonal or cyclic day/night temperature ranges.
6. Able to accommodate construction tolerances, deflection of building structural members, and clearances of intended openings.

2.3 FRAMING MATERIALS

A. Studs and Track: ASTM C955; studs formed to channel, C- or Sigma-shaped with punched web; U-shaped track in matching nominal width and compatible height.
   1. Wall Stud Gage: As required to meet specified performance levels, 20 gage minimum.
   2. Wall Stud Depth: As indicated on drawings.
   3. Galvanized in accordance with ASTM A653/A653M, G90/Z275 coating.

B. Joists: Fabricated from ASTM A653/A653M steel sheet, with G90/Z275 hot dipped galvanized coating.
   1. Base Metal: Structural Steel (SS), Grade 33/230.
   2. Base Metal: As required to meet specified performance levels within maximum depths indicated.
   3. Gage and Depth: As required to meet specified performance levels.

C. Framing Connectors: Factory-made, formed steel sheet.
   1. Material: ASTM A653/A653M SS Grade 33 and 40 (minimum), with G90/Z275 hot dipped galvanized coating for base metal thickness less than 10 gage, 0.1345 inch, and factory punched holes and slots.
   2. Fixed Connections: Provide non-movement connections for floor-to-floor tie-down, joist hangers, gusset plates, and stiffeners.

2.4 FASTENERS

A. Self-Drilling, Self-Tapping Screws, Bolts, Nuts and Washers: Hot dip galvanized per ASTM A153/A153M.

B. Anchorage Devices: Powder actuated.

C. Welding: Comply with AWS D1.1/D1.1M.

2.5 ACCESSORIES

A. Bracing, Furring, Bridging: Formed sheet steel, thickness determined for conditions encountered; finish to match framing components.

B. Plates, Gussets, Clips: Formed Sheet Steel, thickness determined for conditions encountered; finish to match framing components.

C. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20 Type I - Inorganic, complying with VOC limitations of authorities having jurisdiction.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that substrate surfaces are ready to receive work.

B. Verify field measurements and adjust installation as required.

3.2 INSTALLATION OF STUDS

A. Install components in accordance with manufacturers' instructions and ASTM C1007 requirements.

B. Align floor and ceiling tracks; locate to wall layout. Secure in place with fasteners at maximum 24 inches on center. Coordinate installation of sealant with floor and ceiling tracks.

C. Place studs at 16 inches on center; not more than 2 inches from abutting walls and at each side of openings. Connect studs to tracks using method as determined by design professional.

D. Construct corners using minimum of three studs. Install double studs at wall openings, door and window jambs.

E. Install load-bearing studs full length in one piece. Splicing of studs is not permitted.

F. Install load-bearing studs, brace, and reinforce to develop full strength and achieve design requirements.

G. Coordinate placement of insulation in multiple stud spaces made inaccessible after erection.

H. Install intermediate studs above and below openings to align with wall stud spacing.

I. Provide deflection allowance in stud track, directly below horizontal building framing at non-load bearing framing.

J. Attach cross studs to studs for attachment of fixtures anchored to walls.

K. Install framing between studs for attachment of mechanical and electrical items, and to prevent stud rotation.

L. Touch-up field welds and damaged galvanized surfaces with primer.

3.3 INSTALLATION OF JOIST

A. Install framing components in accordance with manufacturer's instructions.

B. Make provisions for erection stresses. Provide temporary alignment and bracing.

C. Place joists at 16 inches on center; not more than 2 inches from abutting walls, and connect joists to supports using fastener method.

D. Set ceiling joists parallel and level, with lateral bracing and bridging.

E. Locate joist end bearing directly over load-bearing studs or provide load distributing member to top of stud track.

F. Provide web stiffeners at reaction points.

G. Touch-up field welds and damaged galvanized surfaces with primer.

3.4 TOLERANCES

A. Maximum Variation of Finished Gypsum Board Surface from True Flatness: 1/8 inch in 10 feet in any direction.

END OF SECTION

SECTION 061000 - ROUGH CARPENTRY

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Preservative treated wood materials.

B. Fire retardant treated wood materials.

C. Miscellaneous framing and sheathing.

D. Communications and electrical room mounting boards.

E. Concealed wood blocking, nailers, and supports.

F. Miscellaneous wood nailers, and furring.

1.2 REFERENCE STANDARDS

A. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.

B. ASTM C557 - Standard Specification for Adhesives for Fastening Gypsum Wallboard to Wood Framing; 2003 (Reapproved 2017).

C. ASTM D3498 - Standard Specification for Adhesives for Field-Gluing Wood Structural Panels (Plywood or Oriented Strand Board) to Wood Based Floor System Framing; 2019a.

D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023b.

E. AWPA U1 - Use Category System: User Specification for Treated Wood; 2023.

F. ICC (IBC) - International Building Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

G. PS 1 - Structural Plywood; 2019.

H. PS 20 - American Softwood Lumber Standard; 2021.

1.3 SUBMITTALS

A. Product Data: Provide technical data on wood preservative materials and application instructions.

1.4 DELIVERY, STORAGE, AND HANDLING

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

B. Fire Retardant Treated Wood: Prevent exposure to precipitation during shipping, storage, and installation.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Dimension Lumber: Comply with PS 20 and requirements of specified grading agencies.
   1. If no species is specified, provide species graded by the agency specified; if no grading agency is specified, provide lumber graded by grading agency meeting the specified requirements.
   2. Grading Agency: Grading agency whose rules are approved by the Board of Review, American Lumber Standard Committee at www.alsc.org, and who provides grading service for the species and grade specified; provide lumber stamped with grade mark unless otherwise indicated.

2.2 DIMENSION LUMBER FOR CONCEALED APPLICATIONS

A. Sizes: Nominal sizes. Rough (unsurfaced).

B. Moisture Content: S-dry or MC19.

C. Miscellaneous Framing, Blocking, Nailers and Furring:
   1. Lumber: No. 2 or Standard Grade.
   2. Boards: Standard or No. 3.

2.3 CONSTRUCTION PANELS

A. Communications and Electrical Room Mounting Boards: PS 1 A-D plywood; 3/4 inch thick; flame spread index of 25 or less, smoke developed index of 450 or less, when tested in accordance with ASTM E84.

2.4 ACCESSORIES

A. Fasteners and Anchors:
   1. Metal and Finish: Hot-dipped galvanized steel complying with ASTM A153/A153M for high humidity and preservative-treated wood locations, unfinished steel elsewhere.
   2. Drywall Screws: Bugle head, hardened steel, power driven type, length three times thickness of sheathing.

2.5 FACTORY WOOD TREATMENT

A. Treated Lumber and Plywood: Comply with requirements of AWPA U1 - Use Category System for wood treatments determined by use categories, expected service conditions, and specific applications.
   1. Fire-Retardant Treated Wood: Mark each piece of wood with producer's stamp indicating compliance with specified requirements.
   2. Preservative-Treated Wood: Provide lumber and plywood marked or stamped by an ALSC-accredited testing agency, certifying level and type of treatment in accordance with AWPA standards.

B. Fire Retardant Treatment:
   1. Interior Type A: AWPA U1, Use Category UCFA, Commodity Specification H, low temperature (low hygroscopic) type, chemically treated and pressure impregnated; capable of providing a maximum flame spread index of 25 when tested in accordance with ASTM E84, with no evidence of significant combustion when test is extended for an additional 20 minutes.
      a. Kiln dry wood after treatment to a maximum moisture content of 19 percent for lumber and 15 percent for plywood.
      b. Interior rough carpentry items are to be fire retardant treated.

C. Preservative Treatment:
   1. Preservative Pressure Treatment of Lumber Above Grade: AWPA U1, Use Category UC3B, Commodity Specification A.
      a. Kiln dry lumber after treatment to maximum moisture content of 19 percent.
      b. Treat lumber in contact with roofing, flashing, or waterproofing.
      c. Treat lumber in contact with masonry or concrete.
      d. Treat lumber less than 18 inches above grade.
      e. Treat lumber in other locations as indicated.
   2. Preservative Pressure Treatment of Plywood Above Grade: AWPA U1, Use Category UC2 and UC3B, Commodity Specification F.
      a. Kiln dry plywood after treatment to maximum moisture content of 19 percent.
      b. Treat plywood in contact with roofing, flashing, or waterproofing.
      c. Treat plywood in contact with masonry or concrete.
      d. Treat plywood less than 18 inches above grade.
      e. Treat plywood in other locations as indicated.

PART 3 EXECUTION

3.1 PREPARATION

A. Coordinate installation of rough carpentry members specified in other sections.

3.2 INSTALLATION - GENERAL

A. Select material sizes to minimize waste.

B. Reuse scrap to the greatest extent possible; clearly separate scrap for use on site as accessory components, including: shims, bracing, and blocking.

C. Where treated wood is used on interior, provide temporary ventilation during and immediately after installation sufficient to remove indoor air contaminants.

D. Comply with fastener size and spacing indicated, but not less than required by applicable codes, AWC (WFCM) Wood Frame Construction Manual, and IBC Chapter 23 Wood Construction Spans and Fastener requirements.

3.3 BLOCKING, NAILERS, AND SUPPORTS

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

B. In metal stud walls, provide continuous blocking around door and window openings for anchorage of frames, securely attached to stud framing.

C. In walls, provide blocking attached to studs as backing and support for wall-mounted items, unless item can be securely fastened to two or more studs or other method of support is explicitly indicated.

D. Provide the following specific nonstructural framing and blocking:
   1. Cabinets and shelf supports.
   2. Wall brackets.
   3. Accessories.
   4. Wall-mounted door stops.
   5. Wall or Ceiling mounted Owner Furnished Equipment.

3.4 INSTALLATION OF CONSTRUCTION PANELS

A. Communications and Electrical Room Mounting Boards: Secure with screws to studs with edges over firm bearing; space fasteners at maximum 24 inches on center on all edges and into studs in field of board.
   1. Size and Location: As indicated on drawings.

3.5 SITE APPLIED WOOD TREATMENT

A. Apply preservative treatment compatible with factory applied treatment at site-sawn cuts, complying with manufacturer's instructions.

B. Allow preservative to dry prior to erecting members.

3.6 TOLERANCES

A. Variation from Plane, Other than Floors: 1/4 inch in 10 feet maximum, and 1/4 inch in 30 feet maximum.

3.7 CLEANING

A. Do not leave wood, shavings, sawdust, etc. on the ground or buried in fill.

B. Prevent sawdust and wood shavings from entering the storm drainage system.

END OF SECTION

SECTION 079200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes joint sealants for the applications listed in 3.6 JOINT SEALANT SCHEDULE below, and including those specified by reference to this Section:

B. Related Sections include the following:

1. Division 08 Section GLAZING for glazing sealants.

1.2 PERFORMANCE REQUIREMENTS

A. Provide elastomeric joint sealants that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.

1.3 SUBMITTALS

A. VOC Statement and Product Data: For each joint-sealant product indicated.

B. Samples for Verification: For each type and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- wide joints formed between two 6-inch- long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

C. Product Certificates: For each type of joint sealant and accessory, signed by product manufacturer.

D. SWRI Validation Certificate: For each elastomeric sealant specified to be validated by SWRI's Sealant Validation Program.

E. Qualification Data: For Installer and testing agency.

F. Preconstruction Field Test Reports: When requested by owner, indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on preconstruction testing specified in "Quality Assurance" Article.

G. Compatibility and Adhesion Test Reports: From sealant manufacturer, indicating the following:

1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.

H. Field Test Report Log: For each elastomeric sealant application.

I. Product Test Reports: Based on comprehensive testing of product formulations performed by a qualified testing agency, indicating that sealants comply with requirements.

J. Warranties: Submit written special warranty as specified in this Section. Include contact information, description of coverage, and start date for each special warranty.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized Installer who is approved or licensed for installation of elastomeric sealants required for this Project.

B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.

C. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.

1. Use ASTM C 1087 or manufacturer’s standard test method to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
2. Submit not fewer than six pieces of each type of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
4. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.
5. Testing will not be required if joint-sealant manufacturers submit joint preparation data that are based on previous testing of current sealant products for adhesion to, and compatibility with, joint substrates and other materials matching those submitted.

D. Product Testing: Obtain test results for "Product Test Reports" Paragraph in "Submittals" Article from a qualified testing agency based on testing current sealant formulations within a 36-month period preceding the commencement of the Work.

1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated, as documented according to ASTM E 548.
2. Test elastomeric joint sealants for compliance with requirements specified by reference to ASTM C 920, and where applicable, to other standard test methods.
3. Test elastomeric joint sealants according to SWRI's Sealant Validation Program for compliance with requirements specified by reference to ASTM C 920 for adhesion and cohesion under cyclic movement, adhesion-in-peel, and indentation hardness.
4. Test other joint sealants for compliance with requirements indicated by referencing standard specifications and test methods.

E. Preconstruction Field-Adhesion Testing: Before installing elastomeric sealants, field test their adhesion to Project joint substrates as follows:

1. Locate test joints in an inconspicuous location.

2. Conduct field tests for each application indicated below:

    a. One test joint for each type of elastomeric sealant and joint substrate indicated.
    b. One test joint for each type of nonelastomeric sealant and joint substrate indicated.

3. Notify M.S.U. Project Manager seven days in advance of dates and times when test joints will be erected.

    a. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193.

        1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.

4. Report whether sealant in joint connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each type of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
5. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

1.5 PROJECT CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer.
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.6 WARRANTY

A. Special Warranty

1. Provide installation warranty for a period of 5 years against defective materials and workmanship.
2. During the warranty period restore defective work to the standard of the contract documents without additional compensation, including all materials, labor, refinishing and other costs incidental to the work. Within 24 hours after receipt of notice from the owner, inspect the work and immediately repair leaks. Restore work found to be defective as defined in the contract documents, within 10 days after receipt of notice from the owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products listed in other Part 2 articles.

2.2 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer, based on testing and field experience.

2.3 ELASTOMERIC JOINT SEALANTS

A. Elastomeric Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied chemically curing sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.

B. Stain-Test-Response Characteristics: Where elastomeric sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.

C. Single-Component Neutral-Curing Silicone Sealant; **SEALANT A**

1. Available Products:

   a. Dow; DOWSIL 790 Silicone Building Sealant.
   b. GE Silicones; SilPruf SCS2000.
   c. Dow; DOWSIL 791 Silicone Weatherproofing Sealant.
   d. Dow; DOWSIL 795 Silicone Building Sealant.
   e. Pecora Corporation; 895.
   f. Dow; DOWSIL 756 SMS Building Sealant.
   g. Or as approved

2. Type and Grade: S (single component) and NS (nonsag).
3. Class: 50.
4. Use Related to Exposure: NT (nontraffic).
5. Stain-Test-Response Characteristics: Nonstaining to porous substrates per ASTM C 1248.

D. Multicomponent Immersible Urethane Sealant **SEALANT B**

1. Available Products:

   a. LymTal International, Inc., Iso-Flex 881 (NS – nonsag)
   b. LymTal International, Inc., Iso-Flex 880 (P – pourable).
   c. Or as approved

2. Type and Grade: M (multicomponent) and NS (nonsag) or P (pourable).
3. Class: 25.
4. Uses Related to Exposure: T (traffic), NT (nontraffic) and I (immersible).

E. Single-Component Mildew-Resistant Acid-Curing Silicone Sealant **SEALANT C.**:

1. Available Products:

   a. Dow; DOWSIL 786 Silicone Sealant - M
   b. GE Silicones; Sanitary SCS1700.
   c. Tremco; Tremsil 200.
   d. Or as approved

2. Type and Grade: S (single component) and NS (nonsag).
3. Class: 25.
4. Use Related to Exposure: NT (nontraffic).

2.4 LATEX JOINT SEALANTS

A. Latex Sealant: Comply with ASTM C 834.**SEALANT D**.

B. Available Products:

1. DAP DYNAFLEX 230.
2. Pecora Corporation; AC-20+Silicone.
3. Or as approved.

2.5 ACOUSTICAL JOINT SEALANTS

A. Acoustical Sealant for Concealed Joints: Manufacturer's standard, nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic-rubber sealant recommended for sealing interior concealed joints to reduce airborne sound transmission**. SEALANT E**.

1. Available Products:

   a. Pecora Corporation; BA-98.
   b. Tremco; Tremco Acoustical Sealant.
   c. Or as approved.

2.6 JOINT-SEALANT BACKING

A. General: Provide sealant backings of material and type that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin) O (open-cell material) or B (bicellular material with a surface skin), 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:

C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

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, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
2. Clean porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:

    a. Masonry.

3. Remove laitance and form-release agents from concrete.
4. Clean nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:

    a. Metal.
    b. Glass.

B. Joint Priming: Prime joint substrates**,** where recommended in writing by joint-sealant manufacturer, based on 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 with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Acoustical Sealant Application Standard: Comply with recommendations in ASTM C 919 for use of joint sealants in acoustical applications as applicable to materials, applications, and conditions indicated.

D. Install sealant backings of type 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.

E. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

F. 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.

G. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified 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 configuration per Figure 5A in ASTM C 1193, unless otherwise indicated.

3.4 CLEANING

A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.6 JOINT-SEALANT SCHEDULE

A. **SEALANT A**: Joints around pipes, conduits, and ducts that penetrate walls and partitions.

B. **SEALANT B**: Expansion and control joints in exterior curbs and walks, and in paving other than concrete road paving, subject to pedestrian and vehicular traffic.

C. **SEALANT C**: Perimeter of counters, interior non-traffic tile joints and other nonporous substrates that are subject to in-service exposures of high humidity and extreme temperatures.

D. **SEALANT D**: Interior joints at the perimeter of hollow metal doorframes .

E. **SEALANT E**: Use as specified in wall assemblies.

END OF SECTION 079200

SECTION 081113 – HOLLOW METAL FRAMES

PART 1 - GENERAL

1.1 M.S.U. ISSUES

A. M.S.U. uses steel frames for openings subject to repeated impact or abuse, or when appropriate to achieve required fire resistance rating

B. Steel framing is the M.S.U. standard for all interior doorways, paired with flush wood doors. (See Division 8 section 081416 FLUSH WOOD DOORS), and for interior windows.

C. All public and personnel doors shall be a minimum of 36” wide to provide barrier free access for mobility aid users.

D. All public and personnel doorway thresholds shall meet the latest ICC/ANSI A117.1 standards to provide barrier free access for mobility and physically impaired users.

1.2 SUMMARY

A. This Section includes the following:

1. Standard hollow-metal steel frames.

B. Related Sections include the following:

1. Division 07 Section JOINT SEALANTS for sealants used in hollow metal frame installation.
2. Division 08 Section GLAZING for glazed lites in standard steel doors.
3. Division 08 Section HARDWARE for door hardware for flush wood doors.
4. Division 08 Section FLUSH WOOD DOORS for flush wood doors.
5. Division 09 Section INTERIOR PAINTING for field painting standard steel doors and frames.

1.3 DEFINITIONS

A. Minimum Thickness: Minimum thickness of base metal without coatings.

1.4 SUBMITTALS

A. Product Data: Include construction details, material descriptions, core descriptions, label compliance, fire resistance rating and finishes for each type of steel door and frame specified.

B. Oversize Construction Certification: For standard steel door assemblies required to be fire rated and exceeding limitations of labeled assemblies; include statement that doors comply with requirements of design, materials, and construction but have not been subjected to fire test.

C. Qualification Data: For Installer.

D. Product Test Reports: Based on evaluation of comprehensive fire tests performed by a qualified testing agency, for each type of standard steel door and frame.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer.

B. Testing Agency Qualifications: An independent agency qualified according to ASTM E 329 for testing indicated, as documented according to ASTM E 548.

C. Source Limitations: Obtain standard steel frames through one source from a single manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver frames palletized, wrapped, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.

1. Provide additional protection to prevent damage to finish of factory-finished doors and frames.

B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store frames under cover at Project site. Place units in a vertical position with heads up, spaced by blocking, on minimum 4-inch- high wood blocking. Avoid using nonvented plastic or canvas shelters that could create a humidity chamber.

1. If wrappers become wet, remove cartons immediately. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

1.7 COORDINATION

A. Coordinate installation of anchorages for standard steel frames. 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:

1. Amweld Building Products, LLC.
2. Ceco Door Products; an ASSA ABLOY Group Company.
3. CURRIES Company; an ASSA ABLOY Group Company.
4. Fleming Door Products Ltd.; an ASSA ABLOY Group Company.
5. Pioneer Industries, Inc.
6. Republic Doors and Frames; a Windsor Republic Door Company
7. Steelcraft; an Ingersoll-Rand Company.

2.2 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum A40 zinc-iron-alloy (galvannealed) coating designation.

D. Supports and Anchors: After fabricating, galvanize units to be built into exterior walls according to ASTM A 153/A 153M, Class B.

E. Inserts, Bolts, and Fasteners: Provide items to be built into exterior walls, hot-dip galvanized according to ASTM A 153/A 153M.

F. Powder-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching standard steel door frames of type indicated.

G. Grout: Comply with ASTM C 476, with a slump of 4 inches for standard steel door frames built into concrete or masonry, as measured according to ASTM C 143/C 143M.

H. Glazing: Comply with requirements in Division 8 Section "Glazing."

I. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.3 STANDARD STEEL FRAMES

A. General: Comply with ANSI A250.8 and with details indicated for type and profile.

B. Interior Frames: Fabricated from cold-rolled steel sheet, unless otherwise indicated to comply with exterior frame requirements.

1. Fabricate frames with mitered or coped and welded face corners.
2. Frames for flush wood doors 0.053-inch- thick steel sheet.

C. Hardware Reinforcement: Fabricate reinforcement plates from same material as frames to comply with the following minimum sizes:

1. Hinges: Minimum 0.123 inches thick by 1-1/2 inches wide by 6 inches longer than hinge, secured by not less than 6 spot welds.
2. Lock Face Closers, and Concealed Holders: Minimum 0.067 inch thick.
3. All Other Surface-Mounted Hardware: Minimum 0.067 inch thick.

D. Supports and Anchors: Fabricated from electrolytic zinc-coated or metallic-coated steel sheet.

E. Jamb Anchors:

1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 0.042 inch thick, with corrugated or perforated straps not less than 2 inches wide by 10 inches long; or wire anchors not less than 0.177 inch thick.
2. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.042 inch thick.
3. Postinstalled Expansion Type for In-Place Concrete or Masonry: Minimum 3/8-inch-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.

F. Floor Anchors: Formed from same material as frames, not less than 0.042 inch 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 height adjustment. Terminate bottom of frames at finish floor surface.

G. Fabricate concealed stiffeners and hardware reinforcement from either cold- or hot-rolled steel sheet.

2.4 STOPS AND MOLDINGS

A. Moldings for Glazed Lites in Doors: Minimum 0.032 inch thick, fabricated from same material as door face sheet in which they are installed.

B. Fixed Frame Moldings: Formed integral with standard steel frames, minimum 5/8 inch high, unless otherwise indicated.

C. Loose Stops for Glazed Lites in Frames: Minimum 0.032 inch thick, fabricated from same material as frames in which they are installed.

2.5 FABRICATION

A. General: Fabricate standard steel doors and frames to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.

B. Standard Steel Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.

1. 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. Plaster Guards: Weld guards to frame at back of hardware mortises in frames installed in concrete, masonry or plastered walls.
4. Where installed in masonry, leave vertical mullions in frames open at top for grouting.
5. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
6. Jamb Anchors: Provide number and spacing of anchors as follows:

    a. Masonry Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:

        1) Two anchors per jamb up to 60 inches in height.
        2) Three anchors per jamb from 60 to 90 inches in height.
        3) Four anchors per jamb from 90 to 120 inches in height.
        4) Four anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof more than 120 inches in height.

    b. Stud-Wall Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:

        1) Three anchors per jamb up to 60 inches in height.
        2) Four anchors per jamb from 60 to 90 inches in height.
        3) Five anchors per jamb from 90 to 96 inches in height.
        4) Five anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof more than 96 inches in height.
        5) Two anchors per head for frames more than 42 inches wide and mounted in metal-stud partitions.

    c. Compression Type: Not less than two anchors in each jamb.
    d. Postinstalled Expansion Type: Locate anchors not more than 6 inches from top and bottom of frame. Space anchors not more than 26 inches o.c.

7. Door Silencers: Except on weather-stripped doors, drill stops to receive door silencers as follows. Provide plastic plugs to keep holes clear during construction.

    a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
    b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.

C. Hardware Preparation: Factory prepare standard steel doors and frames to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping, according to the Door Hardware Schedule and templates furnished as specified in Division 8 Section DOOR HARDWARE.

1. Reinforce frames to receive non-templated mortised and surface-mounted door hardware.
2. Comply with applicable requirements in ANSI A250.6 and ANSI/DHI A115 Series specifications for door and frame preparation for hardware. Locate hardware as indicated on Shop Drawings or, if not indicated, according to ANSI A250.8.

D. 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 frame.
2. Multiple Glazed Lites: Provide fixed and removable stops and moldings such that each glazed lite is capable of being removed independently.
3. Provide fixed frame moldings on secure side of interior frames.
4. Provide loose stops and moldings on inside of frames.
5. Coordinate rabbet width between fixed and removable stops with type of glazing and type of installation indicated.

2.6 STEEL FINISHES

A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Finish standard steel frames after assembly.

B. Metallic-Coated Steel Surface Preparation: Clean surfaces with non-petroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas, and apply galvanizing repair paint specified below to comply with ASTM A 780.

1. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.

C. Steel Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning"; remove dirt, oil, grease, or other contaminants that could impair paint bond. Remove mill scale and rust, if present, from uncoated steel; comply with SSPC-SP 3, "Power Tool Cleaning," or SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

D. Factory Priming for Field-Painted Finish: Apply shop primer specified below immediately after surface preparation and pretreatment. Apply a smooth coat of even consistency to provide a uniform dry film thickness of not less than 0.7 mils.

1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; compatible with substrate and field-applied finish paint system indicated; and providing a sound foundation for field-applied topcoats despite prolonged exposure.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of standard steel frames.

1. Examine roughing-in for embedded and built-in anchors to verify actual locations of standard steel frame connections before frame installation.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove welded-in shipping spreaders installed at factory.

B. Prior to installation and with installation spreaders in place, adjust and securely brace standard steel frames for squareness, alignment, twist, and plumb to the following tolerances:

1. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
2. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
3. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
4. Plumbness: Plus or minus 1/16 inch, measured at jambs on a perpendicular line from head to floor.

C. Drill and tap frames to receive nontemplated mortised and surface-mounted door hardware.

3.3 INSTALLATION

A. General: Provide frames of sizes, thicknesses, and designs indicated. Install standard steel frames plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.

B. Standard Steel Frames: Install standard steel frames for doors and other openings, of size and profile indicated. Comply with SDI 105.

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 due to 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 plumb, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
    g. Apply bituminous coating to backs of all exterior frames and those that are filled with mortar, grout, and plaster containing anti freezing 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. 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.
4. Ceiling Struts: Extend struts vertically from top of frame at each jamb to supporting construction above, 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 above. Provide adjustable wedged or bolted anchorage to frame jamb members.
5. Installation Tolerances: Adjust standard steel door frames for squareness, alignment, twist, and plumb to the following tolerances:

    a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
    b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
    c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
    d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.

C. Glazing: Comply with installation requirements in Division 8 Section "Glazing" and with standard steel door and frame manufacturer's written instructions.

1. Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c., and not more than 2 inches o.c. from each corner.

3.4 ADJUSTING AND CLEANING

A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including standard steel doors or frames that are warped, bowed, or otherwise unacceptable.

B. Clean grout and other bonding material off standard steel doors and frames immediately after installation.

C. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying primer.

D. Galvannealed Surfaces: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

END OF SECTION 081113

SECTION 081416 - FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 M.S.U. ISSUES

A. Transparent finished wood doors and steel frames are the standard interior doors at M.S.U.

B. All public and personnel doors shall be a minimum of 36” wide to provide barrier-free access for mobility aid users.

C. It the intent of MSU that all flush wood doors used on its projects will comply with LEED™ NC 3 Credit Requirements MR Credit 4: Recycled Content, 10% (post-consumer + ½ pre-consumer), MR Credit 4: Recycled Content 20% (post-consumer + ½ pre-consumer), and EQ Credit 4.2 Low-Emitting Materials: Paints and Coatings. EQ Credit 4.2 will apply only in the instance of field finished doors.

1.2 SUMMARY

A. This Section includes the following:

1. Solid-core doors with wood-veneer faces.
2. Factory finishing flush wood doors.
3. Factory fitting flush wood doors to frames and factory machining for hardware.
4. Louvers for flush wood doors.

B. Related Sections include the following:

1. Division 08 Section GLAZING for glass view panels in flush wood doors.
2. Division 08 Section DOOR HARDWARE for hardware for flush wood doors.
3. Division 08 Section HOLLOW METAL FRAMES for steel frames for flush wood doors.

1.3 SUBMITTALS

A. Product Data: For each type of door, include details of core and edge construction, louvers, and trim for openings. Include factory-finishing specifications.

B. Samples for Initial Selection: Color charts consisting of actual materials in small sections for the following:

1. Faces of Factory-Finished Doors: Show the full range of colors available for stained finishes.

C. Samples for Verification:

1. Factory finishes applied to actual door face materials, approximately 8 by 10 inches, for each material and finish. For each wood species and transparent finish, provide set of three samples showing typical range of color and grain to be expected in the finished work.
2. Corner sections of doors, approximately 8 by 10 inches, with door faces and edgings representing typical range of color and grain for each species of veneer and solid lumber required. Finish sample with same materials proposed for factory-finished doors.
3. Frames for light openings, 6 inches long, for each material, type, and finish required.

D. Submit printed statement and product data for field applied finishes in accordance with the General Administrative Requirements of the MSU Construction Standards 01300.1.2. Maximum VOC content when calculated according to South Coast Air Quality Management District (SCAQMD) Rule #1113, Architectural Coatings:

1. Clear Wood Finishes: Varnish Maximum 350 g/l, Lacquer Maximum 550 g/l
2. Stains: Maximum 250 g/l
3. Sealers: Waterproofing 250 g/l
4. Sanding Sealers 275 g/l
5. All Other Sealers 200 g/l

E. Quality Assurance: Provide documentation as described in this section.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain flush wood doors through one source from a single manufacturer.

B. Quality Standard: Comply with AWI's "Architectural Woodwork Quality Standards Illustrated."

1. Provide AWI Quality Certification Labels or an AWI letter of licensing for Project indicating that doors comply with requirements of grades specified.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Comply with requirements of referenced standard and manufacturer's written instructions.

B. Package doors individually in plastic bags or cardboard cartons.

C. Mark each door on top and bottom rail with Project Number and opening number used on Shop Drawings.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install doors until building is enclosed, wet work is complete, and HVAC system is operating and will maintain temperature and relative humidity at occupancy levels during the remainder of the construction period.

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:

1. Flush Wood Doors:

a. Algoma Hardwoods Inc.
b. Eggers Industries; Architectural Door Division.
c. GRAHAM Manufacturing Corp.
d. Marshfield DoorSystems.
e. Mohawk Flush Doors, Inc.
f. Oshkosh Architectural Door Co.
g. VT Industries Inc.

2.2 DOOR CONSTRUCTION, GENERAL

A. Doors for Transparent Finish:

1. Grade: Premium, with Grade AA faces.

2.3 SOLID-CORE DOORS

A. Interior Veneer-Faced Doors:

1. Core: Glued block or structural composite lumber.
2. Construction: Five or seven plies with stiles and rails bonded to core, then entire unit abrasive planed before veneering.

2.4 LIGHT FRAMES

A. Wood Beads for Light Openings in Wood Doors:

1. Wood Species: Species compatible with door faces.
2. Profile: Flush rectangular beads.
3. At 20-minute, fire-rated, wood-core doors, provide wood beads and metal glazing clips approved for such use.

2.5 FABRICATION

A. Fabricate doors in sizes indicated for Project-site fitting.

B. Factory fit doors to suit frame-opening sizes indicated, with the following uniform clearances and bevels, unless otherwise indicated:

1. Comply with clearance requirements of referenced quality standard for fitting. Comply with requirements in NFPA 80 for fire-rated doors.

C. Factory machine doors for hardware that is not surface applied.

1. Coordinate measurements of hardware mortises in metal frames to verify dimensions and alignment before factory machining.
2. Metal Astragals: Premachine astragals and formed-steel edges for hardware for pairs of fire-rated doors.

D. Openings: Cut and trim openings through doors to comply with applicable requirements of referenced standards for kind(s) of door(s) required.

1. Light Openings: Trim openings with moldings of material and profile indicated.

2.6 FACTORY FINISHING

A. General: Comply with AWI's "Architectural Woodwork Quality Standards Illustrated" for factory finishing.

B. Transparent Finish:

1. Grade: Premium.
2. Finish: AWI System TR-4 Conversion Varnish.
3. Sheen: Satin.
4. Color: Match existing doors in suite / area.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine doors and installed door frames before hanging doors.

1. Verify that frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
2. Reject doors with defects.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Hardware: For installation, see Division 8 Section "Door Hardware."

B. Manufacturer's Written Instructions: Install doors to comply with manufacturer's written instructions, referenced quality standard, and as indicated.

C. Job-Fitted Doors: Align and fit doors in frames with uniform clearances and bevels as indicated below; do not trim stiles and rails in excess of limits set by manufacturer or permitted for fire-rated doors. Machine doors for hardware. Seal cut surfaces after fitting and machining.

1. Clearances: Provide 1/8 inch at heads, jambs, and between pairs of doors. Provide 1/8 inch from bottom of door to top of decorative floor finish or covering. Where threshold is shown or scheduled, provide 1/4 inch from bottom of door to top of threshold.

a. Comply with NFPA 80 for fire-rated doors.

2. Bevel non-fire-rated doors 1/8 inch in 2 inches at lock and hinge edges.

D. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.

E. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

F. Field-Finished Doors: Refer to the following for finishing requirements:

1. Division 09 Sections EXTERIOR PAINTING and INTERIOR PAINTING

3.3 ADJUSTING

A. Operation: Rehang or replace doors that do not swing or operate freely.

B. Finished Doors: Replace doors that are damaged or do not comply with requirements. Doors may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION 081416

SECTION 087100 - DOOR HARDWARE

PART 1 - GENERAL

1.1 M.S.U. ISSUES

A. On interior doors, do not install lights that extend below the level of the top of the mounting of the exit device or the lockset.

B. At the end of a project, all unused door hardware should be provided to the M.S.U. Key Shop.

C. When appropriate, wall magnet door holders should be provided to hold doors open during heavy usage periods to save unnecessary wear on the mechanism.

D. Hinges on all doors that open outward (reverse bevel) shall have NRP (Non Removable Pin) hinges.

E. A door closer is required on all doors in new or renovated computer labs (or similar spaces) which are not served by building central air conditioning and have window or room air conditioning equipment if the doors connect to non-air conditioned spaces.

F. All public and personnel doorway hardware shall meet the latest A.D.A. - ICC/ANSI A117.1 standards to provide barrier free access for mobility and physically impaired users.

G. Where card access controls are provided, electrified locksets or electrified panic bars shall be used instead of electric strikes. The electrified hardware shall include an RX (Request to Exit) switch.

1.2 SUMMARY

A. This Section includes the following:

1. Commercial door hardware for the following:

    a. Swinging doors.
    b. Other doors to the extent indicated.

B. Related Sections include the following:

1. Division 08 Section HOLLOW METAL DOORS AND FRAMES for astragals provided as part of a fire-rated labeled assembly and for door silencers provided as part of the frame.
2. Division 08 Section FLUSH WOOD DOORS for astragals provided as part of a fire-rated labeled assembly.

C. The following list is provided as a reference to clearly identify manufacturers cited in this standard:

1.	Arrow	Arrow Architectural Hardware; an ASSA ABLOY Group company
2.	Baldwin	Baldwin Hardware Corporation
3.	Best	Best Access Systems, Division of The Stanley Works
4.	Corbin Russwin	Corbin Russwin Architectural Hardware; an ASSA ABLOY Group company
5.	Glynn-Johnson	Glynn-Johnson; an Ingersoll-Rand Company
6.	Hager	Hager Companies
7.	Ives	Ives; an Ingersoll-Rand Company
8.	LCN	LCN Closers; an Ingersoll-Rand Company
9.	McKinney	McKinney Products Company; an ASSA ABLOY Group company
10.	Pemko	Pemko Manufacturing Co., Inc.; an ASSA ABLOY Group company
11.	Reese	Reese Enterprises, Inc.
12.	Rockwood	Rockwood Manufacturing Company; an ASSA ABLOY Group company
13.	Sargent	Sargent Manufacturing Company; an ASSA ABLOY Group company
14.	National Guard	National Guard Products, Inc.
15.	Von Duprin	Von Duprin; an Ingersoll-Rand Company

1.3 SUBMITTALS

A. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."
2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening.

    a. Organize door hardware sets in same order as in the Door Hardware Schedule at the end of Part 3.

3. Content: Include the following information:

    a. Type, style, function, size, label, hand, and finish of each door hardware item.
    b. Manufacturer of each item.
    c. Fastenings and other pertinent information.
    d. Location of each door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
    e. Explanation of abbreviations, symbols, and codes contained in schedule.
    f. Mounting locations for door hardware.
    g. Door and frame sizes and materials.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with provisions of the following:

1. Michigan Department of Labor, Bureau of Construction Codes and Fire Safety.
2. Michigan State Police Fire Marshal Division.

a. Hardware furnished for labeled openings shall be labeled and have been tested by a testing laboratory recognized by the Michigan State Police Fire Marshal Division.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Each item of hardware shall be individually wrapped and packaged to avoid scratching or marking of the finishes.

B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.

1.6 COORDINATION

A. Coordinate layout and installation of recessed pivots and closers with floor construction. Anchoring inserts shall be cast into concrete.

B. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing door hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

1.7 CYLINDERS AND KEYING

A. All locking devices shall be supplied prepared for seven pin cylinders manufactured by Best Lock Corporation.

B. All existing cylinders and cores will be salvaged to the M.S.U. Key Shop, unless otherwise directed.

C. All cylinders, cores, and keys, temporary and permanent, shall be furnished by the M.S.U. Key Shop, which shall also perform the following:

1. Remove existing cores and install construction cores on ***existing doors*** as required.
2. Furnish construction cylinders, cores, and keys for ***new doors***.

a. The contractor shall supply the M.S.U. Project Representative with a copy of the project Hardware Schedule to allow the Key Shop to match cylinders to the new hardware.

b. The contractor shall pick up cylinders, cores, and keys from the M.S.U. Key shop with the form "Authorization for Construction Cylinders, Cores, and Keys", completed and authorized by the M.S.U. Project Representative.
c. The contractor shall install construction cylinders in new doors for alignment of hardware, for use during construction, and for inspection of operation.
d. All construction keys issued to a contractor for a particular project will be returned to the Key Shop before final payment will be granted. Lost keys are subject to fines consisting of the cost of re-keying all locks on campus, which have the same code as the lost key.
e. The contractor shall tag and supply to the M.S.U. Key shop one copy of the key for each non-standard lock installed.

1.8 SCHEDULED DOOR HARDWARE

A. Hinges

1. Hinge locations shall conform to the National Builders Hardware Association Standards. M.S.U. avoids pivot hinges because they collect dirt and salt.
2. On relatively new installations and when existing conditions warrant, salvage existing hinges, clean, lubricate, and reinstall.
3. Electric hinges shall not be permitted.

HINGE SCHEDULE

Typical Usage	Quantity	Style	Manufacturer
Classrooms, offices, toilet rooms and storerooms of average size	1 1/2 pair	Full mortise 4 1/2" X 4 1/2" ball bearing, standard weight, butt hinges with non-rising removable pins	McKinney Hager BB1279 or approved equal
Low to medium frequency use entrances and toilet rooms, and stairwell doors of high frequency use.	1 1/2 pair	Full mortise 5" x 41/2" ball bearing heavyweight butt hinges with non-rising removable pins	Hager BB1168 McKinney T4B3786 or approved equal
Heavy doors, abused doors, or high frequency doors. Also for dormitory and stairwell doors when replacing frames.	One set, which includes one anchor and one pair butts	Full mortise 5" X 4 1/2" ball bearing, heavyweight, anchor-type hinges with non-rising removable pins, of required hand	Hager AB8505 McKinney or approved equal
New frames for openings with heavy weight and/or large cart traffic. Field check height of existing hinge gains when retrofitting.	1 1/2 pair	5" ball bearing, heavyweight, clearance hinges with non-rising removable pins	Hager BB1267 or approved equal

Typical Usage	Quantity	Style	Manufacturer
Existing frames for openings with medium weight cart traffic. Field check height of existing hinge gains when retrofitting.	1 1/2 pair	4 1/2 inch clearance hinges, TA-TB2895 x NRP	McKinney
These may be used only on existing doorframes when none of the above alternatives are appropriate, and only with the prior approval of the M.S.U. Key Shop.		780-210HD (surface mount) 780-224HD (mortise mount)	Hager-Roton

B. Lock and Latch Sets – Full Mortise

1. The quality of each mortise lock set assembly, including cylinder and escutcheon, must be Grade 1 for both operation and security in accordance with ANSI A156.13 and the latest BHMA "Directory of Certified Locks and Latches."
2. The lock set must accept Best interchangeable 7-pin tumbler cores and cylinders.
3. Locksets shall be full-mortise Corbin Russwin ML 2000 Series, with functions as listed in the lock and latch set schedule below. Knob and trim style shall be Corbin Russwin YWN trim, unless specified otherwise. Lever handle and trim style shall be Corbin Russwin NSN. Locksets shall have screwless shank and 2-¾ inch basket.
4. Provide curved lip strike plate with tongue of appropriate length for type of door trim used.
5. Locksets on doors with card access controls shall be Sargent 8271-RX in either the WTL or LWIL trim style. All electrified locksets shall be 24 VDC.

LOCK AND LATCH SET SCHEDULE

Typical Usage	Lock set
Use only in relatively new existing installations. Field check condition of existing locksets.	Salvage existing – clean lubricate, and reinstall.
Card access control door	Sargent 8271-RX-NSN
Classrooms, laboratories, teaching laboratories, and outside entrances with lock	Corbin Russwin ML2055
Offices	Corbin Russwin ML2051
Closets or passages	Corbin Russwin ML2010
Janitor closets and storage rooms	Corbin Russwin ML2057
Doors to roof, and from penthouse to roof two floors or less above grade and all air plenums.	Corbin Russwin ML2022, keyed both sides with abrasive knob inside

Typical Usage	Lock set
Mechanical rooms, transformer rooms, steam service tunnel access, telephone closets, and from public building space to roof, three floors or more above grade. M.S.U. Key Shop will modify lockset for lock cylinder and rigid knobs both sides when used from public space to roof below the third floor.	Corbin Russwin ML2057-M21, all with abrasive knob outside and free knob inside.
Penthouse to roof access, three floors or more above grade.	Corbin Russwin ML2057, all with abrasive knob outside and free knob inside.
Residence hall rooms	Corbin Russwin ML2065 YW Knob
Residence hall stairwells	Corbin Russwin ML2010
Toilet room with single stool, and barrier-free dormitory rooms.	Corbin Russwin ML2065
Barrier-free offices, used only on special request	Corbin Russwin ML2051
Loading dock floors with heavy cart traffic	Rockwood trim protector bar R111LPB

C. Exit Devices

1. Exit devices shall be rim-mounted and reversible with functions and options as listed below. Devices shall be mounted with panic bar at 37 inches above the floor with the devices undogged, or at the nearest approved manufacturer's standard.
2. **Concealed vertical rod shall not be used.**
3. Use Rockwood push plate's 70B series with all doggable exit devices.
4. All doors with card access controls shall be Von Duprin 98 Series exit devices

EXIT DEVICES SCHEDULE

Typical Usage	Exit Device
Use only for relatively new existing installations. Field check condition of existing.	Salvage existing, clean lubricate and reinstall.
Rated or stairwell opening with card access control	Von Duprin RX98F with E996L Electrified Lever Trim
Stairwell with no lock and that cannot be dogged down	Arrow FS3808 x SL08A Von Duprin 98L-F-BE Sargent 19-12-8815 x ETL

Typical Usage	Exit Device
Stairwell with lock, or entrance in labeled opening where device cannot be dogged down during the day	Arrow FS3808 x SL08 Von Duprin 98L-F Sargent 19-12-8813 x ETL
Entrance door with card access control and key override	Von Duprin RX 98 NL QEL+
Entrance door with card access control and no key override	Von Duprin RX 98 DT QEL+
Entrance with dogging and outside pull trim	Arrow FS3803 x SP02 Von Duprin 98DL Sargent 19-8810 x PTB
Entrance with dogging, outside pull trim and keyed cylinder	Arrow FS3803 x SL03 Von Duprin 98NL Sargent 19-12-8804 x PTB
Fire escapes or low occupancy classrooms with exit only requirements	Arrow FS3803 Von Duprin 98EO-F Sargent 19-12-8810
Locations requiring controlled egress.	VonDuprin CHEXIT Series CX98 controlled exit device.
Residence hall wide stile entrance/exit doors with dogging and without cylinder	Von Duprin 98DT (pull trim and blank escutcheon) Arrow S3803 x SP02 Sargent 19-8810 x PTB
Residence hall wide stile entrance/exit doors with dogging and cylinder	Von Duprin 98DT (pull trim and cylinder) Arrow S3803 x SP03 Sargent 19-8804 x PTB
Rated opening requiring daytime passage and nighttime locking. Door is always latched.	Von Duprin 98 Series Double Cylinder Exit Device

D. Dead Bolts

1. Dead bolts shall be full-mortise Corbin Russwin ML2200 Series with thumb turn lever 519F10 and 2 ¾ inch backset, and with functions as listed below. Unless required to match existing hardware locations or noted on drawing, center of cylinder will be at 60 inches above the finished floor.
   a. Salvage existing dead bolts, clean lubricate and reinstall. Use only for relatively new existing installations. Field check condition of existing.
   b. Corbin Russwin ML 2217 is typical for gang toilet rooms for use by custodial and maintenance workers.

E. Push/Pull Units

1. Push/pull plates shall be stainless steel or bronze as required for the finish desired. Pull handles shall be solid forged metal with finish specified and be through bolted through plate and door. Punch push plate for cylinder when required by dead bolt. Unless otherwise noted, pull handles and plates shall be centered at 38 inches above the floor and push plates at 46 inches above the floor.

PUSH/PULL UNIT SCHEDULE

Salvage existing, reinstall	Use only for relatively new existing installations. Field check condition of existing.
Push plate	Baldwin 8" x 16" wrought push plate, 2210 or equal by Rockwood.
Push plate and handle	Baldwin 8" x 16" wrought pull plate 2110 with 2565 handle or equal by Rockwood.

F. Closers

1. All closers should be overhead, surface mounted closers, and must conform with ADA. **Concealed or floor closers are not acceptable. LCN Series 4040 is not acceptable.**

CLOSERS SCHEDULE

Typical Usage	Maximum Size Interior Door	Maximum Size Exterior Door	LCN Catalog Number	Corbin Russwin Catalog Number
Interior doors - High Frequency: Closer mounted on pull side of door.	Up to 54 inches	n/a	4011	DC8200
Interior doors - Low Frequency: Closer mounted on pull side of door. (offices, storage rooms, electrical, mechanical)	Up to 48 inches	n/a	4011	DC6200

Typical Usage	Maximum Size Interior Door	Maximum Size Exterior Door	LCN Catalog Number	Corbin Russwin Catalog Number
Exterior doors, or interior doors where the closer cannot be mounted on the door side of the frame. This closer mounts on the room side of the frame. It requires four inches or more clearance above the door opening.	Up to 54 inches 60 inches	Up to 42” 60 inches	4021 4025 or 4026 sized to match door	DC8220 DC8220
Exterior doors, or interior doors where the closer cannot be mounted on the door side of the frame and the mounting space on the frame is less than four inches. Design the door header to avoid this closer when possible.	Up to 54 inches 60 inches	Up to 42” 60 inches	4021 with 18G plate 4025 or 4026 with 18G plate, sized to match door	DC8220 x 754F24
Exterior doors and interior doors - high frequency - where hold open is required.	Up to 54”	Up to 42”	4111 w/CUSH-N-STOP x H.O.	DC86210 x A5
Interior Doors – low frequency – where hold open is required (offices, storage rooms, electrical, mechanical)	Up to 48”	n/a	4111 w/ CUSH-N-STOP x H.O.	DC6210 x A5

G. Doorstops

DOORSTOP SCHEDULE

Typical Usage	Doorstop
Typical for lever handle locksets	Glynn-Johnson projected wall-mounted doorstop WB33.
Typical for all doors with knobs unless otherwise required by job condition	Ives wall mounted doorstop (408-1/2 at concrete or masonry, 406-1/2 at all wood and hollow walls with wood blocking, and 407-1/2 only at existing hollow walls having no blocking), or equal by Baldwin. Coordinate blocking in new walls with other trades.
Typical for overhead door control where there is no wall or no closer (e.g. student rooms).	Glynn Johnson 90/GJ900S
When using closer as a stop.	LCN door closer 4111 SHCNS (stop arm)

H. Kick Plates

1. **Kick plates are required on the push side of all doors that have door closers**. Kick plates shall be beveled on three sides and furnished with match oval head screws.

2. Salvage existing, clean and reinstall.

3. Rockwood 304 stainless steel kick plate -.050 inch x 16" high x width of door less 1 inch. Provide higher or lower protection when noted on door schedule.

4. Rockwood bronze kick plate -.050 inch x 16" high x width of door less 1 inch. Provide higher or lower protection when noted on door schedule. Use bronze only to match existing; the bronze corrodes when the lacquer finish wears away. Provide trim protectors at high kick plates for doors with heavy cart traffic.

I. Weather-stripping

WEATHERSTRIPPING SCHEDULE

Typical Usage	Weather-stripping
Field-check condition of existing vinyl and pile seats. Note or specify replacement as required.	Salvage existing when appropriate, clean and reinstall.
At both jambs and head	Pemko extruded aluminum retainer with vinyl bulb, 306A or equal by Reese.
Typical heavy use door bottom on new hollow metal doors. Do not use this door bottom with plastic laminated doors as insufficient material is left for screws.	Pemko full mortise automatic door bottom, 434A or equal by Reese.
Typical heavy use door bottom for plastic laminate doors.	Pemko semi-mortise automatic door bottom, 430AM or equal by Reese.
Typical heavy use door bottom for existing hollow metal doors.	Pemko surface mounted automatic door bottom, 430AS or equal by Reese.
Typical lighter duty door bottom for new doors.	Pemko full mortise automatic door with neoprene sponge, 411 or equal by Reese.
Typical lighter duty door for existing hollow metal doors.	Pemko surface mounted automatic door bottom, 412 or equal by Reese.
Exterior Door Sweeps	National Guard C607A or Pemko 18062
Exterior Door Thresholds	National Guard 425 or Pemko 175

J. Foot and Head Bolts

1. Foot and head bolts shall have 12-inch downset and ¾ inch throw unless otherwise noted. Manual bolts shall have lever operation which allows for partial opening before engaging bolt.

FOOT AND HEAD BOLT SCHEDULE

Typical Usage	Foot and Head Bolts
Head bolt. Use only on non-labeled door openings.	Baldwin extension flush bolt 0610
Floor bolt. Use only on non-labeled door openings.	Baldwin extension flush bolt 0610. Provide Baldwin 0621 or 0622 dustproof strike. Set floor strike in epoxy or expanding grout. Coordinate type and installation of floor strike with floor material (tile, carpet, etc.).
Typical at labeled door opening. Avoid pairs of doors at labeled openings if possible by using ganged single doors.	Ives FB31P. Provide strike plates for active door leaf and dustproof floor strike. Set floor strike in epoxy or expanding grout. Coordinate type and installation of floor strike with floor material (title, carpet, etc.).

K. Coordinators

1. Avoid door coordinators wherever possible by using removable door mullions.

DOOR COORDINATOR SCHEDULE

Typical Usage	Foot and Head Bolts
Salvage only roller type coordinators, and only in low traffic areas.	Salvage existing.
Use at low traffic areas with no potential for vandalism.	Ives projected coordinator with roller operation against active and inactive doors, model 469 or 469 ½, or equal. Provide strikes and required accessories.
Use at high traffic openings and areas subject to vandalism.	Glynn-Johnson linear stop-mounted coordinator, Series COR, with fillers x size as required.

L. Removable Mullion

1. Salvage existing – check anchorage.

2. Von Duprin removable steel mullion KR4954 with MT54 storage unit x prime paint, or equal by Arrow or Sargent.

M. Secret Latch

1. Rockwood RW 602x26D or Major MRS 200 SPB or MRS 200 PA(AL)

1.9 HARDWARE FINISHES

A. Unless noted elsewhere, finish of hardware listed in Scheduled Hardware shall have Dull Bronze or Dull Chromium finish as established by the U.S. Bureau of Standards and listed in the schedule below. Items of hardware not categorized below shall have finish best matching the selected finish series.

HARDWARE FINISHES SCHEDULE

Item	**Dull Bronze (DB) Finish Series**	**Dull Chromium (DC) Finish Series**
Hinges (All hinges shall have extra heavy copper base plating.)	US10	US26D
Locksets (latch sets)	US10	US26D
Panic Devices	US10	US32D (stainless)
Deadbolts	US10	US26D
Push/pull plates	US10	US26D
Doorstops	US10	US26D
Kick plates	US10	US32D or US10
Vision lite glass stops	Natural Anodized Aluminum	Natural Anodized Aluminum
Weather-stripping	Natural Anodized Aluminum	Natural Anodized Aluminum
Closers		
Wood	Dark Bronze	Aluminum
Plastic laminate	Dark Bronze	Aluminum
Hollow metal	Dark Bronze	Aluminum
Natural Anodized Aluminum	Dark Bronze	Aluminum

Item	Dull Bronze (DB) Finish Series	Dull Chromium (DC) Finish Series
Dark Bronze Aluminum	Dark Bronze or KDP Dark if noted	Aluminum or KDP Dark if noted

1.10 INSTALLATION

A. Install all new and/or rework existing hardware in compliance with the manufacturer's recommendations and as noted on Door Schedule and specified herein. Mortised items will be adjusted to fit flush.

B. Do not install surface mounted items until finishes have been completed on the substrates involved.

C. Lubricate and adjust all hardware to operate properly.

1.11 Hardware Sets

HARDWARE GROUP NO. 01

For use on Door #(s):
115F1

Provide each opening with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5 NRP		652	IVE
1	EA	PASSAGE LOCK	ML2010 NSN		626	C-R
1	EA	SURFACE CLOSER	4111 EDA		689	LCN
1	EA	KICK PLATE	8400 16" X 1 1/2" LDW B-CS		630	IVE
1	EA	WALL STOP	WS33/WS33X		626	IVE
1	EA	SOUND SEAL	870AA-S		AA	ZER
1	EA	AUTO DR BOTTOM (MORTISED)	360AA-Z49		AA	ZER
1	EA	THRESHOLD	63A		A	ZER
1	EA	GASKETING	488SBK PSA		BK	ZER
1	EA	MOUNTING BRACKET	870SPB			ZER

HARDWARE GROUP NO. 02

For use on Door #(s):
115D

Provide each opening with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5 NRP		652	IVE
1	EA	PASSAGE LOCK	ML2010 NSN		626	C-R
1	EA	SURFACE CLOSER	4011		689	LCN
1	EA	KICK PLATE	8400 16" X 1 1/2" LDW B-CS		630	IVE
1	EA	WALL STOP	WS33/WS33X		626	IVE
1	EA	GASKETING	488SBK PSA		BK	ZER

HARDWARE GROUP NO. 03

For use on Door #(s):
115F2

Provide each opening with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
8	EA	HINGE	5BB1HW 4.5 X 4.5 NRP		652	IVE
1	EA	CONST LATCHING BOLT	FB51T/FB61T (AS REQ'D)		630	IVE
1	EA	PASSAGE LOCK	ML2010 NSN		626	C-R
1	EA	COORDINATOR	COR X FL (MB AS REQ'D)		628	IVE
2	EA	SURFACE CLOSER	4111 HEDA		689	LCN
2	EA	KICK PLATE	8400 16" X 1" LDW B-CS		630	IVE
2	EA	WALL STOP	WS33/WS33X		626	IVE
1	EA	SOUND SEAL	870AA-S		AA	ZER
2	EA	AUTO DR BOTTOM (MORTISED)	360AA-Z49		AA	ZER
1	EA	OVERLAPPING ASTRAGAL	383AA		AA	ZER
1	EA	THRESHOLD	63A		A	ZER
2	EA	GASKETING	488SBK PSA		BK	ZER
2	EA	MOUNTING BRACKET	870SPB			ZER

HARDWARE GROUP NO. 04

For use on Door #(s):
115C

Provide each opening with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5 NRP		652	IVE
1	EA	POWER TRANSFER	EPT10		689	VON
1	EA	ELECTRIFIED LOCKSET	8271-RX-LW1L		626	SAR
1	EA	CYLINDER/CORE	BY MSU KEY SHOP		626	B/O
1	EA	SURFACE CLOSER	4111 SCUSH		689	LCN
1	EA	KICK PLATE	8400 16" X 1 1/2" LDW B-CS		630	IVE
1	EA	GASKETING	488SBK PSA		BK	ZER
1	EA	DOOR CONTACT	679-05 WD/HM AS REQ'D		BLK	SCE
1	EA	POWER SUPPLY	BY OTHERS		LGR	SCE
1	EA	MAGNETIC CONTACT	SALVAGE AND REUSE EXISTING			B/0
	EA	CARD READER	SALVAGE AND REUSE EXISTING			B/O

DOOR NORMALLY CLOSED AND LOCKED. PRESENTING VALID CREDENTIAL TO READER MOMENTARILY UNLOCKS OUTSIDE LEVER ALLOWING ENTRY. FREE EGRESS AT ALL TIMES.

HARDWARE GROUP NO. 05

For use on Door #(s):
115E

Provide each opening with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
1	EA	PASSAGE LOCK	ML2010 NSN		626	C-R
1	EA	SURFACE CLOSER	4111 EDA		689	LCN
1	EA	WALL STOP	WS33/WS33X		626	IVE

BALANCE OF HARDWARE BY ACCOUSTICAL DOOR MANUFACTURER

END OF SECTION 087100

SECTION 088000 - GLAZING

PART 1 - GENERAL

1.1 SUMMARY

A. This 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. Windows.
2. Doors.

1.2 DEFINITIONS

A. Manufacturers of Glass Products: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.

B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.

C. Deterioration of Laminated Glass: Defects developed from normal use that are attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.

1.3 PERFORMANCE REQUIREMENTS

A. General: Provide glazing systems capable of withstanding normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, and installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

B. Thermal Movements: Provide glazing that allows for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures acting on glass framing members and glazing components. 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.

1.4 SUBMITTALS

A. Product Data: For each glass product and glazing material indicated.

B. Samples: For the following products, in the form of 12-inch- square Samples for glass and of 12-inch- long Samples for sealants. Install sealant Samples between two strips of material representative in color of the adjoining framing system.

C. Samples: For the following products, in the form of 12-inch- square Samples for glass.

1. Each color of glass.
2. For each color (except black) of exposed glazing sealant indicated.

D. Product Certificates: Signed by manufacturers of glass and glazing products certifying that products furnished comply with requirements.

E. Qualification Data: For installers.

F. Preconstruction Adhesion and Compatibility Test Report: From glazing sealant manufacturer indicating glazing sealants were tested for adhesion to glass and glazing channel substrates and for compatibility with glass and other glazing materials.

G. Product Test Reports: For each of the following types of glazing products:

1. Glazing sealants.
2. Glazing gaskets.

H. Warranties: Submit written special warranty as specified in this Section. Include contact information, description of coverage, and start date for each special warranty.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed glazing similar in material, design, and extent to that indicated for this Project; whose work has resulted in glass installations with a record of successful in-service performance.

B. Source Limitations for Glazing Accessories: Obtain glazing accessories through one source from a single manufacturer for each product and installation method indicated.

C. Glass Product Testing: Obtain glass test results for product test reports in "Submittals" Article from a qualified testing agency based on testing glass products.

1. Glass Testing Agency Qualifications: An independent testing agency with the experience and capability to conduct the testing indicated, as documented according to ASTM E 548.

D. Safety Glazing Products: Comply with testing requirements in 16 CFR 1201, and, ANSI Z97.1.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect glazing materials according to manufacturer's written instructions and as needed to prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from other causes.

1.8 WARRANTY

A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer's standard form, made out to Owner and signed by coated-glass manufacturer agreeing to replace coated-glass units that deteriorate as defined in "Definitions" Article, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.

1. Warranty Period: 10 years from date of Substantial Completion.

B. Manufacturer's Special Warranty on Laminated Glass: Manufacturer's standard form, made out to Owner and signed by laminated-glass manufacturer agreeing to replace laminated-glass units that deteriorate as defined in "Definitions" Article, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. 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 GLASS PRODUCTS

A. Kind FT - Fully Tempered Float Glass: ASTM C 1048.

1. Ultra-Clear (Low-Iron) Float Glass: Class I (clear); with a minimum 91 percent visible light transmission.

a. Available Manufacturers

1) AFG Industries Inc.
2) Pilkington Building Products North America
3) PPG Industries, Inc.
4) Cardinal Glass Industries
5) Guardian Industries

6) Libbey-Owens-Ford Co. (LOF)
7) Viracon

b. Applications: Interior lites and door lites.
c. Glass Type: Provide fully tempered glass at interior lites. Provide fully tempered safety glass at door lites.
d. Tint: Clear.

B. Laminated Glass: ASTM C 1172, and complying with other requirements specified and with the following:

1. Interlayer: Polyvinyl butyral of thickness indicated with a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after laminating glass lites and installation.

a. For polyvinyl butyral interlayers, laminate lites in autoclave with heat plus pressure.

2. Laminating Process: Fabricate laminated glass to produce glass free of foreign substances and air or glass pockets.

2.3 GLAZING GASKETS

A. Dense Compression Gaskets: Molded or extruded gaskets of material indicated below, complying with standards referenced with name of elastomer indicated below, and of profile and hardness required to maintain watertight seal:

1. Neoprene, ASTM C 864.
2. EPDM, ASTM C 864.
3. Silicone, ASTM C 1115.
4. Thermoplastic polyolefin rubber, ASTM C 1115.

2.4 GLAZING SEALANTS

A. General: Provide products of type indicated, complying with the following requirements:

1. Compatibility: Select glazing sealants that are compatible with one another and with other materials they will contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.

B. Elastomeric Glazing Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied chemically curing sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.

2.5 GLAZING TAPES

A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based elastomeric tape with a solids content of 100 percent; 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; packaged on rolls with a release paper backing; and complying with ASTM C 1281 and AAMA 800 for products indicated below:

1. AAMA 806.3 tape.

B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; packaged on rolls with release liner protecting adhesive; and complying with AAMA 800 for the following types:

1. Type 1, for glazing applications in which tape acts as the primary sealant.
2. Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.6 MISCELLANEOUS GLAZING MATERIALS

A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.

B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.

D. Spacers: Elastomeric blocks or continuous extrusions with a Shore, Type A durometer hardness required by glass manufacturer to maintain glass lites in place for installation indicated.

E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).

2.7 FABRICATION OF GLAZING UNITS

A. Fabricate glazing units in sizes required to glaze openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine framing glazing, with Installer present, for compliance with the following:

1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
2. Minimum required face or edge clearances.
3. Effective sealing between joints of glass-framing members.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

3.3 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. Glazing channel dimensions, as indicated on Drawings, provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances. Adjust as required by Project conditions during installation.

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 sealant-substrate 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 30 inches as follows:

1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.

2. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

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.

I. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.

J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.

K. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.4 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. Do not remove release paper from tape until just before each glazing unit is installed.

3.5 GASKET GLAZING (DRY)

A. Fabricate compression gaskets in 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. 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. Install gaskets so they protrude past face of glazing stops.

3.6 CLEANING AND PROTECTION

A. 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 by glass manufacturer.

B. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.

C. Wash glass on both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

END OF SECTION 088000

SECTION 09 21 16 - GYPSUM BOARD ASSEMBLIES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Performance criteria for gypsum board assemblies.

B. Metal stud wall framing.

C. Metal channel ceiling framing.

D. Resilient sound isolation clips.

E. Acoustic insulation.

F. Gypsum wallboard.

G. Joint treatment and accessories.

1.2 RELATED REQUIREMENTS

A. Section 05 40 00 – Cold Formed Metal Framing: Formed steel joist and interior wall framing.

B. Section 06 10 00 - Rough Carpentry: Wood blocking product and execution requirements.

1.3 REFERENCE STANDARDS

A. AISI S100 - North American Specification for the Design of Cold-Formed Steel Structural Members; 2016, with Supplement (2020).

B. AISI S201 - North American Standard for Cold-Formed Steel Framing - Product Data; 2017.

C. AISI S220 - North American Standard for Cold-Formed Steel Nonstructural Framing; 2020.

D. AISI S240 - North American Standard for Cold-Formed Steel Structural Framing; 2015, with Errata (2020).

E. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.

F. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.

G. ASTM A1003/A1003M - Standard Specification for Steel Sheet, Carbon, Metallic- and Nonmetallic-Coated for Cold-Formed Framing Members; 2015.

H. ASTM C1007 - Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories; 2020.

I. ASTM C475/C475M - Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board; 2017 (Reapproved 2022).

J. ASTM C514 - Standard Specification for Nails for the Application of Gypsum Board; 2004 (Reapproved 2020).

K. ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products; 2020.

L. ASTM C840 - Standard Specification for Application and Finishing of Gypsum Board; 2020.

M. ASTM C954 - Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness; 2022.

N. ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs; 2022.

O. ASTM C1047 - Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base; 2019.

P. ASTM C1396/C1396M - Standard Specification for Gypsum Board; 2017.

Q. ASTM C1629/C1629M - Standard Classification for Abuse-Resistant Nondecorated Interior Gypsum Panel Products and Fiber-Reinforced Cement Panels; 2023.

R. ASTM C1658/C1658M - Standard Specification for Glass Mat Gypsum Panels; 2019, with Editorial Revision (2020).

S. ASTM D3273 - Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber; 2021.

T. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023b.

U. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements; 2009 (Reapproved 2016).

V. ASTM E413 - Classification for Rating Sound Insulation; 2022.

W. GA-216 - Application and Finishing of Gypsum Panel Products; 2021.

1.4 SUBMITTALS

A. Product Data: Provide data on metal framing, gypsum board, accessories, and joint finishing system.
   1. Provide manufacturer's data on partition head to structure connectors, showing compliance with requirements.

B. Shop Drawings: Indicate special details associated with acoustic seals.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Member of Steel Stud Manufacturers Association (SSMA): www.ssma.com/#sle.

B. Installer Qualifications: Company specializing in performing work of the type specified and with at least five years of documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store gypsum products and accessories indoors and keep above freezing. Elevate boards above floor, on nonwicking supports, in accordance with manufacturer's recommendations.

B. Store metal products to prevent corrosion.

PART 2 PRODUCTS

2.1 GYPSUM BOARD ASSEMBLIES

A. Provide completed assemblies complying with ASTM C840 and GA-216.
   1. See PART 3 for finishing requirements.

B. Interior Partitions: Provide completed assemblies with the following characteristics:
   1. Sound Transmission Loss (STL) indicated on the Wall Type Schedule on the Drawings.
   2. Acoustic Attenuation: STC of 45-49 minimum calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90.

2.2 METAL FRAMING MATERIALS

A. Material and Product Requirements Criteria: AISI S201.

B. Steel Sheet: ASTM A1003/A1003M, subject to the ductility limitations indicated in AISI S220 or equivalent.

C. Nonstructural Framing System Components: AISI S220; galvanized sheet steel, of size and properties necessary to comply with ASTM C754 for the spacing indicated, with maximum deflection of wall framing of L/120 at 5 psf.
   1. At wall brittle wall finishes such as tile or masonry veneer maximum deflection of wall framing is limited to L/240 at 5 psf.
   2. Studs: C-shaped with knurled or embossed faces.
   3. Runners: U shaped, sized to match studs.
   4. Furring Members: Hat-shaped sections, minimum depth of 7/8 inch.
   5. Resilient Sound Isolation Clips: Steel resilient clips with molded rubber isolators, attaches to framing; improves noise isolation performance of wall and floor-ceiling assemblies.
   6. Minimum stud gauge as indicated on the Wall Type Schedule on the Drawings. Use heavier gauge if required to meet the performance requirements of this Section.

D. Partition Head to Structure Connections: Provide mechanical anchorage devices that accommodate deflection and prevent rotation of studs while maintaining structural performance of partition.
   1. Structural Performance: Maintain lateral load resistance and vertical movement capacity required by applicable code, when evaluated in accordance with AISI S100.
   2. Material: ASTM A653/A653M steel sheet, SS Grade 50/340, with G60/Z180 hot-dipped galvanized coating.
   3. Provide components UL-listed for use in UL-listed fire-resistance-rated head of partition joint systems of fire rating and movement required.
   4. Provide mechanical anchorage devices as described above that accommodate deflection while maintaining the fire-resistance rating of the wall assembly.
      a. Products:
         1) ClarkDietrich; MaxTrak.

         2) Metal-Lite, Inc; The System.

E. Structural Steel Framing for Application of Gypsum Board: See Section 05 40 00.

F. Non-structural Framing Accessories:
   1. Ceiling Hangers: Type and size as specified in ASTM C754 for spacing required.
   2. Partial Height Wall Framing Support: Provides stud reinforcement and anchored connection to floor.
      a. Materials: ASTM A36/A36M formed sheet steel support member with factory-welded ASTM A1003/A1003M steel plate base.
      b. Products:
         1) ClarkDietrich; Pony Wall (PW): www.clarkdietrich.com/#sle.
   3. Framing Connectors: ASTM A653/A653M G90 galvanized steel clips; secures cold rolled channel to wall studs for lateral bracing.

2.3 BOARD MATERIALS

A. Gypsum Wallboard: Paper-faced gypsum panels as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
   1. Application: Use for vertical surfaces and ceilings, unless otherwise indicated.
   2. Glass mat faced gypsum panels, as defined in ASTM C1658/C1658M, suitable for paint finish, of the same core type and thickness may be substituted for paper-faced board.
   3. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
      a. Mold resistant board is required at all locations.
   4. At Assemblies Indicated with Fire-Resistance Rating or as indicated on Drawings: Use type required by indicated tested assembly; if no tested assembly is indicated, use Type X board, UL or WH listed.
   5. Thickness: As indicated on Drawings.

B. Impact Resistant Wallboard:
   1. Application: Where indicated on the Wall Type Schedule on the Drawings.
   2. Surface Abrasion: Level 3, minimum, when tested in accordance with ASTM C1629/C1629M.
   3. Indentation: Level 1, minimum, when tested in accordance with ASTM C1629/C1629M.
   4. Soft Body Impact: Level 3, minimum, when tested in accordance with ASTM C1629/C1629M.
   5. Hard Body Impact: Level 2, minimum, when tested in accordance with ASTM C1629/C1629M.
   6. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
   7. Type: Fire-resistance-rated Type X, UL or WH listed.

C. Ceiling Board: Special sag resistant gypsum ceiling board as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
   1. Application: Ceilings, unless otherwise indicated.
   2. Thickness: 5/8 inch.
   3. Edges: Tapered.

2.4 GYPSUM BOARD ACCESSORIES

A. Acoustic Insulation: Preformed glass fiber or mineral wool, friction fit type, unfaced. Thickness as required to fill the full depth of the stud cavity.

B. Sound Isolation Tape: Elastomeric foam tape for sound decoupling.
   1. Surface Burning Characteristics: Provide assemblies with flame spread index of 75 or less and smoke developed index of 450 or less, when tested in accordance with ASTM E84.
   2. Tape Thickness: 1/4 inch.

C. Acoustic Sealant: Acrylic emulsion latex or water-based elastomeric sealant; do not use solvent-based non-curing butyl sealant.

D. Beads, Joint Accessories, and Other Trim: ASTM C1047, rigid plastic or galvanized steel, unless noted otherwise.
   1. Corner Beads: Low profile, for 90 degree outside corners.
   2. L-Trim with Tear-Away Strip: Sized to fit 5/8 inch thick gypsum wallboard.
   3. Wall Mounted Deflection Beads: Flexible gasket and bead with 1-1/8 inch flange.
   4. Expansion Joints:
      a. Type: V-shaped PVC with tear away fins.

E. Joint Materials: ASTM C475/C475M and as recommended by gypsum board manufacturer for project conditions.
   1. Paper Tape: 2 inch wide, creased paper tape for joints and corners.
   2. Joint Compound: Drying type, vinyl-based, field-mixed. For use with paper tape.

F. Screws for Fastening of Gypsum Panel Products to Cold-Formed Steel Studs Less than 0.033 inches in Thickness and Wood Members: ASTM C1002; self-piercing tapping screws, corrosion-resistant.

G. Screws for Fastening of Gypsum Panel Products to Steel Members from 0.033 to 0.112 inch in Thickness: ASTM C954; steel drill screws, corrosion-resistant.

H. Nails for Attachment to Wood Members: ASTM C514.

I. Anchorage to Substrate: Tie wire, nails, screws, and other metal supports, of type and size to suit application; to rigidly secure materials in place.

J. Vibration Isolators: Provide vibration isolators / hangers. Size and space hangers as required to support ceiling load (grid and gypsum board) per manufacturer installation guidelines and requirements.
   1. Manufacturers:
      a. Eaton.
      b. Kinetics Noise Control.
      c. Zoro.
      d. Similar approved equals.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that project conditions are appropriate for work of this section to commence.

B. Start of Work indicates acceptance of conditions.

3.2 FRAMING INSTALLATION

A. Metal Framing: Install in accordance with ASTM C1007AISI S220 and manufacturer's instructions.

B. Studs: Space studs at 16 inches on center minimum.
   1. Extend partition framing to structure in all locations.
   2. Partitions Terminating at Structure: Attach top runner to structure, maintain clearance between top of studs and structure, and connect studs to track using specified mechanical devices in accordance with manufacturer's instructions; verify free movement of top of stud connections; do not leave studs unattached to track.

C. Openings: Reinforce openings as required for weight of doors or operable panels, using not less than double studs at jambs.

D. Resilient Sound Isolation Clips: Install resilient sound isolation clips, and where applicable, associated furring sections and channels, in accordance with clip manufacturer's written instructions.

E. Blocking: Install wood blocking for support of:
   1. Light fixtures.
   2. Ceiling mounted devices and fixtures.
   3. Wall-mounted cabinets.
   4. Accessories.
   5. Other locations where indicated in Division 6 Section 'Rough Carpentry'.
   6. Other locations where indicated on the Drawings.

3.3 ACOUSTIC ACCESSORIES INSTALLATION

A. Acoustic Insulation: Place tightly within spaces, around cut openings, behind and around electrical and mechanical items within partitions, and tight to items passing through partitions.

B. Sound Isolation Tape: Apply to vertical studs and top and bottom tracks/runners in accordance with manufacturer's instructions.

C. Acoustic Sealant: Install in accordance with manufacturer's instructions.
   1. Place one bead continuously on substrate before installation of perimeter framing members.
   2. Place continuous bead at perimeter of each layer of gypsum board.
   3. Seal around all penetrations by conduit, pipe, ducts, and rough-in boxes, except where firestopping is provided.

3.4 BOARD INSTALLATION

A. Comply with ASTM C840, GA-216, and manufacturer's instructions. Install to minimize butt end joints, especially in highly visible locations.

B. Single-Layer Nonrated: Install gypsum board in most economical direction, with ends and edges occurring over firm bearing.

C. Multiple-Layer, Nonrated: Use gypsum board for first layer, placed parallel to framing or furring members, with ends and edges occurring over firm bearing. Place second layer perpendicular to framing or furring members. Offset joints of second layer from joints of first layer. Alternate subsequent layers in similar manner.

D. Installation on Metal Framing: Use screws for attachment of gypsum board.

E. Installation of Impact Resistant Gypsum Board: Outer most layer of gypsum board up to 8 feet above finish floor shall be impact resistant gypusm board in Instrument Area D115, Krios Room D115E, Helios Room D115F and Storage D115G.

3.5 INSTALLATION OF TRIM AND ACCESSORIES

A. Control Joints: Place control joints consistent with lines of building spaces and as indicated.
   1. Not more than 30 feet apart on walls and ceilings over 50 feet long.
   2. At exterior soffits, not more than 30 feet apart in both directions.

B. Corner Beads: Install at external corners, using longest practical lengths.

C. Edge Trim: Install at locations where gypsum board abuts dissimilar materials.

3.6 JOINT TREATMENT

A. Paper Faced Gypsum Board: Use paper joint tape, embed with drying type joint compound and finish with drying type joint compound.

B. Finish gypsum board in accordance with levels defined in ASTM C840, as follows:
   1. Level 4: Walls and ceilings to receive paint finish or wall coverings, unless otherwise indicated.
   2. Level 2: In utility areas, behind cabinetry, and on backing board to receive tile finish.
   3. Level 1: Wall areas above finished ceilings, whether or not accessible in the completed construction.

C. Tape, fill, and sand exposed joints, edges, and corners to produce smooth surface ready to receive finishes.
   1. Feather coats of joint compound so that camber is maximum 1/32 inch.

D. Fill and finish joints and corners of cementitious backing board as recommended by manufacturer.

3.7 TOLERANCES

A. Maximum Variation of Finished Gypsum Board Surface from True Flatness: 1/8 inch in 10 feet in any direction.

3.8 PROTECTION

A. Protect installed gypsum board assemblies from subsequent construction operations.

END OF SECTION

SECTION 095113 - ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes acoustical panels and exposed suspension systems for ceilings.

B. Related Sections include the following:

1. Division 07 Section JOINT SEALANTS.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated and including VOC Statements for Sealants and Adhesives.

B. Maintenance Data: For finishes to include in maintenance manuals.

C. Certificate of Accreditation: Provide certificate as described in this section.

D. Scope of Accreditation: Provide scope as described in this section.

1.3 QUALITY ASSURANCE

A. Acoustical Testing Agency Qualifications: An independent testing laboratory, or an NVLAP-accredited laboratory, with the experience and capability to conduct the testing indicated, as documented according to ASTM E 548. NVLAP-accredited laboratories must document accreditation, based on a "Certificate of Accreditation" and a "Scope of Accreditation" listing the test methods specified.

B. Source Limitations:

1. Acoustical Ceiling Panel: Obtain each type through one source from a single manufacturer.
2. Suspension System: Obtain each type through one source from a single manufacturer.

C. Fire-Test-Response Characteristics: Provide acoustical panel ceilings that comply with the following requirements:

1. Surface-Burning Characteristics: Provide acoustical panels with surface-burning characteristics complying with ASTM E 1264 for Class A materials as determined by testing identical products per ASTM E 84:

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver acoustical panels, suspension system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

B. Before installing acoustical panels, permit them to reach room temperature and stabilized moisture content.

C. Handle acoustical panels carefully to avoid chipping edges or damaging units in any way.

1.5 PROJECT CONDITIONS

A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

1. Pressurized Plenums: Operate ventilation system for not less than 48 hours before beginning acoustical panel ceiling installation.

1.6 COORDINATION

A. Coordinate layout and installation of acoustical panels and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply for product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.

2.2 ACOUSTICAL PANELS, GENERAL

A. Acoustical Panel Standard: Provide manufacturer's standard panels of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances, unless otherwise indicated.

B. Acoustical Panel Colors and Patterns: Match appearance characteristics indicated for each product type.

1. Where appearance characteristics of acoustical panels are indicated by referencing pattern designations in ASTM E 1264 and not manufacturers' proprietary product designations, provide products selected by Architect from each manufacturer's full range that comply with requirements indicated for type, pattern, color, light reflectance, acoustical performance, edge detail, and size.

2.3 CAST OR MOLDED, MINERAL-BASE ACOUSTICAL PANELS FOR ACOUSTICAL PANEL CEILING

A. Available Manufacturers:

1. Armstrong World Industries, Inc.
2. BPB Celotex Corporation; Architectural Ceilings Marketing Dept.
3. National Gypsum
4. USG Interiors. Inc.

B. Classification: Provide panels complying with ASTM E 1264 for type, form, and pattern as follows:

1. Type and Form: Type III, mineral base with painted finish; Form 4, cast or molded.

C. Color: White

D. Edge Detail: Reveal sized to fit flange of exposed suspension system member.

E. Thickness: ¾ inch.

F. Size: 24 by 24 inches.

2.4 METAL SUSPENSION SYSTEMS, GENERAL

A. Metal Suspension System Standard: Provide manufacturer's standard direct-hung metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635.

B. Finishes and Colors, General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Provide manufacturer's standard factory-applied finish for type of system indicated.

1. High-Humidity Finish: Comply with ASTM C 635 requirements for "Coating Classification for Severe Environment Performance" where high-humidity finishes are indicated.

C. Attachment Devices: Size for five times the design load indicated in ASTM C 635, Table 1, "Direct Hung," unless otherwise indicated.

1. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated, and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing per ASTM E 1190, conducted by a qualified testing and inspecting agency.

D. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:

1. Zinc-Coated Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
2. Size: Select wire diameter so its stress at three times hanger design load (ASTM C 635, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.106-inch- diameter wire.

E. Joint Sealants: See 07 Section JOINT SEALANTS.

2.5 METAL SUSPENSION SYSTEM FOR ACOUSTICAL PANEL CEILING:

A. Available Manufacturers:

1. Armstrong World Industries, Inc.
2. BPB Celotex Corporation; Architectural Ceilings Marketing Dept.
3. Chicago metallic Corporation
4. USG Interiors, Inc.

B. Wide-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, not less than G30 coating designation, with prefinished 15/16-inch- wide metal caps on flanges.

1. Structural Classification: Intermediate-duty system.
2. End Condition of Cross Runners: Butt-edge type.
3. Face Design: Flat, flush.
4. Cap Material: Steel cold-rolled sheet.
5. Cap Finish: Painted white .

2.6 METAL EDGE MOLDINGS AND TRIM

A. Available Manufacturers:

1. Armstrong World Industries, Inc.
2. BPB Celotex Corporation; Architectural Ceilings Marketing Dept.
3. Chicago Metallic Corporation.
4. Fry Reglet Corporation.
5. Gordon, Inc.

6. MM Systems, Inc.
7. USG Interiors, Inc.

B. Roll-Formed Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that fit acoustical panel edge details and suspension systems indicated; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension system runners.

1. For lay-in panels with reveal edge details, provide stepped edge molding that forms reveal of same depth and width as that formed between edge of panel and flange at exposed suspension member.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders, and comply with layout shown on reflected ceiling plans.

3.3 INSTALLATION, GENERAL

A. General: Install acoustical panel ceilings to comply with ASTM C 636 and seismic requirements indicated, per manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."

B. Suspend ceiling hangers from building's structural members and as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.

4. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
5. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
6. Do not attach hangers to steel deck tabs.
7. Do not attach hangers to steel roof deck. Attach hangers to structural members.
8. Space hangers not more than 48 inches o.c. along each member supported directly from hangers, unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.

C. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.

1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
2. Screw attach moldings to substrate at intervals not more than 16 inches o.c. and not more than 3 inches from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet. Miter corners accurately and connect securely.
3. Do not use exposed fasteners, including pop rivets, on moldings and trim.

D. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

E. Install acoustical panels with undamaged edges and fit accurately into suspension system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.

1. Arrange directionally patterned acoustical panels as follows:
   a. Install panels with pattern running in one direction parallel to long axis of space.
2. For reveal-edged panels on suspension system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
3. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.

3.4 CLEANING

A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 095113

SECTION 096519 - RESILIENT FLOORING

PART 1 - GENERAL

1.1 M.S.U. ISSUES

A. The factory applied finish on the tile shall be removed using a floor-scrubbing machine and the stripper prepared by the manufacturer of the wax to be applied; and a new finish applied. The M.S.U. Project Manager will contact Housing and Food Services or Physical Plant Custodial Services to identify the current finish being used by M.S.U.

B. It is the intent of MSU that all resilient floor tile installation used on its projects will comply with LEED™ NC 2.2 Credit Requirements EQ Credit 4.1: Low Emitting Materials: Adhesives and Sealants

C. It is the intent of MSU that all resilient tile flooring materials and methods of installation shall meet the latest ICC/ANSI A117.1 standards for slip resistance and provide barrier free access for mobility and physically impaired users.

1.2 SUMMARY

A. This Section includes the following:

1. Vinyl composition tile (VCT).
2. homogenous vinyl sheet flooring installation
3. Resilient Sheet Flooring.
4. Resilient wall base and accessories.

1.3 SUBMITTALS

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

B. Samples for Verification: Full-size units of each color and pattern of resilient floor tile required.

1. Resilient Wall Base and Accessories: Manufacturer's standard-size Samples, but not less than 12 inches long, of each resilient product color and pattern required.

C. Maintenance Data: For resilient products to include in maintenance manuals.

D. Submit printed VOC statement and product data for adhesives in accordance with the General Administrative Requirements of the MSU Construction Standards 01300.1.2. Maximum VOC content when calculated according to South Coast Air Quality Management District (SCAQMD) Rule #1168, effective July 1, 2005 and amended January 7, 2005:

1. Cove Base Adhesives 50 g/l
2. Rubber Floor Adhesives 60 g/l

1.4 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: Provide products identical to those tested for fire-exposure behavior per test method indicated by a testing and inspecting agency acceptable to authorities having jurisdiction.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F. Store tiles on flat surfaces.

1.6 PROJECT CONDITIONS

A. Maintain temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F in spaces to receive floor tile during the following time periods:

1. 48 hours before installation.
2. During installation.
3. 48 hours after installation.

B. After postinstallation period, maintain temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.

C. Close spaces to traffic during floor covering installation.

D. Close spaces to traffic for 48 hours after floor covering installation.

E. Install resilient products after other finishing operations, including painting, have been completed.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Floor Tile: Furnish 2 boxes of each type, color, and pattern of floor tile installed.
2. Resilient Wall Base and Accessories: Furnish not less than 20 linear feet of each type, color, pattern, and size of resilient product installed.

PART 2 - PRODUCTS

2.1 VINYL COMPOSITION TILE

A. Vinyl Composition Tile (VCT): ASTM F 1066.

B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. AB ColorPlus, American Biltrite (Canada) Ltd.
2. Armstrong World Industries, Inc. (Basis of Design)
3. Azrock Commercial Flooring, DOMCO.
4. Congoleum Corporation.
5. Mannington Mills, Inc.
6. Tarkett Inc.

C. Class: 2 (through-pattern tile).

D. Wearing Surface: Smooth.

E. Thickness: 0.125 inch.

F. Size: 12 by 12 inches.

G. Fire-Test-Response Characteristics:

1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm per ASTM E 648.

2.2 HOMOGENOUS VINYL SHEET FLOORING

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Tarkett Commerical (Basis of Design)
2. Or approved equals

B. Sheet Standard: ASTM F1913, Standard Specification for Vinyl Sheet Floor Covering Without Backing.

C. Thickness Wearlayer: 0.080 inch.

D. Color: As indicated on Drawings.

E. Test Data:
1. Flexibilty (ASTM F137): Passes
2. Chemical Resistance (ASTM F925): Passes
3. Static Load Limit (ASTM F 970): Passes 250 psi
4. Resistance to Heat (ASTM F1514): $\Delta E \leq 8$
5. Resistance to Light (ASTM F1515): $\Delta E \leq 8$
6. Residual Indentation (ASTM F1914): Passes
7. Static Coefficient of Friction (ASTM D 2047): ≥ 0.5 SCOF
8. Flamability (ASTM E648, Critical Radiant Flux): Class 1 (≥ 0.45 W/cm^2)
9. Limited Commercial Warranty: 20 years

2.3 RESILIENT WALL BASE

A. Wall Base: ASTM F 1861.

B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following

1. AFCO-USA, American Floor Products Company, Inc.
2. Armstrong World Industries, Inc.
3. Azrock Commercial Flooring, DOMCO.
4. Burke Mercer Flooring Products.
5. Roppe Corporation.
6. VPI, LLC, Floor Products Division.
7. Johnsonite®

C. Type (Material Requirement): TV (vinyl).

D. Group (Manufacturing Method): I (solid, homogenous).

E. Style: Cove (with top-set toe) for installation on resilient flooring. Straight (toeless) for installation on carpeted flooring.

F. Minimum Thickness: 0.125 inch.

G. Height: 4 inches.

H. Lengths: Coils in manufacturer's standard length.

I. Outside Corners: Job formed.

J. Inside Corners: Job formed.

K. Surface: Smooth.

2.4 ACCESSORIES

A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic cement based formulation provided or approved by resilient product manufacturer for applications indicated.

B. Adhesives: Water-resistant type recommended by manufacturer to suit resilient products and substrate conditions indicated.

C. Moldings, Transition and Edge Strips: Same material as flooring.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for installation tolerances, moisture content, and other conditions affecting performance.

1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare substrates according to manufacturer's written recommendations to ensure adhesion of resilient products.

B. Concrete Substrates: Prepare according to ASTM F 710.

1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
2. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.
3. Moisture Testing:

a. Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.

C. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.

D. Isolation Pad: Remove protective film of oil or other coating using method recommended by access flooring manufacturer.

E. Use trowelable leveling and patching compound to fill cracks, holes, and depressions in substrates.

F. Move resilient products and installation materials into spaces where they will be installed at least 48 hours in advance of installation.

1. Do not install resilient products until they are same temperature as space where they are to be installed.

G. Sweep and vacuum clean substrates to be covered by resilient products immediately before installation. After cleaning, examine substrates for moisture, alkaline salts, carbonation, and dust. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION – GENERAL

A. Starting installation constitutes acceptance of subfloor conditions.

B. Install in accordance with manufacturer's written instructions.

C. Adhesive-Applied Installation:

1. Spread only enough adhesive to permit installation of materials before initial set.
2. Fit joints and butt seams tightly.
3. Set flooring in place, press with heavy roller to attain full adhesion.

D. Where type of floor finish, pattern, or color are different on opposite sides of door, terminate flooring under centerline of door.

E. Install resilient edge strips at unprotected or exposed edges, where flooring terminates, and where indicated. Attach to substrate using adhesive.

F. Scribe flooring to walls, columns, cabinets, floor outlets, and other appurtenances to produce tight joints.

3.4 TILE INSTALLATION

A. Lay out tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.

1. Lay tiles square with room axis.

B. Match tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles.

C. Scribe, cut, and fit tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, edgings, door frames, thresholds, and nosings.

D. Extend tiles into toe spaces, door reveals, closets, and similar openings.

E. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent, nonstaining marking device.

F. Install tiles on covers for telephone and electrical ducts and similar items in finished floor areas. Maintain overall continuity of color and pattern with pieces of tile installed on covers. Tightly adhere tile edges to substrates that abut covers and to cover perimeters.

G. Adhere tiles to flooring substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

3.5 HOMOGENOUS VINYL SHEET FLOORING INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient sheet flooring.

B. Resilient Sheet Flooring:
   1. Install with manufacture adhesive specified for the site conditions and follow adhesive label for proper use.
   2. Install rolls in sequential order following roll numbers on the labels.
   3. Lay flooring with joints and seams parallel to longer room dimensions, to produce minimum number of seams. Lay out seams to avoid widths less than 1/3 of roll width; match patterns at seams.
   4. Reverse non-pattern sheets as referenced in the Manufacturer Installation Instructions.
   5. Roll the flooring in both directions using a 100 pound three-section roller.
   6. Seal seams by heat welding.

3.6 RESILIENT WALL BASE INSTALLATION

A. Apply wall base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.

B. Install wall base in lengths as long as practicable without gaps at seams and with tops of adjacent pieces aligned.

C. Tightly adhere wall base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.

D. Do not stretch wall base during installation.

E. On masonry surfaces or other similar irregular substrates, fill voids along top edge of wall base with manufacturer's recommended adhesive filler material.

F. Job-Formed Corners:

   1. Outside Corners: Use straight pieces of maximum lengths possible. Form without producing discoloration (whitening) at bends. Shave back of base at points where bends occur and remove strips perpendicular to length of base that are only deep enough to produce a snug fit without removing more than half the wall base thickness.
   2. Inside Corners: Use straight pieces of maximum lengths possible. Form by cutting an inverted V-shaped notch in toe of wall base at the point where corner is formed. Shave back of base where necessary to produce a snug fit to substrate.

3.7 RESILIENT ACCESSORY INSTALLATION

A. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of floor coverings that would otherwise be exposed.

3.8 CLEANING AND PROTECTION

A. Perform the following operations immediately after completing resilient product installation:

1. Remove adhesive and other blemishes from exposed surfaces.
2. Sweep and vacuum surfaces thoroughly.
3. Damp-mop surfaces to remove marks and soil.

a. Do not wash surfaces until after time period recommended by manufacturer.

B. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period. Use protection methods recommended in writing by manufacturer.

1. Do not move heavy and sharp objects directly over surfaces. Place hardboard or plywood panels over flooring and under objects while they are being moved. Slide or roll objects over panels without moving panels.

END OF SECTION 096519

SECTION 099123 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 M.S.U. ISSUES

A. LEED

1. For paints and coatings applied on the interior of buildings and applied on-site maximum VOC shall be in accordance with Green Seal Standard GS-11, Paints, First Edition, May 20, 1993.
   a. Flat paints and coatings: VOC content of not more than 50 g/L
   b. Non-flat paints and coatings: VOC content of not more than 150 g/L

2. Anticorrosive and anti-rust paints shall meet requirements of Green Seal Standard GC-03, Anti-corrosive Paints, Second Edition, January 7, 1997
   a. Anticorrosive coatings: VOC content of not more than 250 g/L

3. Clear wood finishes, floor coatings, stains, and shellacs applied to interior elements shall meet requirements of South Coast Air Quality Managements District (SCAQMD Rule #1113.
   a. Varnish: VOC content of not more than 350 g/L
   b. Lacquer: VOC content of not more than 550 g/L
   c. Floor coatings: VOC content of not more than 100 g/L
   d. Shellacs (clear): VOC content of not more than 730 g/L
   e. Shellacs (pigmented): VOC content of not more than 550 g/L
   f. Stains: VOC content of not more than 550 g/L
   g. Sealers (waterproofing sealers): VOC content of not more than 250 g/L
   h. Sealers (sanding sealers): VOC content of not more than 275 g/L
   i. Sealers: (other than above listed) VOC content of not more than 200 g/L

4. Paints and coatings shall have a maximum of 1.0% of Total Aromatic Compounds (hydrocarbon compounds containing one or more benzene rings).

5. Paints and coatings shall not contain any of the following:
   a. Acrolein
   b. Acrylonitrile
   c. Antimony
   d. Benzene
   e. Butyl benzyl phthalate
   f. Cadmium
   g. Di(2-ethylhexyl) phthalate
   h. Di-n-butyl phthalate
   i. Di-n-octyl phthalate
   j. 1,2-dichlorobenzene
   k. Diethyl phthalate

l. Dimethyl phthalate
m. Ethylbenzene
n. Formaldehyde
o. Hexavalent chromium
p. Isophorone
q. Lead
r. Mercury
s. Methyl ethyl ketone
t. Methyl isobutyl ketone
u. Methylene chloride
v. Napthalene
w. Toluene (methylbenzene)
x. 1,1,1-trichloroethane
y. Vinyl chloride

B. Painting is not required on pre-finished items, finished metal surfaces, concealed surfaces, operating parts, and labels.

1. Pre-finished items NOT to be painted include the following factory-finished components:
   a. Acoustic materials
   b. Architectural woodwork and casework
   c. Finished mechanical and electrical equipment
   d. Light fixtures
   e. Switchgear

2. Concealed surfaces NOT to be painted include wall or ceiling surfaces in the following generally inaccessible areas:
   a. Foundation spaces
   b. Furred areas
   c. Pipe spaces
   d. Mechanical rooms

3. Operating parts NOT to be painted include moving parts of operating equipment such as the following:
   a. Valve and damper operators
   b. Linkages
   c. Sensing devices
   d. Motor and fan shafts

4. Finished metal surfaces NOT to be painted include:
   a. Anodized aluminum
   b. Stainless steel
   c. Chromium plate
   d. Copper
   e. Bronze
   f. Brass
   g. Galvanized steel (unless specifically designated to be painted)

5. Do not paint over Underwriter's Laboratories, Factory Mutual or other code-required labels or equipment name, identification, performance rating or nomenclature plates.

C. Painting includes field painting exposed bare and covered pipes and ducts (including color coding), hangers, exposed steel and ironwork, and primed metal surfaces of mechanical and electrical equipment, in interior finished spaces only. Refer to Division 21 for additional fire protection painting requirements. Access panel covers must be painted separately, according to the following code: Electrical – orange, Communications – blue, Alarms – red.

D. Paint exposed surfaces whether or not colors are designated in paint schedules, except where a specific designation indicates the surface or material is not to be painted or is to remain natural. Where an item or surface is not specifically mentioned, paint the same as similar adjacent materials or surfaces. If color or finish is not designated, the M.S.U. project representative will select from standard colors or finishes available.

1.2 SUMMARY

A. This Section includes surface preparation and the application of paint systems on the following interior substrates:

1. Steel.
2. Galvanized metal.
3. Aluminum (not anodized or otherwise coated).
4. Gypsum board.

B. Surface preparation, priming and finish coats specified in this section are in addition to shop priming and surface treatment specified under other sections.

C. Related Sections include the following:

1. Division 05 Sections for shop priming of metal substrates with primers specified in this Section.
2. Division 08 Sections for factory priming windows and doors with primers specified in this Section.
3. Division 21 Section WET-PIPE SPRINKLER SYSTEMS for fire protection painting.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated, submitted to the M.S.U. Project Representative prior to project inception. List each material by the manufacturer's catalog number and general classification. The University retains the right to approve or disapprove any proposed equivalent paint products.

1. Submit printed VOC statements.
2. Submit printed aromatic compound statements.
3. Submit printed statements demonstrating that no restricted compounds are used.

B. Samples for initial color selection: in the form of manufacturer's color charts. After color selection, the M.S.U. project representative will furnish color chips for surfaces to be coated. It is the contractor's responsibility to provide the M.S.U. project representative with three draw downs of each product and color combination to be used for final approval.

C. Samples for Verification, when requested: For each type of paint system and each color and gloss of topcoat indicated.

1. Submit Samples on rigid backing, 8 inches square.
2. Step coats on Samples to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.

D. An actual color sample, 4' X 4', shall be painted on one wall of the jobsite for verification of actual wall color prior to any other painting. Actual color samples of other selected paints shall be painted on appropriate surfaces for verification as directed by the M.S.U. project representative.

E. Product List: For each product indicated, include the following:

1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the job site in the manufacturer's original, unopened packages and containers bearing manufacturer's name and label and the following information:

1. Product name or title of material.
2. Product description (generic classification or binder type).
3. Federal Specification number, if applicable
4. Manufacturer's stock number and date of manufacture.
5. Thinning instructions.
6. Application instructions.
7. Color name and number.

B. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperature continuously maintained at not less than 45 deg F.

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Keep storage area neat and orderly. Remove rags and waste from storage areas daily. Take necessary measures to ensure that workers and work areas are protected from fire and health hazards from handling, mixing and application.
3. Paint/varnish removers shall be non-flammable.

1.5 PROJECT CONDITIONS

A. Apply water based paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 90 deg F.

B. Apply solvent-thinned paints only when temperature of surfaces to be painted and ambient air temperatures are between 45 and 95 deg F.

C. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces. Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified by the manufacturer during application and drying periods.

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:

1. The Glidden Co./PPG
2. O'Leary Paints (O'Leary
3. Sherwin-Williams Company (The).
4. Benjamin Moore & Co.
5. PPG

If products by manufacturers not listed above are recommended, they must be approved by M.S.U. at least 2 weeks prior to bidding.

2.2 PAINT, GENERAL

A. Material Compatibility:

1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

B. METAL PRIMERS

C. Synthetic Int., Rust-Inhibiting Acrylic Primer: Quick drying, rust-inhibiting primer for priming galvanized and ferrous and non-ferrous metal on the interior under acrylic paints and odorless alkyd semigloss or alkyd gloss enamels.

1. PPG: Devoe Devflex 4020 PF
2. O'Leary Paints: 36-11 180-11 Acrylic Metal Primer
3. Sherwin-Williams Company (The): Pro-Cryl B66 Series (W1310)
4. Benjamin Moore & Co.: P04 Super Spec HP Acrylic Metal Primer
5. PPG: Pitt-Tech Interior/Exterior Primer/Finish DTM 90-712/912 Series

D. Alkyd-Type Zinc Metal Primer: Primers used for priming galvanized and ferrous metals under acrylic or alkyd enamel finishes.

1. PPG: Pitt-Tech Interior/Exterior Primer/Finish DTM 90-712/912 Series
2. O'Leary Paints: 36-11 Acrylic Metal Primer
3. Sherwin-Williams Company (The): Pro-Cryl B66 Series(W1310)
4. Benjamin Moore & Co.: P04 Super Spec HP Acrylic Metal Primer

E. Non-Ferrous Metal Primer: Bonding type primer used to prime interior non-ferrous metal surfaces:

1. PPG: Devoe Devflex 4020PF
2. O'Leary Paints: 182 Industrial Acrylic DTM
3. Sherwin-Williams Company (The): DTM Bonding Primer B66A50, or Pro-Cryl B66 Series (W1310)
4. Benjamin Moore & Co.: (N023) Fresh Start Acrylic Primer
5. PPG: Pitt-Tech Interior/Exterior Primer/Finish DTM 90-712/912 Series

2.3 INTERIOR LATEX PRIMERS

A. Interior 100% Acrylic Primer: Acrylic primer used on plaster under flat, semigloss and gloss finishes. This primer must be specifically designed for application to gypsum drywall surfaces and over all alkyd paints as primer for re-coat.

1. PPG/Glidden: Gripper Primer Sealer 3210-1200
2. O'Leary Paints: L50 Block-it Acrylic Wall Primer
3. Sherwin-Williams Company (The): Loxon Primer LX02 Series (LX02W0050)
4. Benjamin Moore & Co.: N023 Fresh Start Acrylic Primer
5. PPG: Seal Grip Interior/Exterior Acrylic Universal Primer/Sealer 17-921 Series

2.4 INTERIOR LATEX PAINTS

A. Interior Acrylic Machinery Enamel Semi-Gloss: Premium quality semi-gloss 100% acrylic enamel for use on interior metal surfaces where abrasion is a problem. This product shall have excellent adhesion characteristics even to existing alkyd finish coats and provide a smooth brush-mark free surface. TO BE USED ON METAL DOORS AND FRAMES. Use deep base and ultra deep base in the same product line.

1. PPG: Devoe Devflex 4216 HP Acrylic DTM Semi-Gloss
2. O'Leary Paints: L 9000 Duramax Acrylic Semi-Gloss
3. Sherwin-Williams Company (The): DTM Semi-Gloss B66W211
4. Benjamin Moore & Co.: P29 Semi
5. Pitt-Tech Plus Int./Ext. Semi-gloss DTM Industrial Enamel 90-1210 Series

B. Acrylic DTM Semi-Gloss: Weather resistant, exterior acrylic semi-gloss for use on metal ducts, galvanized metals and ferrous and non-ferrous. Use deep base and ultra deep base in the same product line.

1. PPG: Devoe DevFlex 4216 HP Acrylic DTM Semi-Gloss
2. O'Leary Paints: 182 Industrial Acrylic DTM Semi G
3. Sherwin-Williams Company (The): DTM Acrylic Semi-Gloss B66W211
4. Benjamin Moore & Co.: P29 DTM Semi
5. Pitt-Tech Plus Int./Ext. Semi-gloss DTM Industrial Enamel 90-1210 Series

C. Latex Based Interior Eggshell Enamel: Low odor 100% acrylic or modified styrene acrylic, (NO VINYL ACRYLIC) latex enamel for use as an eggshell finish over gypsum drywall. This product shall have abrasion resistance at least equal to 75% of the Leneta "C" Panel when tested in accordance with ASTM D2486. Use deep base and ultra deep base in the same product line.

1. PPG/Glidden: Diamond Eggshell 7200
2. O'Leary Paints: L-1007 Interior Latex Eggshell
3. Sherwin-Williams Company (The): Solo A75W53 100% Acrylic Eggshell
   (Deep Base) 0 VOC B66-W663
   (Ultra Deep Base) 0 VOC B66-T664
4. Benjamin Moore & Co.: N374 Eco Spec WB Acrylic Egg Shell
5. PPG: Manor Hall Interior Eggshell 82-300 Series

D. Latex Based Interior Flat Paint: Ready mixed, latex based paint for use over gypsum drywall, and on all ceilings. Use deep base and ultra deep base in the same product line.

1. PPG/Glidden: Diamond Flat 7100
2. O'Leary Paints: 1400 Flat Ceramic Coat Latex Flat
3. Sherwin-Williams Company (The): Solo Flat 100% Acrylic A74W51
4. Benjamin Moore & Co.: N373 Eco Spec WB Acrylic Flat
5. PPG: Manor Hall Interior Flat 82-100 Series

2.5 SURFACE PREPARATION AGENTS: Paint and varnish removers shall be non-flammable.

A. Oil and Grease Emulsifier: Oil and grease emulsifier for cleaning walls, ceilings floors and equipment.

1. PPG: Devoe Devprep 88
2. O'Leary Paints: Coronado 93-500
3. Sherwin-Williams Company (The): Extra Muscle Cleaner
4. Benjamin Moore & Co.: P83 Oil & Grease Emulsifier
5. PPG: Duraprep Prep88 water-based alkaline cleaner

B. Epoxy and Urethane Remover: For stripping old epoxy or urethane coatings from surfaces to be re-coated.

1. O'Leary Paints: Star to Paste Stripper
2. Sherwin-Williams Company (The): Savagran Super-Strip
3. PPG: Duraprep Prep220 Commercial Coating Remover

C. Rust Removal and Metal Pre-treatment: For use in converting rust oxide and treatment of metal to promote coating adhesion.

1. O'Leary Paints: Coronado 93-300
2. Sherwin-Williams Company (The): Macroproxy 920 Pre-Prime B58T101
3. Benjamin Moore & Co.: None
4. PPG: Amerlock Sealer penetrating epoxy primer sealer

D. Rust Converter: For converting rust into a black protective film.

1. PPG: Devoe Preprime 167
2. O'Leary Paints: Coronado 93-900
3. Sherwin-Williams Company (The): Oshpo Rust Converter.
4. Benjamin Moore & Co.: P85 Rust Converter

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. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Gypsum Board: 12 percent.

C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

D. 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

A. Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, electrical panel box doors and similar items already in place that are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
2. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

B. Protect work of other trades, whether to be painted or not, against damage by painting. Correct damage by cleaning, repairing, replacing, and/or repainting, as acceptable to the M.S.U. project representative. Provide “Wet Paint” signs to protect newly painted finishes. At completion of construction activities of other trades, touch up and restore all damaged or defaced painted surfaces.

C. Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, and incompatible paints and encapsulants.

1. Schedule cleaning and painting so dust and other contaminants from the cleaning process will not fall onto wet, newly painted surfaces.
2. Provide barrier coats over incompatible primers or remove and re-prime. Notify M.S.U. project representative in writing of problems anticipated with use of specified finish coat material with substrates primed by others.

D. Steel Substrates: Clean non-galvanized ferrous-metal surfaces that have been shop coated: remove oil, grease, dirt, loose mill scale and other foreign substances. Use solvent or mechanical cleaning methods that comply with recommendations of the Steel Structures Painting Council. Touch up bare areas and shop-applied prime coats that have been damaged. Wire-brush; clean with solvents recommended by the paint manufacturer, and touch-up with the same primer as the shop coat.

E. Galvanized-Metal Substrates: Clean galvanized surfaces with non-petroleum-based solvents so the surface is free of oil and surface contaminants. Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints. If galvanized metal is chromate passivated (“bonderized”) consult manufacturers for appropriate surface preparation and primers.

F. Aluminum Substrates: Remove surface oxidation.

G. Exterior Gypsum Board Substrates: Do not begin paint application until finishing compound is dry and sanded smooth.

H. Repainting: Prime coats may be omitted with the exception of patched or repaired areas that should be spot-primed to ensure a uniform finish. Special care should be taken in re-coating existing alkyd or epoxy surfaces to prevent inter-coat adhesion failures. Painting of patch and repair work shall be painted out to the nearest break line, including areas in corridors, as directed by the M.S.U. Project Representative.

I. Paint: Carefully mix and prepare paint materials in accordance with manufacturer's directions. Maintain containers used in mixing and application of paint in a clean condition, free of foreign materials or residue. Stir material before application to produce a mixture of uniform density; stir as required during application. Remove any surface film and, if necessary, strain material before using. Do not stir surface film into material. Use only thinners approved by the paint manufacturer and only within recommended limits.

J. Tinting: Where multiple coats of the same material are applied, tint undercoats to match the color of the finish coat, but in a sufficiently lighter shade to distinguish each separate coat.

3.3 APPLICATION

A. Paint colors, surface treatments, and finishes are indicated in schedules. Provide finish coats that are compatible with primers used.

B. Before application of finish coats, apply a prime coat of material as recommended by the manufacturer to material that is required to be painted or finished and has not been primed by others. Re-coat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to ensure a finish coat with no burn through or other defects due to insufficient sealing.

C. Apply materials at not less than the manufacturer's recommended spreading rate. Provide a total dry film thickness of the entire system as recommended by the manufacturer. Apply block fillers to concrete masonry block at a rate to ensure complete coverage with pores filled.

D. Apply paints according to manufacturer's written instructions. Use applicators and techniques best suited for paint and substrate indicated. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.

E. The number of coats and film thickness required is the same regardless of the application method. Do not apply succeeding coats until the previous coat has cured as recommended by the manufacturer. Sand between applications where sanding is required in order to produce and even, smooth surface in accordance with the manufacturer's directions. Sand lightly between each succeeding enamel or varnish coat

F. Apply first coat to surfaces that have been cleaned, pre-treated or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.

G. The term “exposed surfaces” includes areas visible when a permanent or built-in fixture, convector covers, covers for finned tube radiation, grilles, and similar components are in place. Extend coatings in these areas as required to maintain the system integrity and provide desired protection. Paint interior surfaces of ducts, where visible through registers or grilles, with a flat, nonspecular black paint. Paint back sides of access panels and removable or hinged covers to match exposed surfaces.

H. Paint surfaces behind movable items same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items with prime coat only.

I. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance. Give special attention to ensure that surfaces, including edges, corners, crevices, welds and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.

J. All materials will be applied under adequate lighting, evenly spread and flowed on smoothly. Cut in sharp lines and color breaks.

1. Pigmented (opaque) finishes: Completely cover to provide an opaque, smooth surface of uniform finish, color, appearance, and overage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, or other surface imperfections will not be acceptable.
2. Transparent (clear) finishes: Use multiple coats to produce a glass-smooth surface film of even luster. Provide a finish free of laps, cloudiness, color irregularity, runs, brush marks, orange peel, nail holes, or other surface imperfections. Provide satin finish for final coats.

3.4 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. 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.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.5 INTERIOR PAINTING SCHEDULE

A. Ferrous (and Non-Ferrous, Galvanized, and Aluminum) Metal Substrates:

1. Semi-Gloss Acrylic System
   a. Two coats over primer with total dry film thickness not less than 2.5 mils.
      1) Prime Coat: Acrylic Zinc Metal Primer
      2) First Coat: DTM Acrylic Semi-Gloss Enamel
      3) Second Coat: DTM Acrylic Semi-Gloss Enamel

B. Gypsum Drywall Systems:

1. Lusterless (Flat) Emulsion System

   a. Two coats. Flat latex finish with good washability and excellent touch-up characteristics. This system to be used only on ceilings, or on wall surfaces that are above eight feet high.

      1) Prime Coat: Interior 100% Acrylic Primer
      2) Topcoat: Latex Based Interior Flat Paint

2. Latex Interior Eggshell System

   a. Two coats over primer

      1) Prime Coat: Interior 100% Acrylic Primer
      2) Intermediate Coat: Latex Based Interior Eggshell Enamel
      3) Topcoat: Latex Based Interior Eggshell Enamel

3. Latex Interior Semi-Gloss System

   a. Two coats over primer

      1) Prime Coat: Interior 100% Acrylic Primer
      2) Intermediate Coat: Latex Based Interior Semi-Gloss Latex Enamel
      3) Topcoat: Latex Based Interior Semi-Gloss Latex Enamel

4. Odorless Acrylic Enamel Semi-Gloss System

   a. Three coats with total dry film thickness not less than 2.5 mils.

      1) Prime Coat: Interior 100% Acrylic Primer
      2) Intermediate Coat: DTM Acrylic Semi-Gloss Enamel
      3) Topcoat: DTM Acrylic Semi-Gloss Enamel

END OF SECTION 099123

SECTION 12 24 00 - WINDOW SHADES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Interior manual roller shades.

1.2 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets, including materials, finishes, fabrication details, dimensions, profiles, mounting requirements, and accessories.

B. Shop Drawings: Include shade schedule indicating size, location and keys to details, head, jamb and sill details, mounting dimension requirements for each product and condition, and operation direction.

C. Verification Samples: Minimum size 6 inches square, representing actual materials, color and pattern.

D. Manufacturer's Instructions: Include instructions for storage, handling, protection, examination, preparation, and installation of product.

E. Operation and Maintenance Data: Furnish to Owner list of all components with part numbers, sources of supply, and operation and maintenance instructions; include copy of shop drawings.

F. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than five years of documented experience.

B. Installer Qualifications: Company specializing in performing work of this type with minimum five years of documented experience with shading systems of similar size and type.

1.4 MOCK-UP

A. Mock-Up: Provide full size mock-up of window shade system complete with selected shade fabric including example of seams and batten pockets when applicable.
   1. Obtain Architect and owner approval of light and privacy characteristics of fabric prior to fabrication.
   2. Full-sized mock-up may become part of the final installation.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver shades in manufacturer's unopened packaging, labeled to identify each shade for each opening.

B. Handle and store shades in accordance with manufacturer's recommendations.

1.6 WARRANTY

A. Provide manufacturer's warranty from Date of Substantial Completion, covering the following:
   1. Shade Hardware: One year.
   2. Fabric: One year.
   3. Aluminum and Steel Coatings: One year.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Interior Manually Operated Roller Shades:
   1. Draper, Inc; Clutch Operated FlexShade: www.draperinc.com/#sle.
   2. Hunter Douglas Architectural; RB500 Manual Roller Shades: www.hunterdouglasarchitectural.com/#sle.
   3. Levolor: www.levolor.com/commercial/#sle.
   4. Lutron Electronics Co., Inc; Contract Roller Manual Roller Shades: www.lutron.com/#sle.
   5. MechoShade Systems LLC; Mecho/5 System: www.mechoshade.com/#sle.

2.2 ROLLER SHADES

A. General:
   1. Provide shade system components that are easy to remove or adjust without removal of mounted shade brackets.
   2. Provide shade system that operates smoothly when shades are raised or lowered.

B. Interior Roller Shades - Basis of Design: Draper, Inc: Clutch Operated FlexShade: www.draperinc.com/#sle.
   1. Description: Single roller, manually operated fabric window shade system complete with mounting brackets, roller tubes, hembars, hardware, and other components necessary for complete installation.
      a. Mounting: Mounted to existing Gypusm Board Window Head. Do not fasten through existing window frame. Confirm location of existing stud framing and / or blocking at head prior to mounting. Notify architect if existing stud framing and / or blocking is insufficient.
   2. Brackets and Mounting Hardware: As recommended by manufacturer for mounting indicated and to accommodate shade fabric roll-up size and weight.
      a. Hardware Type: Mounting end caps with fascia.

3. Roller Tubes: As required for type of shade operation; designed for removal without removing mounting hardware.
   a. Material: Extruded aluminum or steel, with wall thickness and material selected by manufacturer.
   b. Size: As recommended by manufacturer; selected for suitability for installation conditions, span, and weight of shades.
4. Hembars: Designed to maintain bottom of shade straight and flat, selected from manufacturer's standard options.
   a. Style: Closed pocket; aluminum elliptical slat inside pocket with heat-sealed ends.
5. Manual Operation:
   a. Clutch Operator: Manufacturer's standard material and design, permanently lubricated.
   b. Drive Chain: Continuous loop stainless steel beaded ball chain, 95 pounds minimum breaking strength. Provide upper and lower limit stops.
6. Accessories:
   a. Fascia: Extruded aluminum, size as required to conceal shade mounting, attachable to mounting end caps, without exposed fasteners; powder coat finish.
      1) Color: Clear Anodized Aluminum
   b. Fasteners: Noncorrosive, and as recommended by shade manufacturer.

2.3 SHADE FABRIC

A. Fabric: Nonflammable, color-fast, impervious to heat and moisture, and able to retain its shape under normal operation.
   1. Manufacturer: Mermet SunConrol Textiles: www.mermetusa.com
   2. Material: Vinyl coated polyester.
   3. Openness Factor: 5%.
   4. Color: E-Screen series; White/White.

2.4 ROLLER SHADE FABRICATION

A. Field measure finished openings prior to ordering or fabrication.

B. Dimensional Tolerances: As recommended in writing by manufacturer.

C. At openings requiring continuous multiple shade units with separate rollers, locate roller joints at window mullion centers; butt rollers end-to-end.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine finished openings for deficiencies that may preclude satisfactory installation.

B. Start of installation shall be considered acceptance of substrates.

3.2 PREPARATION

A. Prepare surfaces using methods recommended by manufacturer for achieving best result for substrate under the project conditions.

B. Coordinate with window installation and placement of concealed blocking to support shades.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions and approved shop drawings, using mounting devices as indicated.

B. Replace shades that exceed specified dimensional tolerances at no extra cost to Owner.

C. Adjust level, projection, and shade centering from mounting bracket. Verify there is no telescoping of shade fabric. Ensure smooth shade operation.

3.4 CLEANING

A. Clean soiled shades and exposed components as recommended by manufacturer.

B. Replace shades that cannot be cleaned to "like new" condition.

3.5 CLOSEOUT ACTIVITIES

A. Demonstration: Demonstrate operation and maintenance of window shade system to Owner's personnel.

3.6 PROTECTION

A. Protect installed products from subsequent construction operations.

B. Touch-up, repair, or replace damaged products before Substantial Completion.

END OF SECTION 12 24 00

SECTION 123600 - COUNTERTOPS

PART 1 GENERAL

1.1SECTION INCLUDES

A. Wall-hung counters.

1.2 REFERENCE STANDARDS

A. ANSI A208.1 - American National Standard for Particleboard; 2022.

B. ASTM D635 - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position; 2022.

C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023b.

D. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition; 2014, with Errata (2016).

E. AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards; 2021, with Errata.

F. ISFA 2-01 - Classification and Standards for Solid Surfacing Material; 2013.

G. NEMA LD 3 - High-Pressure Decorative Laminates; 2005.

H. SEFA 2 - Installations; 2010.

I. SEFA 3 - Laboratory Work Surfaces; 2010.

1.3 SUBMITTALS

A. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Specimen warranty.

B. Shop Drawings: Complete details of materials and installation .

C. Verification Samples: For each finish product specified, minimum size 6 inches square, representing actual product, color, and patterns.

D. Installation Instructions: Manufacturer's installation instructions and recommendations.

E. Maintenance Data: Manufacturer's instructions and recommendations for maintenance and repair of countertop surfaces.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing work of the type specified in this section, with not less than five years of documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. 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 FIELD 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. In the absence of written recommendations by the manufacturer do not deliver or install countertops until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants for the previous 72 hours as well as the remainder of the construction period.

B. Verify dimensions of adjacent construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 PRODUCTS

2.1 COUNTERTOPS

A. Quality Standard: Custom Grade, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless noted otherwise.
   1. If the Contract Documents contain requirements that are more stringent than the referenced quality standard, comply with requirements of Contract Documents in addition to those of the referenced quality standard.

B. Quality Standard: SEFA 3 for laboratory worksurfaces.

C. Epoxy Resin Countertops: Filled epoxy resin molded into homogenous, non-porous sheets; no surface coating and color and pattern consistent throughout thickness; with integral or adhesively seamed components.
   1. Flat Surface Thickness: 1 inch, nominal.
   2. Flammability: Self-extinguishing, when tested in accordance with ASTM D635.

3. Surface Finish: Smooth, non-glare.
4. Color: As indicated on Drawings..
5. Back and End Splashes: Same material, same thickness; separate for field attachment.

D. Solid Surfacing Countertops: Solid surfacing sheet or plastic resin casting over continuous substrate.
1. Flat Sheet Thickness: 1/2 inch, minimum.
2. Solid Surfacing Sheet and Plastic Resin Castings: Complying with ISFA 2-01 and NEMA LD 3; acrylic or polyester resin, mineral filler, and pigments; homogenous, non-porous and capable of being worked and repaired using standard woodworking tools; no surface coating; color and pattern consistent throughout thickness.
   a. Surface Burning Characteristics: Flame spread index of 25, maximum; smoke developed index of 450, maximum; when tested in accordance with ASTM E84.
   b. Manufacturer and Finish on Exposed Surfaces: As indicated on Drawings.
   c. Color and Pattern: As indicated on drawings.
3. Other Components Thickness: 1/2 inch, minimum.
4. Exposed Edge Treatment: Built up to minimum 1-1/4 inch thick; square edge.
5. Back and End Splashes: Same sheet material, square top; minimum 4 inches high.

2.2 MATERIALS

A. Particleboard for Supporting Substrate: ANSI A208.1 Grade 2-M-2, 45 pcf minimum density; minimum 3/4 inch thick; join lengths using metal splines.

B. Adhesives: Chemical resistant waterproof adhesive as recommended by manufacturer of materials being joined.

C. Joint Sealant: Mildew-resistant silicone sealant, color as selected by Architect.

D. Grommets: Doug Mockett & Company, Inc.; MM6 Grommet Cap. Black.

E. Countertop Brackets: Rakks / Rangine Corporation; www.rakks.com.
1. Surface Mount Counter Brackets: For counter up to 30 inches deep EH-1824 Surface Series, rated for 450 pounds per bracket.
2. Pole-Supported Counter Bracket: For counters 36 inches deep, Pole-Supported Counter Bracket, rated for 450 pounds per bracket.
3. Finish: Black.

2.3 FABRICATION

A. Fabricate tops and splashes in the largest sections practicable, with top surface of joints flush.
1. Join lengths of tops using best method recommended by manufacturer.
2. Fabricate to overhang fronts and ends of cabinets 1 inch except where top butts against cabinet or wall.

3. Prepare all cutouts accurately to size; replace tops having improperly dimensioned or unnecessary cutouts or fixture holes.
   a. At cutouts, seal edges of supporting substrate.

B. Provide back/end splash wherever counter edge abuts vertical surface unless otherwise indicated.
   1. Secure to countertop with concealed fasteners and with contact surfaces set in waterproof glue.
   2. Height: 4 inches, unless otherwise indicated.

C. Solid Surfacing: Fabricate tops and wall panels up to 144 inches long in one piece; join pieces with adhesive sealant in accordance with manufacturer's recommendations and instructions.

D. Wall-Mounted Counters: Provide skirts, aprons, brackets, and braces as indicated on drawings, finished to match.

PART 3 EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

C. Verify that wall surfaces have been finished and mechanical and electrical services and outlets are installed in proper locations.

3.2 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

A. Install laboratory worksurface countertops in compliance with requirements of SEFA 2.

B. Securely attach countertops to cabinets using concealed fasteners. Make flat surfaces level; shim where required.

C. Attach epoxy resin countertops using compatible adhesive.

D. Seal joint between back/end splashes and vertical surfaces.

3.4 TOLERANCES

A. Variation From Horizontal: 1/8 inch in 10 feet, maximum.

B. Offset From Wall, Countertops: 1/8 inch maximum; 1/16 inch minimum.

C. Field Joints: 1/8 inch wide, maximum.

3.5 CLEANING

A. Clean countertops surfaces thoroughly.

3.6 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Date of Substantial Completion.

END OF SECTION

SECTION 210500 - COMMON WORK RESULTS FOR FIRE SUPPRESSION

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. Piping materials and installation instructions common to most piping systems.
2. Mechanical sleeve seals.
3. Sleeves.
4. Escutcheons.
5. Grout.
6. Fire-suppression equipment and piping demolition.
7. Equipment installation requirements common to equipment sections.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Mechanical sleeve seals.

1.5 QUALITY ASSURANCE

A. Electrical Characteristics for Fire-Suppression Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

1.7 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for fire-suppression installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for fire-suppression items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

D. Coordinate systems shutdown (water, fire protection, hot water heating, steam, chilled water, etc.) with MSU Project Manager/MSU Project Representative. Activation and shut down of existing systems shall be conducted by MSU personnel only.

PART 2 - PRODUCTS

2.1 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 21 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.2 JOINING MATERIALS

A. Refer to individual Division 21 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.3 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Manufacturers:

a. Link-Seal.
b. Metraflex Co.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Carbon steel. Include two for each sealing element.
4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.4 SLEEVES

A. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

B. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

2.5 ESCUTCHEONS

A. Description: Plastic wall and ceiling escutcheons, with an ID to closely fit around pipe and an OD that completely covers opening.

2.6 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 21 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Do not route piping through transformer vaults or above transformers, panelboards, or switchboards, including the required service space for this equipment, unless the piping is serving this equipment.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls and ceilings. Paint escutcheons to match the adjoining wall or ceiling.

M. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

1. Sleeves placed in floors shall be flush with the ceiling and shall have planed, square ends, extending 2 inches above the finished floor, unless otherwise specified or detailed.
2. Where sleeves pass through reinforced concrete floors, they shall be properly set in position before the concrete is poured, and shall be maintained in position by the Contractor until the concrete is set.
3. Sleeves placed in concrete beams shall be flush with the side of the beam and large enough to accommodate the bare pipe only. All other sleeves shall be of adequate size to accommodate pipe insulation undiminished in size.
4. Pipes passing through above grade floor slabs and masonry walls shall have the space between the pipe or insulation and the sleeve packed with non-asbestos wicking or other suitable, approved, non-combustible material.
5. Pipes passing through walls of Mechanical Equipment Rooms shall be made gas-tight by caulking the space between the pipe and sleeve with a fiber saturated with an approved type of plastic material.
6. Install sleeves in new walls and slabs as new walls and slabs are constructed.
7. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

N. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

O. Verify final equipment locations for roughing-in.

P. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 21 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

E. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.3 CONCRETE BASES

A. Refer to Division 03 Section "Cast-in-Place Concrete" or "Miscellaneous Cast-in-Place Concrete."

B. Anchor equipment to concrete base according to equipment manufacturer's written instructions.

3.4 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor fire-suppression materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.5 GROUTING

A. Mix and install grout for fire-suppression equipment base bearing surfaces, pump and other equipment base plates, and anchors.

END OF SECTION 210500

SECTION 211313 - WET-PIPE SPRINKLER SYSTEMS

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. Pipes, fittings, and specialties.
2. Fire-protection valves.
3. Sprinklers.
4. Alarm devices.
5. Manual control stations.
6. Control panels.
7. Pressure gages.

1.3 DEFINITIONS

A. High-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure higher than standard 175 psig (1200 kPa), but not higher than 250 psig (1725 kPa).

B. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175 psig (1200 kPa) maximum.

1.4 SYSTEM DESCRIPTIONS

A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply through alarm valve. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated.

B. Deluge Sprinkler System: Open sprinklers are attached to piping connected to water supply through deluge valve. Fire-detection system, in same area as sprinklers, opens valve. Water flows into piping system and discharges from attached sprinklers when valve opens.

C. Combined Sprinkler / Standpipe System: A standpipe system having piping that supplies both hose connections and automatic sprinklers.

1.5 PERFORMANCE REQUIREMENTS

A. Standard-Pressure Piping System Component: Listed for 175-psig (1200-kPa) minimum working pressure.

B. High-Pressure Piping System Component: Listed for 250-psig (1725-kPa) minimum working pressure.

C. Delegated Design: Design sprinkler system(s) per NFPA 13-2013, FM Global and additional design criteria on documents where indicated.

D. Sprinkler system design shall be approved by authorities having jurisdiction.

E. Sprinkler system shall be hydraulically designed and have a density of at least that required by the hazard rating of the area protected.

1.6 SUBMITTALS

A. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13 and FM Global that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.

B. Welding certificates.

1.7 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. NFPA Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:

1. NFPA 13, "Installation of Sprinkler Systems."

1.8 PROJECT CONDITIONS

A. Interruption of Existing Sprinkler Service: Do not interrupt sprinkler service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sprinkler service according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of sprinkler service.
2. Do not proceed with interruption of sprinkler service without Owner's written permission.

1.9 COORDINATION

A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

1.10 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. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.

2.2 STEEL PIPE AND FITTINGS

A. Standard Weight, Black-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B. Hot dipped galvanized where indicated. Pipe ends may be factory or field formed to match joining method.

B. Black-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends, hot dipped galvanized where indicated.

C. Steel Couplings: ASTM A 865, threaded, hot dipped galvanized where indicated.

D. Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern, hot dipped galvanized where indicated.

E. Malleable- or Ductile-Iron Unions: UL 860.

F. Cast-Iron Flanges: ASME 16.1, Class 125.

G. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.

H. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.

I. Grooved-Joint, Steel-Pipe Appurtenances:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Shurjoint Piping Products.
b. Tyco Fire & Building Products LP.
c. Victaulic Company.

2. Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe, hot dipped galvanized where indicated.
3. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

2.3 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick or ASME B16.21, nonmetallic and asbestos free.

1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
2. Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 LISTED FIRE-PROTECTION VALVES

A. General Requirements:

1. Valves shall be UL listed or FM approved.
2. Minimum Pressure Rating for Standard-Pressure Piping: 175 psig (1200 kPa).
3. Minimum Pressure Rating for High-Pressure Piping: 250 psig (1725 kPa).

B. Ball Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Anvil International, Inc.
    b. NIBCO.
    c. Victaulic Company.

2. Standard: UL 1091 except with ball instead of disc.
3. Valves NPS 1-1/2 (DN 40) and Smaller: Bronze body with threaded ends.
4. Valves NPS 2 and NPS 2-1/2 (DN 50 and DN 65): Bronze body with threaded ends or ductile-iron body with grooved ends.
5. Valves NPS 3 (DN 80): Ductile-iron body with grooved ends.

C. Butterfly Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Anvil International, Inc.
    b. Kennedy Valve; a division of McWane, Inc.
    c. Milwaukee Valve Company.
    d. NIBCO INC.
    e. Shurjoint Piping Products.
    f. Tyco Fire & Building Products LP.
    g. Victaulic Company.

2. Standard: UL 1091.
3. Valves NPS 2 (DN 50) and Smaller: Bronze body with threaded ends.
4. Valves NPS 2-1/2 (DN 65) and Larger: Cast or ductile iron body with flanged or grooved ends.

D. Check Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Anvil International, Inc.
    b. Clow Valve Company; a division of McWane, Inc.
    c. Crane Co.; Crane Valve Group; Crane Valves.
    d. Crane Co.; Crane Valve Group; Jenkins Valves.
    e. Crane Co.; Crane Valve Group; Stockham Division.
    f. Fire-End & Croker Corporation.
    g. Kennedy Valve; a division of McWane, Inc.
    h. Milwaukee Valve Company.
    i. Mueller Co.; Water Products Division.
    j. NIBCO INC.
    k. Potter Roemer.
    l. Reliable Automatic Sprinkler Co., Inc.
    m. Shurjoint Piping Products.
    n. Tyco Fire & Building Products LP.
    o. Victaulic Company.
    p. Viking Corporation.

2. Standard: UL 312.
3. Type: Swing check.
4. Body Material: Cast iron.
5. End Connections: Flanged or grooved.

E. OS&Y Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Clow Valve Company; a division of McWane, Inc.
    b. Crane Co.; Crane Valve Group; Crane Valves.
    c. Crane Co.; Crane Valve Group; Jenkins Valves.
    d. Crane Co.; Crane Valve Group; Stockham Division.
    e. Hammond Valve.
    f. Milwaukee Valve Company.
    g. Mueller Co.; Water Products Division.
    h. NIBCO INC.
    i. Shurjoint Piping Products.
    j. Tyco Fire & Building Products LP.

2. Standard: UL 262.
3. Valves NPS 2 (DN 50) and Smaller: Bronze body with threaded ends.
4. Valves NPS 2-1/2 (DN 65) and Larger: Cast or ductile iron body with flanged or grooved ends.

F. Indicating-Type Butterfly Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Anvil International, Inc.
   b. Kennedy Valve; a division of McWane, Inc.
   c. Milwaukee Valve Company.
   d. NIBCO INC.
   e. Shurjoint Piping Products.
   f. Tyco Fire & Building Products LP.
   g. Victaulic Company.

2. Standard: UL 1091.
3. Pressure Rating: 175 psig (1200 kPa) minimum.
4. Valves NPS 2 (DN 50) and Smaller:

   a. Valve Type: Ball or butterfly.
   b. Body Material: Bronze.
   c. End Connections: Threaded.

5. Valves NPS 2-1/2 (DN 65) and Larger:

   a. Valve Type: Butterfly.
   b. Body Material: Cast or ductile iron.
   c. End Connections: Flanged, grooved, or wafer.

6. Valve Operation: Integral electrical, 115-V ac, prewired, two-circuit, supervisory switch visual indicating device.

2.5 TRIM AND DRAIN VALVES

A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating: 175 psig (1200 kPa) minimum.

2.6 SPECIALTY VALVES

A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.

2. Pressure Rating:

    a. Standard-Pressure Piping Specialty Valves: 175 psig (1200 kPa) minimum.
    b. High-Pressure Piping Specialty Valves: 250 psig (1725 kPa) minimum.

3. Body Material: Cast or ductile iron.
4. Size: Same as connected piping.
5. End Connections: Flanged or grooved.

B. Alarm Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Reliable Automatic Sprinkler Co., Inc.
    b. Tyco Fire & Building Products LP.
    c. Victaulic Company.
    d. Viking Corporation.

2. Standard: UL 193.
3. Design: For horizontal or vertical installation.
4. Drip Cup Assembly: Pipe drain with check valve to main drain piping.

C. Automatic (Ball Drip) Drain Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Reliable Automatic Sprinkler Co., Inc.
    b. Tyco Fire & Building Products LP.

2. Standard: UL 1726.
3. Pressure Rating: 175 psig (1200 kPa) minimum.
4. Type: Automatic draining, ball check.
5. Size: NPS 3/4 (DN 20).
6. End Connections: Threaded.

2.7 SPRINKLER SPECIALTY PIPE FITTINGS

A. Branch Outlet Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Shurjoint Piping Products.
   b. Tyco Fire & Building Products LP.
   c. Victaulic Company.

2. Standard: UL 213.
3. Pressure Rating: 175 psig (1200 kPa) minimum.
4. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
5. Type: Mechanical-T and -cross fittings.
6. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
7. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
8. Branch Outlets: Grooved, plain-end pipe, or threaded.

B. Flow Detection and Test Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. AGF Manufacturing Inc.
   b. Reliable Automatic Sprinkler Co., Inc.
   c. Tyco Fire & Building Products LP.
   d. Victaulic Company.

2. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
3. Pressure Rating: 175 psig (1200 kPa) minimum.
4. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded.

C. Branch Line Testers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Elkhart Brass Mfg. Company, Inc.
   b. Fire-End & Croker Corporation.
   c. Potter Roemer.

2. Standard: UL 199.
3. Pressure Rating: 175 psig (1200 kPa).
4. Body Material: Brass.
5. Size: Same as connected piping.
6. Inlet: Threaded.
7. Drain Outlet: Threaded and capped.
8. Branch Outlet: Threaded, for sprinkler.

D. Sprinkler Inspector's Test Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. AGF Manufacturing Inc.
    b. Tyco Fire & Building Products LP.
    c. Victaulic Company.
    d. Viking Corporation.

2. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
3. Pressure Rating: 175 psig (1200 kPa) minimum.
4. Body Material: Cast- or ductile-iron housing with sight glass.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded.

2.8 SPRINKLERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Reliable Automatic Sprinkler Co., Inc.
2. Tyco Fire & Building Products LP.
3. Victaulic Company.
4. Viking Corporation.

B. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating for Automatic Sprinklers: 175 psig (1200 kPa) minimum.
3. Pressure Rating for High-Pressure Automatic Sprinklers: 250 psig (1725 kPa) minimum.
4. Temperature Rating: 165 deg. F unless otherwise indicated.

C. Automatic Sprinklers with Heat-Responsive Element:

1. Early-Suppression, Fast-Response Applications: UL 1767.
2. Nonresidential Applications: UL 199.
3. Characteristics: Nominal 1/2-inch (12.7-mm) orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.
4. Element Type: Glass bulb.

D. Open Sprinklers with Heat-Responsive Element Removed: UL 199.

1. Characteristics:

a. Nominal 1/2-inch (12.7-mm) Orifice: With Discharge Coefficient K between 5.3 and 5.8.
b. Nominal 17/32-inch (13.5-mm) Orifice: With Discharge Coefficient K between 7.4 and 8.2.

E. Sprinkler Finishes:

1. Chrome plated.
2. Bronze.
3. Painted.

F. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.

G. Sprinkler Guards:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Reliable Automatic Sprinkler Co., Inc.
b. Tyco Fire & Building Products LP.
c. Victaulic Company.
d. Viking Corporation.

2. Standard: UL 199.
3. Type: Wire cage with fastening device for attaching to sprinkler.

2.9 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Water-Motor-Operated Alarm:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Tyco Fire & Building Products LP.
    b. Victaulic Company.
    c. Viking Corporation.

2. Standard: UL 753.
3. Type: Mechanically operated, with Pelton wheel.
4. Alarm Gong: Cast aluminum with red-enamel factory finish.
5. Size: 10-inch (250-mm) diameter.
6. Components: Shaft length, bearings, and sleeve to suit wall construction.
7. Inlet: NPS 3/4 (DN 20).
8. Outlet: NPS 1 (DN 25) drain connection.

C. Electrically Operated Alarm Bell:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Notifier; a Honeywell company.
    b. Potter Electric Signal Company.

2. Standard: UL 464.
3. Type: Vibrating, metal alarm bell.
4. Size: 10-inch (250-mm) diameter.
5. Finish: Red-enamel factory finish, suitable for outdoor use.

D. Water-Flow Indicators:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. McDonnell & Miller; ITT Industries.
    b. Potter Electric Signal Company.
    c. System Sensor; a Honeywell company.
    d. Viking Corporation.

2. Standard: UL 346.
3. Water-Flow Detector: Electrically supervised.
4. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
5. Type: Paddle operated.

6. Pressure Rating: 250 psig (1725 kPa).
7. Design Installation: Horizontal or vertical.

E. Pressure Switches:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Potter Electric Signal Company.
    b. System Sensor; a Honeywell company.
    c. Tyco Fire & Building Products LP.
    d. Viking Corporation.

2. Standard: UL 346.
3. Type: Electrically supervised water-flow switch with retard feature.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design Operation: Rising pressure signals water flow.

F. Valve Supervisory Switches:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Kennedy Valve; a division of McWane, Inc.
    b. Potter Electric Signal Company.
    c. System Sensor; a Honeywell company.

2. Standard: UL 346.
3. Type: Electrically supervised.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design: Signals that controlled valve is in other than fully open position.

G. Indicator-Post Supervisory Switches:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Potter Electric Signal Company.
    b. System Sensor; a Honeywell company.

2. Standard: UL 346.
3. Type: Electrically supervised.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design: Signals that controlled indicator-post valve is in other than fully open position.

2.10 PRESSURE GAGES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AMETEK; U.S. Gauge Division.
2. Ashcroft, Inc.

B. Standard: UL 393.

C. Dial Size: 3-1/2- to 4-1/2-inch (90- to 115-mm) diameter.

D. Pressure Gage Range: 0 to 250 psig (0 to 1725 kPa) minimum.

E. Water System Piping Gage: Include "WATER" or "AIR/WATER" label on dial face.

F. Air System Piping Gage: Include "AIR" or "AIR/WATER" label on dial face.

PART 3 - EXECUTION

3.1 PREPARATION

A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.

B. Report test results promptly and in writing.

3.2 PIPING INSTALLATION

A. Refer to Division 21 Section "Common Work Result for Fire Suppression" for basic installation requirements.

B. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.

1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.

C. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13.

D. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

E. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.

F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.

G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13. Unless indicated otherwise, inspector's test connections shall be located at the end of the most remote branch line in the upper story. Test valve shall be located not over 7' above the floor and in lockable rooms. Discharge shall be to floor drain equipped with a funnel.

H. Install sprinkler piping with drains for complete system drainage. Terminate drain lines to the nearest floor drain with funnel or to a service sink.

I. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

J. For combined sprinkler / standpipe systems, install 2-1/2” hose valve and sprinkler control assembly including OS&Y valves with tamper, flow switch, and inspector’s test and drain valves in each floor. Connect drain lines to drain risers.

K. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.

L. Install alarm devices in piping systems. A flow alarm switch shall be provided in the sprinkler riser and shall be wired into the fire alarm system. Where a main line branches out, a separate alarm shall be installed on each branch to a different building or section of building. A separate flow alarm switch for the standpipe risers is not required for the combined system.

M. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.

N. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 (DN 8) and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.

O. Fill sprinkler system piping with water.

P. Install electric heating cables and pipe insulation on sprinkler piping in areas subject to freezing. Comply with requirements for heating cables in Division 21 "Heat Tracing for Fire-Suppression Piping" and for piping insulation in Division 21 Section "Fire-Suppression Systems Insulation."

Q. Underground pipe and fittings for fire protection shall be installed in accordance with AWWA specification. Refer to Water Distribution Section in Division 2 for details.

3.3 JOINT CONSTRUCTION

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.

B. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.

C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.

D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.

G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

H. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.

I. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.

J. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

3.4 VALVE AND SPECIALTIES INSTALLATION

A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. System water supply valves, isolation control valves, and other valves in feed mains shall be supervised by locking valves open. Padlocks with Best cylinders will be provided by MSU, and installed by the Contractors.

D. Install backflow preventers in potable-water-supply sources.

E. Specialty Valves:

1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
2. Alarm Valves: Include bypass check valve and retarding chamber drain-line connection.

3.5 SPRINKLER INSTALLATION

A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels.

B. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.

C. Provide automatic sprinklers of ordinary or intermediate temperature rating in the elevator machine room. Each system shall have a readily accessible shut-off valve, that is electronically supervised, located outside the protected area, per agreement signed by the Bureau of Fire Services, Plan Review Division and the Bureau of Construction Codes, Elevator Safety Division.

3.6 IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

C. All exposed sprinkler piping in unfinished areas shall be painted red. All exposed piping in finished areas shall be painted to match the adjoining walls and ceilings. At intervals not to exceed 50 feet, provide printed identification and flow direction labels entitled "SPRINKLER-FIRE." Color shall be white letters on red background. Labels shall be snap on style equal to Seton "Setmark."

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
4. Energize circuits to electrical equipment and devices.
5. Start and run excess-pressure pumps.
6. Coordinate with fire-alarm tests. Operate as required.
7. Coordinate with fire-pump tests. Operate as required.
8. Verify that equipment hose threads are same as local fire-department equipment.

C. Sprinkler piping system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.8 CLEANING

A. Clean dirt and debris from sprinklers.

B. Remove and replace sprinklers with paint other than factory finish.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specialty valves and pressure-maintenance pumps.

3.10 PIPING SCHEDULE

A. Piping between Fire-Department Connections and Check Valves: Galvanized, standard-weight steel pipe with grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.

B. Piping between Domestic Water Supply Connection and Backflow Preventers: Galvanized, standard-weight steel pipe with grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.

C. Standard-pressure, wet-pipe sprinkler system, NPS 2 (DN 50) and smaller, shall be one the following:

1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.

D. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 (DN 65) and larger, shall be the following:

1. Standard-weight, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
2. Standard-weight, black-steel pipe with plain ends; steel welding fittings; and welded joints.

E. High-pressure, wet-pipe sprinkler system, NPS 4 (DN 100) and smaller, shall be the following:

1. Standard-weight, black-steel pipe with plain ends; steel welding fittings; and welded joints.

F. High-pressure, wet-pipe sprinkler system, NPS 5 (DN 125) and larger, shall be the following:

1. Standard-weight, black-steel pipe with plain ends; steel welding fittings; and welded joints.

3.11 SPRINKLER SCHEDULE

A. Use sprinkler types in subparagraphs below for the following applications:

1. Rooms without Ceilings: Upright sprinklers.
2. Rooms with Suspended Ceilings: Pendent, recessed, flush, and concealed sprinklers as indicated.
3. Wall Mounting: Sidewall sprinklers.
4. Spaces Subject to Freezing: Upright, pendent, dry sprinklers; and sidewall, dry sprinklers as indicated.
5. Special Applications: Extended-coverage, flow-control, and quick-response sprinklers where indicated.

B. Provide sprinkler types in subparagraphs below with finishes indicated.

1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
2. Flush Sprinklers: Bright chrome, with painted white escutcheon.
3. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
4. Residential Sprinklers: Dull chrome.

5. Upright, Pendent and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes; with listed guard in exposed areas.

END OF SECTION 211313

SECTION 212200 – CLEAN AGENT FIRE EXTINGUISHING SYSTEMS

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 furnishing and installation of a cross-zoned detection and total flooding, clean agent extinguishing system.

B. Division of Work: In accordance with the General Conditions, Contractor is responsible for dividing Work among the Subcontractors and Suppliers and for delineating the work to be performed by specific trades. The following are suggestions as to how Work may be divided. This is not a complete list of the entire work:
   1. Fire Protection Subcontractor:
      a. Prepare system design and layout.
      b. Furnish and install system piping and components including, but not necessarily limited to, flow switches, valve supervisory switches, and pressure switches.
      c. Secure approvals from agencies having jurisdiction.
   2. Mechanical Subcontractor: Provide dampers and ventilation equipment.
   3. Electrical Subcontractor:
      a. Provide necessary wiring interface and wire to building fire alarm system.
      b. Wiring of ventilation equipment and dampers.
      c. Provide power to system panel.

1.3 REFERENCES

A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
   1. NFPA:
      a. 70 - National Electric Code.
      b. 72 - National Fire Alarm Code.
      c. 2001 - Standard on Clean Agent Fire Extinguishing Systems.

1.4 SYSTEM DESCRIPTION

A. Provide a total flooding system consisting of a supply of a clean agent gaseous fire extinguishing agent as defined in NFPA 2001, designed to discharge into an enclosed space and filling that space to the proper concentration.

B. The suppression system shall be engineered, permanently piped, fixed nozzle type with ancillary components of one Manufacturer.

1.5 DESIGN AND PERFORMANCE REQUIREMENTS

A. Concentration Requirements:
   1. The system shall be a total flooding FM-200 or Inergen extinguishing system designed to provide a uniform concentration of 7% minimum of FM-200 or [40%] [50%] of Inergen.
   2. The amount of clean agent to be provided shall be the amount required to obtain the minimum uniform concentration for 10 minutes:
   3. Take into consideration such factors as unclosable openings (if any), run-down time of fans, time required for dampers to close (and requirements for additional dampers), and other feature of the facility that could affect concentration.

1.6 SUBMITTALS

A. Shop Drawings: For complete system and components.
   1. Details of construction and installation.
   2. Name of Manufacturer.
   3. Detailed drawing of system showing components, including floor plans.
   4. Dimensional data on components.
   5. System calculations to illustrate volumetric concentrations and distribution.
   6. Operating sequence.
   7. Field connection requirements.

B. Submit certification from Manufacturer of installer’s qualification to install, test, maintain, and recharge system.

C. Operation and Maintenance Manuals: For complete system.
   1. Equipment function, normal operating characteristics, and limiting conditions.
   2. Assembly, installation, alignment, adjustment, and checking instructions.
   3. Operating instructions for start-up, routine and normal operating, regulation and control, and shutdown and emergency conditions.
   4. Parts lists.
   5. Outline, cross-sections, assembly drawings, engineering data, and wiring diagrams.

D. As-Built Drawings:
   1. Upon completion of each system, provide 4 copies of as-built drawings showing actual installation details.
   2. Indicate equipment locations (manual stations, abort switches, alarms, detectors, control panels) as well as exact conduit and piping routing details and agent storage positions.
   3. Illustrate facility modifications, including door and damper installations and modifications to ensure required soak times.
   4. Provide 1 copy of reproducible drawings reflecting actual installation details.

1.7 QUALITY ASSURANCE

A. Fabrication and Installation Personnel Qualifications:
   1. Trained and experienced in the design, fabrication, and installation of the materials and equipment.
   2. Knowledgeable of the design and the reviewed Shop Drawings.

3. The installer shall have a minimum of 7 years experience in the design, installation and testing of the proposed clean agent system.
4. Provide list of similar projects upon request by Owner or Engineer.

B. Regulatory Requirements: For equipment and components shall comply with:
1. Applicable NFPA Standards.
2. Factory Mutual (FM) Approval Guide.
3. Underwriters Laboratories (UL).
4. Local authority.

1.8 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in original, unbroken, brand marked containers.

B. Handle and store materials in a manner which will prevent deterioration or damage, contamination with foreign matter, and damage by weather or elements and according to Manufacturer's directions.

C. Reject damaged, deteriorated or contaminated material and immediately remove from the Site. Replace rejected materials with new materials at no additional cost to Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Ansul Fire Protection.

B. Fireboy-Xintex.

C. Kidde-Fenwal.

D. Approved equal.

2.2 MATERIALS AND EQUIPMENT

A. General Requirements:
1. Extinguishing agent shall be FM-200 [or 3M Novec 1230] as furnished by Kidde-Fenwal or Fireboy-Xintex, or Inergen as furnished by Ansul.
2. Materials and equipment shall be standard products of the Manufacturer’s latest design and suitable to perform the functions intended.
3. When one or more pieces of equipment must perform the same functions, they shall be duplicates produced by one Manufacturer.
4. Devices and equipment shall be UL listed or FM approved, or both.

2.3 CONTROLS

A. The control panel shall be as manufactured by the system Manufacturer and shall perform the functions necessary to operate the detection and the clean agent suppression system.

B. The control unit shall be approved by Underwriter's Laboratories, Inc., as a system control unit.

C. Control Unit Construction and Features:
   1. Housed in a wall mounted, sheet metal enclosure suitable for protecting electrical circuits.
   2. NEMA Type 1 metal cabinet with hinged, locked doors.
   3. In the event of a loss of rectified power, visual and audible trouble signs shall be activated.
   4. Emergency Power Supply:
      a. Built-in, rechargeable standby batteries to provide a minimum of 24-hours emergency power.
      b. A trouble signal shall be initiated if battery leads are disconnected or the battery is in an abnormally low state of charge.

D. System Actuation:
   1. The system shall be actuated by a combination of ionization and photoelectric smoke detectors.
   2. Automatic operation in each separate protected area shall be as follows:
      a. Actuation of 1 detector in either loop shall:
         1) Illuminate the respective zone (circuit) lamp on the control unit.
         2) Energize a pre-alarm audible and visual signal associated with that area in which the detector was operated.
         3) Actuate door closer/holders on access doors to the protected area.
         4) Transmit a signal to the building's fire alarm system.
      b. Actuation of a second detector in the same area, but on the second detection loop, shall:
         1) Illuminate the respective zone circuit lamp on the control unit.
         2) Energize an evacuation audible and visual signal associated with the area in which the detector was operated.
         3) Start time-delay sequence.
         4) Shut down ventilation system or close dampers, or both as applicable.
      c. Discharge of the fire extinguishing agent shall occur at the end of the time delay period.
      d. Upon discharge of fire extinguishing agent, power to high voltage equipment shall be interrupted.
   3. Manual Operation:
      a. The system shall be capable of being actuated by manual discharge switches located at each fire exit.
      b. Operation of manual switch shall duplicate the cross-zones sequence description above, except that time-delay shall be bypassed.
      c. The manual discharge station shall be of the electrical actuation type and be supervised at the control panel.
      d. Local, manual, mechanical release shall be installed on each pilot cylinder.
      e. Manual actuation shall bypass the delay and abort functions and shall cause alarm and shutdown devices to operate the same as if the system had operated automatically.

2.4 COMPONENTS

A. Manual Pull Stations:
   1. Dual action type, which shall require that an outer door be lifted to expose the actuation door.
   2. The concealed release switch shall be double action DPDT.
   3. The front shall be marked with the legend "Fire Extinguishing Agent Release."

B. Smoke Detectors:
   1. Locate in accordance with the Manufacturer's specifications and within the guidelines of NFPA 72.
   2. Ionization products-of-combustion smoke detectors: Kidde-Fenwal CPD-7051; equal provided by Ansul, or as approved.
   3. Photoelectric smoke detectors: Kidde-Fenwal PSD-7155; equal provided by Ansul, Fireboy-Xintex, or as approved.

C. Alarm Horns/Strobes: Kidde-Fenwal P/N MT-24-LS-VAR; equal provided by Ansul or Fireboy-Xintex; or as approved.

D. Abort Stations:
   1. "Dead man" type, located next to each manual station.
   2. Supervised and shall indicate a trouble condition at the control unit if depressed.

2.5 WIRING

A. Wiring shall be installed in electrical metallic tubing (EMT) or conduit.

B. Wiring shall be installed to conform to the requirements of the National Electrical Code (NEC), Article 725 for Class 1 signal systems, except as otherwise permitted for limited energy circuits, as described in NFPA 72.

C. The complete electrical installation of the system and components shall be grounded in accordance with the NEC.

D. Comply with the requirements of Divisions 26 and 28.

2.6 STORAGE AND DISTRIBUTION

A. Each protected area shall have its own separate supply of extinguishing agent:
   1. Locate each supply within the hazard area or as near to it as possible so that a minimum of distribution piping is used.
   2. Containers:
      a. Store the extinguishing agent in floor mounted cylindrical containers.
      b. Containers shall be super pressurized with dry nitrogen to 360 psig at 70 degrees F.
      c. Containers shall be of high strength alloy steel construction that complies with the Department of Transportation regulation for refillable pressure vessels and conforms to NFPA 2001.
      d. Containers Valves:
         1) Actuated by solenoid operation only.
         2) Parallel wired initiators shall not be permitted.
      e. Each agent storage container shall also have a pressure gage to facilitate visual supervision of the container pressure.
      f. Each container shall have a pressure relief device that automatically operates when internal pressure exceeds 805 psig.

g. It shall be possible to determine the agent liquid level within each container without removing the storage container from its mounting bracket, disconnecting the distribution piping, or shutting down the system.

3. Securely mount each agent storage container to a rigid surface.

B. Nozzles:
1. Discharge nozzles shall distribute the extinguishing agent throughout the protected area.
2. Furnished by the system Manufacturer and designed to provide proper distribution and weight of the agent.
3. Ceiling penetrations shall be finished with chrome plated escutcheons.
4. Nozzles shall be brass.

2.7 WARNING SIGNS

A. Provide warning signs at entrances and exits of the protected area.

B. Entrance sign shall read: "WARNING - DO NOT ENTER ROOM WHEN ALARM SOUNDS, FIRE EXTINGUISHING AGENT BEING RELEASED".

C. Exit sign shall read: "WHEN ALARM SOUNDS, VACATE AT ONCE, FIRE EXTINGUISHING AGENT BEING RELEASED".

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with the Manufacturer’s written instructions. the approved Shop Drawings, and NFPA requirements.

B. Piping:
1. Install distribution piping in accordance with the latest requirements listed in NFPA 2001.
2. Pipe lengths shall be reamed, blown clear, and swabbed with suitable solvents to remove burrs, mill varnish, and cutting oil before assembly.
3. For threaded fittings, use Teflon tape, applied to male pipe threads only.

C. Wiring:
1. Securely fasten system components to their support independent of the wiring.
2. Runs of conduit and wiring shall be straight, neatly arranged, properly supported, and parallel or perpendicular to walls and partitions, as applicable.
3. Wires shall be tagged at junction points and shall be free from grounds or crosses between conductors.
4. Make final connections between equipment and the system wiring under direct supervision of a factory trained representative.
5. Comply with the requirements of Division 26 and 28.

3.2 SYSTEM CHECKOUT AND TESTING

A. Testing:
   1. Completed installation shall be inspected by authorized personnel and shall include full operational test of components in accordance with equipment Manufacturer recommendations and NFPA 2001 requirements.
   2. Testing shall be done in presence of Owner's representative, Engineer's representative, and insuring authority or local authority having jurisdiction.
   3. Test mechanical and electrical components according to Manufacturer's recommended procedure to verify system integrity.
   4. Functional Test:
      a. Complete prior to concentration test.
      b. Consists of detection, release, alarm, accessories related to system, control unit and review of tanks, piping, fittings, hangers and cylinder pressure.
      c. Test in the presence of Owner, Engineer, and local authority.
      d. Functions, including system and equipment interlocks, shall be operational at least 10 days prior to the final acceptance test.
      e. Each detector shall be tested in accordance with the Manufacturer’s recommended procedures.
      f. The system and equipment interlocks, such as door releases, audible and visual alarms, and equipment shut downs shall function at that time.
      g. Each circuit shall be tested for trouble by inducing a trouble condition to the system.
   5. Concentration Test:
      a. Provide under supervision of Manufacturer’s authorized personnel in presence of Owner's representative, local authorities and insuring authority.
      b. Test procedures shall be as recommended by equipment Manufacturer and agent Supplier.
      c. Gas Analyzers:
         1) Provide two 3-chart thermal conductivity gas analyzers capable of automatically recording 3 or more sampling points.
         2) Concentration recording shall continue until authorities are satisfied with hazard integrity or until 10 minutes have elapsed.
         3) Locate sampling points at strategic areas but not higher than highest combustible contents.
      d. If test results indicate that design concentration was not achieved or held, determine cause of failure, recharge system and again place in operation.
      e. Contractor shall only be responsible for retest based on equipment failure.

B. Inspection:
   1. Provide inspection which includes complete checkout of electronic system, and certification of weight and cylinder pressure.
   2. File written inspection report with Owner.

3.3 TRAINING

A. Prior to final acceptance, provide operation training to each shift of Owner’s personnel.

B. Each training session shall include emergency procedures, abort functions, system control panel operation, trouble procedures, and safety requirements.

C. Each session shall include a complete demonstration of the system.

D. Coordinate dates and times of the training period with Owner not less than 2 weeks prior to session.

END OF SECTION 212200

SECTION 220500 - COMMON WORK RESULTS FOR PLUMBING

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. Piping materials and installation instructions common to most piping systems.
2. Mechanical sleeve seals.
3. Sleeves.
4. Escutcheons.
5. Grout.
6. Plumbing demolition.
7. Equipment installation requirements common to equipment sections.
8. Concrete bases.
9. Supports and anchorages.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:

1. CPVC: Chlorinated polyvinyl chloride plastic.
2. PE: Polyethylene plastic.
3. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.
2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Transition fittings.
2. Dielectric fittings.
3. Mechanical sleeve seals.
4. Escutcheons.

B. Welding certificates.

C. Certificate of Acceptance: Provide certificate as described in this section.

1.5 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."

C. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

D. Permits and Inspections

1. The Plumbing Contractor shall obtain and pay for all permits required by the State of Michigan Department of Licensing and Regulatory Affairs, Plumbing Division.

2. The Plumbing Contractor shall submit, to precede request for final payment, a copy of the Certificate of Acceptance of the plumbing systems.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

D. Coordinate systems shutdown (water, fire protection, hot water heating, steam, chilled water, etc.) with MSU Project Manager/MSU Project Representative. Activation and shut down of existing systems shall be conducted by MSU personnel only.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 22 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

    a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
    b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASTM A-354 Grade BD and SAE J-429 Grade 8 for steam and condensate application, and ASTM A-354 and SAE J-429 Grade 5 for other low service temperature applications, unless otherwise indicated.

D. Solder Filler Metals: ASTM B 32, lead-free alloys, 95/5 tin-copper. Include water-flushable flux according to ASTM B 813.

E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

G. Solvent Cements for Joining Plastic Piping:

1. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
2. CPVC Piping: ASTM F 493.

H. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.4 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Manufacturers:

    a. Link-Seal.
    b. Metraflex Co.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Carbon steel. Include two for each sealing element.
4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.5 SLEEVES

A. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, plain ends.

2.6 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Type: With set screw.

1. Finish: Polished chrome-plated.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.

1. Finish: Polished chrome-plated.

E. One-Piece, Floor-Plate Type: Cast-iron floor plate.

F. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.7 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PLUMBING DEMOLITION

A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.

B. Disconnect, demolish, and remove plumbing systems, equipment, and components indicated to be removed.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections. T-drill system for mechanically formed tee connections and couplings, and Victaulic hole cut piping system are not allowed.

J. Install piping to allow application of insulation.

K. Piping shall not project beyond walls or steel lines nor shall it hang below slabs more than is absolutely necessary. Particular attention shall be paid to the required clearances.

L. Offset piping where required to avoid interference with other work, to provide greater headroom or clearance, or to conceal pipe more readily. Offsets shall be properly drained or trapped where necessary.

M. Provide swing joints and expansion bends wherever required to allow the piping to expand without undue stress to connections or equipment.

N. Isolate pipe from the building construction to prevent transmission of vibration to the structure and to eliminate noise.

O. Exposed piping around fixtures or in other conspicuous places shall not show tool marks at fittings.

P. Do not route piping through transformer vaults or above transformers, panelboards, or switchboards, including the required service space for this equipment, unless the piping is serving this equipment.

Q. Select system components with pressure rating equal to or greater than system operating pressure.

R. Eccentric reducing couplings shall be provided in all cases where air or water pockets would otherwise occur due to a reduction in pipe size. Eccentric couplings shall make the pipe flush on the top for water lines.

S. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:

1. New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
d. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.

e. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with rough-brass finish.
f. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
g. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

2. Existing Piping: Use the following:

a. Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.
b. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
c. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
d. Bare Piping in Unfinished Service Spaces: Split-casting, cast-brass type with rough-brass finish.
e. Bare Piping in Equipment Rooms: Split-casting, cast-brass type.
f. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.

T. All pipes extending through the roof shall be flashed with six pound lead flashing extending 6 inches beyond the pipe, welded to a lead sleeve extended up around the vent pipes, and rolled over into the pipe.

U. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

1. Sleeves placed in floors shall be flush with the ceiling and shall have planed, square ends, extending 2 inches above the finished floor, unless otherwise specified or detailed.
2. Where sleeves pass through reinforced concrete floors, they shall be properly set in position before the concrete is poured, and shall be maintained in position by the Contractor until the concrete is set.
3. Sleeves placed in concrete beams shall be flush with the side of the beam and large enough to accommodate the bare pipe only. All other sleeves shall be of adequate size to accommodate pipe insulation undiminished in size.
4. Pipes passing through above grade floor slabs and masonry walls shall have the space between the pipe or insulation and the sleeve packed with non-asbestos wicking or other suitable, approved, non-combustible material.
5. Pipes passing through walls of Mechanical Equipment Rooms shall be made gas-tight by caulking the space between the pipe and sleeve with a fiber saturated with an approved type of plastic material.

V. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.
2. Install cast-iron "wall pipes" for sleeves 6 inches (150 mm) and larger in diameter.

3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

W. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

X. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

Y. Verify final equipment locations for roughing-in.

Z. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

AA. Return hot water line shall be no further than 15’ from the fixture needing hot water.

3.3 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.

3.4 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

B. Unions shall be used in preference to couplings where their use will facilitate dismantling the pipe for maintenance.

C. Install transition couplings at joints of dissimilar piping.

D. No Uni-flange pipe adapters will be allowed.

3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

3.6 CONCRETE BASES

A. Refer to Division 03 Section "Cast-in-Place Concrete" or "Miscellaneous Cast-in-Place Concrete."

B. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions at Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.

3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section 055000 "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.8 GROUTING

A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.

END OF SECTION 220500

SECTION 220519 - METERS AND GAGES FOR PLUMBING PIPING

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. Liquid-in-glass thermometers.
2. Thermowells.
3. Dial-type pressure gages.
4. Gage attachments.

B. Related Sections:

1. Division 21 Section "Facility Fire-Suppression Water-Service Piping" for fire-protection water-service meters outside the building.
2. Division 21 fire-suppression piping Sections for fire-protection pressure gages.
3. Division 22 Section "Facility Water Distribution Piping" for domestic water meters and combined domestic and fire-protection water-service meters outside the building.
4. Division 22 Section " Domestic Water Piping" for water meters inside the building.

1.3 SUBMITTALS

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

B. Product Certificates: For each type of meter and gage, from manufacturer.

C. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Trerice, H. O. Co.
   b. Weiss Instruments, Inc.

2. Standard: ASME B40.200.
3. Case: Cast aluminum; 9-inch (229-mm) nominal size unless otherwise indicated.
4. Case Form: Adjustable angle unless otherwise indicated.
5. Tube: Glass with magnifying lens and blue or red organic liquid.
6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C).
7. Window: Glass or plastic.
8. Stem: Aluminum and of length to suit installation.

   a. Design for Thermowell Installation: Bare stem.

9. Connector: 1-1/4 inches (32 mm), with ASME B1.1 screw threads.
10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.2 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: CNR or CUNI.
4. Material for Use with Steel Piping: CRES.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, (DN 15, DN 20, or NPS 25,) ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch (13, 19, and 25 mm), with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.3 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. AMETEK, Inc.; U.S. Gauge.
   b. Ashcroft Inc.
   c. Trerice, H. O. Co.
   d. Weiss Instruments, Inc.

2. Standard: ASME B40.100.
3. Case: Liquid-filled type(s); cast aluminum or drawn steel; 4-1/2-inch (114-mm) nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2 (DN 8 or DN 15), ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi (kPa).
8. Pointer: Dark-colored metal.
9. Window: Glass or plastic.
10. Ring: Metal.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.4 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2 (DN 8 or DN 15), ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.

B. Valves: Brass ball, with NPS 1/4 or NPS 1/2 (DN 8 or DN 15), ASME B1.20.1 pipe threads.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending one-third of pipe diameter and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.

G. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

H. Install remote-mounted pressure gages on panel.

I. Install valve and snubber in piping for each pressure gage for fluids.

J. Install test plugs in piping tees.

K. Install thermometers in the following locations:

1. Outlet of each water heater.
2. Inlet of hot water return to cold water supply to water heater.
3. Outlets of each domestic water heat exchanger.
4. Inlet and outlet of each domestic hot-water storage tank.
5. Inlet and outlet of each remote domestic water chiller.

L. Install pressure gages in the following locations:

1. Building water service entrance into building.
2. Inlet and outlet of each pressure-reducing valve.
3. Suction and discharge of each domestic water pump.

3.2 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

3.3 ADJUSTING

A. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Domestic Cold-Water Piping: 0 to 100 deg F (Minus 20 to plus 50 deg C).

B. Scale Range for Domestic Hot-Water Piping: 0 to 250 deg F (0 to 150 deg C).

C. Scale Range for Domestic Cooled-Water Piping: 0 to 100 deg F (Minus 20 to plus 50 deg C).

3.5 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Water Service Piping: 0 to 100 psi (0 to 600 kPa).

B. Scale Range for Domestic Water Piping: 0 to 160 psi (0 to 1100 kPa).

3.6 FLOWMETER SCHEDULE

Meter Application	**Provided by**	**Installed By**	**Wired By**	**Line Size in Inch**	**Flow Range in lbs/hr**	**Notes**
Steam	MSU	Contractor	MSU			
Chilled Water	Contractor	Contractor	Contractor			
Domestic Water	MSU	Contractor	MSU			
Heating Hot Water	Contractor	Contractor	Contractor			
BTU Calculator	Contractor	Contractor	Contractor			MSU to wire network card
Condensate	MSU	Contractor	MSU	N/A	N/A	

END OF SECTION 220519

SECTION 220523 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

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. Bronze ball valves.
2. Cast iron ball valves.
3. Iron, single-flange butterfly valves.
4. Iron, grooved-end butterfly valves.
5. Bronze lift check valves.
6. Bronze swing check valves.
7. Iron swing check valves.
8. Iron, grooved-end swing check valves.
9. Iron, center-guided check valves.
10. Bronze gate valves.
11. Iron gate valves.

B. Related Sections:

1. Division 22 plumbing piping Sections for specialty valves applicable to those Sections only.
2. Division 22 Section "Identification for Plumbing Piping and Equipment" for valve tags and schedules.
3. Division 33 water distribution piping Sections for general-duty and specialty valves for site construction piping.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

D. NRS: Nonrising stem.

E. OS&Y: Outside screw and yoke.

F. RS: Rising stem.

G. SWP: Steam working pressure.

1.4 ACTION SUBMITTALS

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

1.5 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.1 for power piping valves.
3. ASME B31.9 for building services piping valves.

C. NSF Compliance: NSF 61 for valve materials for potable-water service.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set angle, gate, and globe valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to valve schedule articles for applications of valves.

B. Valve Sizes: Same as upstream piping unless otherwise indicated.

C. Valve Actuator Types:

1. Gear Actuator: For quarter-turn valves NPS 8 (DN 200) and larger.
2. Handwheel: For valves other than quarter-turn types.
3. Handlever: For quarter-turn valves NPS 6 (DN 150) and smaller.
4. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 10 plug valves, for each size square plug-valve head.

D. Valves in Insulated Piping: With 2-inch (50-mm) stem extensions and the following features:

1. Gate Valves: With rising stem.
2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
3. Butterfly Valves: With extended neck.

E. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Grooved: With grooves according to AWWA C606.
3. Solder Joint: With sockets according to ASME B16.18.
4. Threaded: With threads according to ASME B1.20.1.

F. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Apollo Valves; Model #77C-100 or 77C-200.
b. Crane Co.; Crane Valve Group; Crane Valves; Model #9302 or 9302S.
c. Hammond Valve; Model #8501, 8301A or 8511, 8311A.
d. Milwaukee Valve Company; Model #BA-400 or BA-450.
e. NIBCO INC; Model #T585-70 or S585-70.

2. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig (1035 kPa).
c. CWP Rating: 600 psig (4140 kPa).
d. Body Design: Two piece.
e. Body Material: Bronze.
f. Ends: Threaded.
g. Seats: PTFE or TFE.
h. Stem: Bronze.
i. Ball: Chrome-plated brass.
j. Port: Full.

B. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Conbraco Industries, Inc.; Apollo Valves.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Hammond Valve.
d. Milwaukee Valve Company.
e. NIBCO INC.

2. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig (1035 kPa).
c. CWP Rating: 600 psig (4140 kPa).
d. Body Design: Two piece.
e. Body Material: Bronze.
f. Ends: Threaded.
g. Seats: PTFE or TFE.
h. Stem: Stainless steel.
i. Ball: Stainless steel, vented.
j. Port: Full.

2.3 CAST IRON BALL VALVES

A. Two-Piece, Full-Port, Cast Iron Ball Valves with Stainless-Steel Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Conbraco Industries, Inc.; Apollo Valves; Model 6PLF (Lead Free)
b. Approved equal

2. Description:

   a. Standard: MSS SP-72.
   b. SWP Rating: 125 psig.
   c. CWP Rating: 200 psig.
   d. Body Design: Two piece.
   e. Body Material: Class 125 Cast Iron.
   f. Ends: Threaded.
   g. Seats: PTFE .
   h. Stem: Stainless steel.
   i. Ball: Stainless steel, vented.
   j. Port: Full.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.
2. Center-Guided Check Valves: In horizontal or vertical position, between flanges.
3. Lift Check Valves: With stem upright and plumb.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Shutoff Service:

a. 6” and smaller: Ball valves

2. Butterfly Valve Dead-End Service: Single-flange (lug) type.
3. Throttling Service: Globe valves.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:

1. For Copper Tubing, NPS 2 (DN 50) and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
2. For Copper Tubing, NPS 2-1/2 (DN 65) and Larger: Flanged ends.
3. For Steel Piping, NPS 2 (DN 50) and Smaller: Threaded ends.
4. For Steel Piping, NPS 2-1/2 (DN 65): Flanged ends.
5. For Grooved-End Copper Tubing and Steel Piping: Valve ends may be grooved.

3.5 LOW-PRESSURE, COMPRESSED-AIR VALVE SCHEDULE (150 PSIG (1035 kPa) OR LESS)

A. Pipe NPS 2 (DN 50) and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Ball Valves: Two piece, full port, bronze with brass, bronze or stainless-steel trim.
3. Bronze Lift Check Valves: Class 125, bronze disc.
4. Bronze Swing Check Valves: Class 125, bronze disc.

3.6 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Ball Valves: Two piece, full port, bronze with brass, bronze or stainless-steel trim.
3. Bronze Swing Check Valves: Class 125, bronze disc.

END OF SECTION 220523

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

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. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Thermal-hanger shield inserts.
4. Fastener systems.
5. Pipe positioning systems.
6. Equipment supports.

B. Related Sections:

1. Division 22 Section "Expansion Fittings and Loops for Plumbing Piping" for pipe guides and anchors.
2. Division 22 Section "Vibration Controls for Plumbing Piping and Equipment" for vibration isolation devices.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 SUBMITTALS

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

B. Shop Drawings: Show fabrication and installation details for the following; include Product Data for components:

1. Trapeze pipe hangers.
2. Equipment supports.

C. Welding certificates.

1.6 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following:

1. Clevis.
2. Fee and Mason.
3. Anvil.
4. PHD Manufacturing, Inc.
5. Hilti, Inc.

2.2 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

5. Hanger Rods: Continuous-thread rod, nuts, and washer made of hot dip galvanized or cadmium plated.

B. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.4 THERMAL-HANGER SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. PHS Industries, Inc.
2. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.

B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig (688-kPa).

C. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass with 100-psig (688-kPa).

D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

F. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, stainless- steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.6 PIPE POSITIONING SYSTEMS

A. Description: IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.7 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.8 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

D. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

E. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. See Division 22 plumbing fixture Sections for requirements for pipe positioning systems for plumbing fixtures.

F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

A. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

B. Install hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

C. Install lateral bracing with pipe hangers and supports to prevent swaying.

D. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 (DN 65) and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

E. Holes shall not be drilled or punched in beams and supporting members. Do not support piping from roof deck, other piping, ducts or equipment.

F. Hangers and supports shall also be provided at every change of direction and within 1' of any pipe fittings and valves.

G. Pipe hangers in fan rooms and in mechanical equipment rooms shall be provided with suitable vibration isolation units to eliminate noise transmission between the piping and the building structure.

H. Hanger components shall not be used for purposes other than for which they were designed.

I. Vertical runs of piping not subject to appreciable expansion shall be supported by approved wrought steel clamps or collars, securely clamped to the risers. Where required, spring supports and guides shall be provided.

J. Where negligible movement of pipe occurs at hanger locations, rod hangers may be used for suspended lines. For piping supported from below, bases, brackets or structural cross members may be used.

K. If the vertical angle of the hanger is greater than 4 degrees, a traveling device shall be provided for horizontal movement. For piping supported from below, rollers or roller carriages shall be used.

L. Where significant vertical movement of the pipe occurs at the hanger location, a resilient support shall be used. Spring Cushion Hangers may be used where vertical movement does not exceed 1/4".

M. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.

N. Riser Supports

1. On a riser subject to expansion, only one support of the rigid type shall be used.
2. Riser clamps shall have a positive means of engagement between the pipe and the clamp.
3. Vertical runs of piping not subject to appreciable expansion shall be supported by approved wrought steel clamps or collars, securely clamped to the risers. Where required, spring supports and guides shall be provided.

O. Anchors, Guides and Restraints: Anchors, guides and restraints shall be provided wherever necessary to support risers, to maintain pipe in position, and to properly distribute expansion.

P. Supplemental Framing: Supplemental framing, angles, channels or beams, shall be provided where the anchor locations do not align with the building structure or where the intended loads exceed the structural framing maximum load carrying capacity.

Q. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

R. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

S. Insulated Piping:

1. Attach clamps and spacers to piping.

    a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
    b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
    c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

    a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
    b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
    c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
    d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
    e. NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.

5. Pipes NPS 8 (DN 200) and Larger: Include reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

T. Plastic Pipe Hanger Installation:

1. Rigid plastic piping shall normally be supported by the same type of hangers used with steel pipe. In pressure application, hangers shall be provided with pads or cushions on the bearing surfaces.
2. Flexible plastic tubing shall be supported continuously by metal angles or channels with special hangers.

U. Polypropylene Pipe Hanger Installation: Support continuously between its hangers in either angle iron or sheet metal angles.

V. Fiberglass Pipe Hanger Installation: Comply with applicable portions of MSS SP-69 and MSS SP-89. Install hangers and attachments as required to properly support piping from building structure.

W. Glass Piping Hanger Installation:

1. Hangers shall be provided with pads or cushions on the bearing surfaces. Supports shall be as recommended by the pipe manufacturer.
2. Hangers shall be placed approximately one foot from each side of fittings or couplings. At least two hangers shall be used for each 10-foot section.

3.2 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (40 mm).

3.4 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports and metal framing systems and attachments for general service applications.

F. Use stainless-steel pipe hangers and stainless-steel or corrosion-resistant attachments for hostile environment applications.

G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

H. Use padded hangers for piping that is subject to scratching.

I. Use thermal-hanger shield inserts for insulated piping and tubing.

J. Use of "C" clamps and beam clamps of "C" pattern and any modifications thereof is prohibited.

K. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
2. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
3. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
4. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
5. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30 (DN 25 to DN 750), from two rods if longitudinal movement caused by expansion and contraction might occur.
6. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24 (DN 65 to DN 600), from single rod if horizontal movement caused by expansion and contraction might occur.
7. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 (DN 50 to DN 1050) if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
8. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 (DN 50 to DN 600) if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
9. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 (DN 50 to DN 750) if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

L. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24 (DN 24 to DN 600).
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) if longer ends are required for riser clamps.

M. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
2. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.

N. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.

2. Use of "C" clamps and beam clamps of "C" pattern and any modifications thereof is prohibited.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles. Use only when it is not possible to use center loading beam clamps. Subject to prior approval by the A/E.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
6. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
7. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.

O. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

P. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches (32 mm).
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

    a. Horizontal (MSS Type 54): Mounted horizontally.
    b. Vertical (MSS Type 55): Mounted vertically.
    c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

Q. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

R. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

S. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

T. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 220529

SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

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. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Stencils.
5. Valve tags.
6. Warning tags.

1.3 ACTION SUBMITTALS

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

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve numbering scheme.

E. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following:

1. Emed.
2. Marking Services Inc.
3. Seton Name Plate Co.

2.2 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: Brass, 0.032-inch (0.8-mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
3. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
4. Fasteners: Stainless-steel rivets or self-tapping screws.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) thick, and having predrilled holes for attachment hardware.
2. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
3. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
4. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
5. Fasteners: Stainless-steel rivets or self-tapping screws.
6. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number.

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch (A4) bond paper. Tabulate equipment identification number. Equipment schedule shall be included in operation and maintenance data.

2.3 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) thick, and having predrilled holes for attachment hardware.

B. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).

C. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).

D. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

E. Fasteners: Stainless-steel rivets or self-tapping screws.

F. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

G. Label Content: Include caution and warning information, plus emergency notification instructions.

2.4 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches (38 mm) high.

2.5 STENCILS

A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; and minimum letter height of 3/4 inch (19 mm) for access panel and door labels, equipment labels, and similar operational instructions.

2.6 VALVE TAGS

A. Valve Tags: 1-1/2" diameter round with 3/16" top hole, stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) numbers.

1. Tag Material: Brass, 0.032-inch (0.8-mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: #16 solid brass jack chain.
3. No painted tags will be accepted.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

C. Number sequences shall be from 1 thru 999 with top line legends as follow:

1. Domestic Cold Water CW
2. Domestic Hot Water HW
3. Domestic Hot Water Return HWR
4. Compressed Air A
5. Natural Gas GAS
6. Vacuum VAC
7. Reverse Osmosis Water RO
8. Deionized Water DI

2.7 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: 3 by 5-1/4 inches (75 by 133 mm) minimum.
2. Fasteners: Brass grommet and wire.
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment including the following:

1. Motor Driven Equipment
2. Starters and Disconnect Switches
3. Control Devices

B. Locate equipment labels where accessible and visible.

C. Location signs shall be provided for safety showers, eyewash stations, and emergency gas shutoff

3.3 PIPE LABEL INSTALLATION

A. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels with painted, color-coded bands or rectangles, complying with ASME A13.1, on each piping system.

B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
7. Spaced at maximum intervals of 50 feet (15 m) along each run. Reduce intervals to 25 feet (7.6 m) in areas of congested piping and equipment.

C. Pipe Label Legends:

1. General Services

a. Compressed Air – Control
b. Compressed Air – Laboratory
c. Deionized Water Supply
d. Deionized Water Return
e. Domestic Cold Water
f. Domestic Hot Water Supply
g. Domestic Hot Water Return
h. Process Water
i. Natural Gas
j. Reverse Osmosis Water Supply
k. Reverse Osmosis Water Return
l. Sanitary Waste
m. Storm - Primary
n. Storm - Overflow
o. Vacuum – Cleaning
p. Vacuum – Laboratory
q. Vent

2. Special Services

a. Oxygen, nitrogen, nitrous oxide, etc.
b. Chemical Waste.

3.4 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. All valves and regulators (except those directly serving equipment) shall be provided with a brass tag securely wired in place on the valve stem below the packing gland nut. Tags shall clearly indicate the part of system, or room name and/or number controlled by the valve.

C. Furnish four (4) hot-press laminated typewritten copies of valve schedule, giving valve number controlled by the valve and location of valve. One copy will be mounted on a directory board in the main mechanical room, and one copy will be placed in each of the three mechanical brochures.

D. Prepare separate directories and drawings for the plumbing, heating, and air conditioning systems showing system layout as installed, and giving the number, location, and purpose of each component. The Contractor shall contact the A/E before starting the directory to insure proper tagging and listing.

E. Where it is necessary to operate more than one valve to control a section of piping, this fact and the numbers of the secondary valves shall be noted on the directory.

3.5 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 220553

SECTION 220700 - PLUMBING INSULATION

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. Insulation Materials:

    a. Calcium silicate.
    b. Cellular glass.
    c. Flexible elastomeric.
    d. Mineral fiber.
    e. Polyolefin.

2. Insulating cements.
3. Adhesives.
4. Mastics.
5. Lagging adhesives.
6. Sealants.
7. Factory-applied jackets.
8. Field-applied fabric-reinforcing mesh.
9. Field-applied cloths.
10. Field-applied jackets.
11. Tapes.
12. Securements.
13. Corner angles.

B. Related Sections include the following:

1. Division 21 Section "Fire-Suppression Systems Insulation."
2. Division 23 Section "HVAC Insulation."

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).

B. Shop Drawings:

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties, equipment connections, and access panels.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.
8. Detail field application for each equipment type.

C. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

D. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application and equipment Installer for equipment insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Calcium Silicate:

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

a. Industrial Insulation Group (The); Thermo-12 Gold.

2. Preformed Pipe Sections: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
3. Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
4. Prefabricated Fitting Covers: Comply with ASTM C 450 and ASTM C 585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

G. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

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

    a. Aeroflex USA Inc.; Aerocel.
    b. Armacell LLC; AP Armaflex.

H. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

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

    a. CertainTeed Corp.; Duct Wrap.
    b. Johns Manville; Microlite.
    c. Knauf Insulation; Duct Wrap.
    d. Owens Corning; All-Service Duct Wrap.

I. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For equipment applications, provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

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

    a. CertainTeed Corp.; Commercial Board.
    b. Johns Manville; 800 Series Spin-Glas.
    c. Knauf Insulation; Insulation Board.
    d. Owens Corning; Fiberglas 700 Series.

J. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ jacket complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. (40 kg/cu. m) or more. Thermal conductivity (k-value) at 100 deg F (55 deg C) is 0.29 Btu x in./h x sq. ft. x deg F (0.042 W/m x K) or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

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

    a. CertainTeed Corp.; CrimpWrap.

b. Johns Manville; MicroFlex.
c. Knauf Insulation; Pipe and Tank Insulation.
d. Owens Corning; Fiberglas Pipe and Tank Insulation.

K. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.

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

a. Armacell LLC; Tubolit.
b. Nomaco Inc.; IMCOLOCK, IMCOSHEET, NOMALOCK, and NOMAPLY.

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.

C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F (10 to 427 deg C).

C. Cellular-Glass, Phenolic, Polyisocyanurate, and Polystyrene Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F (minus 59 to plus 149 deg C).

D. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

E. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

F. Polystyrene Adhesive: Solvent- or water-based, synthetic resin adhesive with a service temperature range of minus 20 to plus 140 deg F (29 to plus 60 deg C).

G. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

H. PVC Jacket Adhesive: Compatible with PVC jacket.

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.

2.5 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.

2.6 SEALANTS

A. Joint Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Permanently flexible, elastomeric sealant.
3. Service Temperature Range: Minus 100 to plus 300 deg F (Minus 73 to plus 149 deg C).
4. Color: White or gray.

B. FSK and Metal Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
4. Color: Aluminum.

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
4. Color: White.

2.7 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.8 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

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

a. Johns Manville; Zeston.

2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White.
4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

5. Factory-fabricated tank heads and tank side panels.

C. Metal Jacket:

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

a. Childers Products, Division of ITW; Metal Jacketing Systems.

2. Aluminum Jacket: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105 or 5005, Temper H-14.

a. Finish and thickness are indicated in field-applied jacket schedules.
b. Moisture Barrier for Indoor Applications: 1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper.
c. Moisture Barrier for Outdoor Applications: 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper.
d. Factory-Fabricated Fitting Covers:

1) Same material, finish, and thickness as jacket.
2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
3) Tee covers.
4) Flange and union covers.
5) End caps.
6) Beveled collars.
7) Valve covers.
8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

3. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.

    a. Material, finish, and thickness are indicated in field-applied jacket schedules.
    b. Moisture Barrier for Indoor Applications: 1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper.
    c. Moisture Barrier for Outdoor Applications: 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper.
    d. Factory-Fabricated Fitting Covers:

        1) Same material, finish, and thickness as jacket.
        2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
        3) Tee covers.
        4) Flange and union covers.
        5) End caps.
        6) Beveled collars.
        7) Valve covers.
        8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.9 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

2.10 SECUREMENTS

A. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch (38-mm) galvanized carbon-steel washer.

3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.

4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.

5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.

6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm) thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.

7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.

C. Wire: 0.080-inch (2.0-mm) nickel-copper alloy or 0.062-inch (1.6-mm) soft-annealed, stainless steel.

2.11 CORNER ANGLES

A. PVC Corner Angles: 30 mils (0.8 mm) thick, minimum 1 by 1 inch (25 by 25 mm), PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040 inch (1.0 mm) thick, minimum 1 by 1 inch (25 by 25 mm), aluminum according to ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105 or 5005; Temper H-14.

C. Stainless-Steel Corner Angles: 0.024 inch (0.61 mm) thick, minimum 1 by 1 inch (25 by 25 mm), stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304 or 316.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

1. Verify that systems and equipment to be insulated have been tested and are free of defects.

2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment and pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches (50 mm) o.c.

    a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches (50 mm) below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Division 07 Section "Penetration Firestopping"irestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.

2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches (50 mm) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch (50-mm) overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch- (1.6-mm-) thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch (38-mm) laps at longitudinal seams and 3-inch- (75-mm-) wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches (300 mm) o.c. and at end joints.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
2. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.8 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Vertical portions of the storm and sanitary drains.
2. Chemical waste.
3. Drainage piping located in crawl spaces.
4. Underground piping.
5. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

C. PVC jackets shall be installed on insulated piping in conjunction with fitting covers to provide a total sealed system as required by USDA and FDA for applications in food and pharmaceutical facilities.

D. Insulate cold pipes conveying fluids below ambient temperature with vapor retardant jackets with self sealing laps.

1. Domestic cold water.
2. Horizontal portions of the storm and sanitary drain.
3. Chilled water.
4. Condensate drain.
5. Refrigerant suction.

3.9 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water:

1. All pipe sizes: Insulation shall be one of the following:

a. Flexible Elastomeric: 1 inch (25 mm) thick.
b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.
c. Polyolefin: 1 inch (25 mm) thick.

B. Domestic Hot and Recirculated Hot Water:

1. NPS 1-1/4 (DN 32) and Smaller: Insulation shall be one of the following:

a. Flexible Elastomeric: 1 inch (19 mm) thick.
b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (13 mm) thick.
c. Polyolefin: 1 inch (19 mm) thick.

2. NPS 1-1/2 (DN 40) and Larger: Insulation shall be one of the following:

a. Flexible Elastomeric: 1.5 inch (25 mm) thick.
b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1.5 inch (25 mm) thick.
c. Polyolefin: 1.5 inch (25 mm) thick.

C. Exposed or concealed sanitary drains prone to condensation:

1. All Pipe Sizes: Insulation shall be one of the following:

a. Flexible Elastomeric: 1 inch (13 mm) thick.
b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (13 mm) thick.

3.10 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. Equipment, Concealed:

1. None.

C. Equipment, Exposed:

1. None.

D. Piping, Concealed:

1. None.

E. Piping exposed in mechanical equipment rooms or in finished spaces below 10' above finished floor:

1. PVC: 20 mils (0.5 mm) thick.
2. Aluminum, Smooth: 0.016 inch (0.41 mm) thick.

END OF SECTION 220700

SECTION 221116 - DOMESTIC WATER PIPING

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. Under-building-slab and aboveground domestic water pipes, tubes, and fittings inside buildings.
2. Encasement for piping.

B. Related Section:

1. Division 22 Section "Facility Water Distribution Piping" for water-service piping outside the building from source to the point where water-service piping enters the building.

1.3 ACTION SUBMITTALS

A. Product Data: For transition fittings and dielectric fittings.

1.4 INFORMATIONAL SUBMITTALS

A. System purging and disinfecting activities report.

B. Field quality-control reports.

1.5 FIELD CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:

1. Notify Construction Representative no fewer than seven days in advance of proposed interruption of water service.
2. Do not proceed with interruption of water service without Construction Representative's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

B. Potable-water piping and components shall comply with NSF 14 and NSF 61. Plastic piping components shall be marked with "NSF-pw."

C. Piping materials shall bear label, stamp, or other markings of specified testing agency.

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B) water tube, drawn temper.

B. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

C. Appurtenances for Grooved-End Copper Tubing:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Anvil International.
b. Grinnell Mechanical Products.
c. Shurjoint Piping Products.
d. Victaulic Company.

2. Bronze Fittings for Grooved-End, Copper Tubing: ASTM B 75 (ASTM B 75M) copper tube or ASTM B 584 bronze castings.

3. Mechanical Couplings for Grooved-End Copper Tubing:

a. Copper-tube dimensions and design similar to AWWA C606.
b. Ferrous housing sections.
c. EPDM-rubber gaskets suitable for hot and cold water.
d. Bolts and nuts.
e. Minimum Pressure Rating: 300 psig (2070 kPa).

2.3 PIPING JOINING MATERIALS

A. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

2.4 ENCASEMENT FOR PIPING

A. Standard: ASTM A 674 or AWWA C105/A21.5.

B. Form: Sheet.

C. Color: Black or natural.

2.5 TRANSITION FITTINGS

A. General Requirements:

1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

2.6 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.

1. Manufacturers:

a. Central Plastics Company.
b. Watts Industries, Inc.; Water Products Div.
c. Zurn Industries, Inc.; Wilkins Div.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

1. Manufacturers:

a. Central Plastics Company.
b. Watts Industries, Inc.; Water Products Div.

E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

1. Manufacturers:

a. Lochinvar Corp.

F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

1. Manufacturers:

a. Perfection Corp.; Clearflow Dielectric Waterway.
b. Precision Plumbing Products, Inc.
c. Sioux Chief Manufacturing Co., Inc.
d. Victaulic Co. of America.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Refer to Division 22 Section “Common Work Results for Plumbing” for basic installation requirements.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install eccentric reducing couplings, flush on the top for water lines, where air or water pockets would otherwise occur due to a reduction in pipe size.

D. Cap and plug all openings in pipes with suitable metal plugs or cap to keep out dirt and rubbish during construction until equipment is connected.

E. Install domestic water piping level without pitch and plumb.

F. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages and Division 22 Section "Domestic Water Piping Specialties" for drain valves and strainers.

G. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

H. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.

I. Install underground copper tube and ductile-iron pipe in PE encasement according to ASTM A 674 or AWWA C105/A21.5.

J. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment. Use ball for piping NPS 6 and smaller. Use butterfly valves for piping NPS 8 and larger.

K. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping. Drain valves are specified in Division 22 Section "Domestic Water Piping Specialties."

L. Install calibrated balancing valves in each hot-water circulation return branch and discharge side of each pump and circulator. Set calibrated balancing valves partly open to restrict but not stop flow. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for calibrated balancing valves.

3.2 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

E. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

F. Joint Construction for Grooved-End Copper Tubing: Make joints according to AWWA C606. Roll groove ends of tubes. Lubricate and install gasket over ends of tubes or tube and fitting. Install coupling housing sections over gasket with keys seated in tubing grooves. Install and tighten housing bolts.

G. Joint Construction for Grooved-End, Ductile-Iron Piping: Make joints according to AWWA C606. Cut round-bottom grooves in ends of pipe at gasket-seat dimension required for specified (flexible or rigid) joint. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.

H. Joint Construction for Grooved-End Steel Piping: Make joints according to AWWA C606. Roll groove ends of pipe as specified. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.

I. Flanged Joints: Select appropriate asbestos-free gasket material, size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

J. Joint Construction for Solvent-Cemented Plastic Piping: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
3. PVC Piping: Join according to ASTM D 2855.

K. Joints for PEX Piping: Join according to ASTM F 1807.

L. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.3 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

3.4 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

1. NPS 2 (DN 50) and Smaller: Use dielectric couplings or nipples.
2. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric nipples.
3. NPS 5 (DN 125) and Larger: Use dielectric flange kits.

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.

1. Vertical Piping: MSS Type 8 or 42, riser clamps.
2. Individual, Straight, Horizontal Piping Runs:

    a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support vertical piping and tubing at base and at each floor.

C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch (10 mm).

D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 3/4 (DN 20) and Smaller: 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
2. NPS 1 and NPS 1-1/4 (DN 25 and DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
3. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
4. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.
5. NPS 3 to NPS 5 (DN 80 to DN 125): 10 feet (3 m) with 1/2-inch (13-mm) rod.
6. NPS 6 (DN 150): 10 feet (3 m) with 5/8-inch (16-mm) rod.
7. NPS 8 (DN 200): 10 feet (3 m) with 3/4-inch (19-mm) rod.

E. Install supports for vertical copper tubing every 10 feet (3 m).

F. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4 (DN 32) and Smaller: 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
2. NPS 1-1/2 (DN 40): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
3. NPS 2 (DN 50): 10 feet (3 m) with 3/8-inch (10-mm) rod.
4. NPS 2-1/2 (DN 65): 11 feet (3.4 m) with 1/2-inch (13-mm) rod.
5. NPS 3 and NPS 3-1/2 (DN 80 and DN 90): 12 feet (3.7 m) with 1/2-inch (13-mm) rod.
6. NPS 4 and NPS 5 (DN 100 and DN 125): 12 feet (3.7 m) with 5/8-inch (16-mm) rod.
7. NPS 6 (DN 150): 12 feet (3.7 m) with 3/4-inch (19-mm) rod.
8. NPS 8 to NPS 12 (DN 200 to DN 300): 12 feet (3.7 m) with 7/8-inch (22-mm) rod.

G. Install supports for vertical steel piping every 15 feet (4.5 m).

H. Install hangers for cast iron piping with the following horizontal spacing:

1. 10 feet maximum.
2. Minimum of one hanger per pipe section close to joint on the barrel. Also at change of direction and branch connections.

I. Install hangers for ductile iron piping with the following horizontal spacing:

1. 10 feet maximum.
2. Minimum of one hanger per pipe section close to the joint behind the bell and at change of direction and branch connections.

J. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment and machines to allow service and maintenance.

C. Pipe sizes indicated shall be carried full size to equipment served. Any change of size to match equipment connection shall be made within one foot of the equipment. At temperature control valves with sizes smaller than connected lines, reduction shall be made immediately adjacent to valves.

D. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

E. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
3. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Comply with requirements in Division 22 plumbing fixture Sections for connection sizes.
4. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 (DN 65) and larger.

3.7 IDENTIFICATION

A. Identify system components. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment" for identification materials and installation.

B. Label pressure piping with system operating pressure.

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Piping Inspections:

1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.

2. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

    a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
    b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

3. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

C. Piping Tests:

1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
4. Cap and subject piping to static water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow standing for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
6. Prepare reports for tests and for corrective action required.

D. Domestic water piping will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.9 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

    a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.

b. Adjust calibrated balancing valves to flows indicated.

5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.10 CLEANING

A. All piping shall be cleaned before the installation, and flushed after the installation and before system startup.

B. Equipment, detergents, solvents and other cleaning agents shall be furnished by a qualified water treatment services.

C. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
b. Fill and isolate system according to either of the following:

1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.

c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
d. Repeat procedures if biological examination shows contamination.
e. Submit water samples in sterile bottles to authorities having jurisdiction.

D. Clean non-potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.

2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:

    a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

E. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

F. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.11 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Fitting Option: Brazed joints may be used on aboveground copper tubing. Extruded-tee connections are prohibited.

D. Aboveground domestic water piping, NPS 2 (DN 50) and smaller, shall be the following:

1. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); wrought- copper solder-joint fittings; and soldered joints.

3.12 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Shutoff Duty: Use ball valves for piping NPS 6 and smaller. Use butterfly valves with flanged ends for piping NPS 8 and larger.
2. Throttling Duty: Use ball or globe valves for piping NPS 2 (DN 50) and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.
3. Hot-Water Circulation Piping, Balancing Duty: Calibrated balancing valves.
4. Drain Duty: Hose-end drain valves.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

C. Iron grooved-end valves may be used with grooved-end piping.

END OF SECTION 221116

SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES

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 domestic water piping specialties:

1. Vacuum breakers.
2. Temperature-actuated water mixing valves.

B. Related Sections include the following:

1. Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers, pressure gages, and flow meters in domestic water piping.
2. Division 22 Section "Domestic Water Piping" for water meters.
3. Division 22 Section "Domestic Water Filtration Equipment" for water filters in domestic water piping.
4. Division 22 Section "Emergency Plumbing Fixtures" for water tempering equipment.
5. Division 22 Section "Drinking Fountains and Water Coolers" for water filters for water coolers.

1.3 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

1.4 ACTION SUBMITTALS

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

1.5 INFORMATION SUBMITTALS

A. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

A. Potable-water piping and components shall comply with NSF 61 and NSF 14. Mark "NSF-pw" on plastic piping components.

2.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig (860 kPa) unless otherwise indicated.

2.3 VACUUM BREAKERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ames Co.
2. Apollo Valves by Conbraco Industries, Inc.
3. Conbraco Industries, Inc.
4. FEBCO; SPX Valves & Controls.
5. Sioux Chief.
6. Watts Industries, Inc.; Water Products Div.
7. Woodford Manufacturing Company.
8. Zurn Plumbing Products Group; Wilkins Div.

B. Pipe-Applied, Atmospheric-Type Vacuum Breakers:

1. Standard: ASSE 1001.
2. Body: Bronze.
3. Inlet and Outlet Connections: Threaded.
4. Finish: Rough bronze.

C. Hose-Connection Vacuum Breakers:

1. Standard: ASSE 1011
2. Body: Brass, nonremovable, with automatic drain.
3. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
4. Finish: Rough bronze.

D. Pressure Vacuum Breakers:

1. Standard: ASSE 1020.
2. Operation: Continuous-pressure applications.
3. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.
4. Accessories: Ball valves, on inlet and outlet.

E. Laboratory-Faucet Vacuum Breakers:

1. Standard: ASSE 1035.
2. Body: Bronze.
3. End Connections: Threaded.
4. Finish: Chrome plated.

F. Spill-Resistant Vacuum Breakers:

1. Standard: ASSE 1056.
2. Operation: Continuous-pressure applications.
3. Accessories: Ball valves, on inlet and outlet.

2.4 TEMPERATURE-ACTUATED WATER MIXING VALVES

A. Primary, Thermostatic, Water Mixing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Armstrong International, Inc.
   b. Leonard Valve Company.
   c. Powers; a Watts Industries Co.
   d. Symmons Industries, Inc.
   e. Apollo Valves by Conbraco Industries, Inc.

2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig.
4. Type: Cabinet-type as indicated, thermostatically controlled water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded union inlets and outlet.
7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Valve Pressure Rating: 125 psig minimum, unless otherwise indicated.
9. Valve Finish: Rough bronze.
10. Piping Finish: Copper.
11. Cabinet: Factory-fabricated, stainless steel, for surface mounting and with hinged, stainless-steel door.

B. Individual-Fixture, Water Tempering Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Apollo Valves by Conbraco Industries, Inc.
b. Leonard Valve Company.
c. Powers; a Watts Industries Co.; Hydroguard Series e480.
d. Symmons.
e. Apollo Valves by Conbraco Industries, Inc.

2. Standard: ASSE 1016/1070, thermostatically controlled water tempering valve.
3. Pressure Rating: 125 psig minimum, unless otherwise indicated.
4. Body: Solid brass construction with corrosion-resistant interior components.
5. Temperature Control: Adjustable temperature selection with locknut to prevent tampering.
6. Inlets and Outlet: Threaded. Integral checks on inlets.

2.5 SPECIALTY VALVES

A. Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for general-duty metal valves.

2.6 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Flex-Hose Co., Inc.
2. Metraflex, Inc.

B. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.

1. Working-Pressure Rating: Minimum 250 psig (1725 kPa).
2. End Connections NPS 2 (DN 50) and Smaller: Threaded copper pipe or plain-end copper tube.
3. End Connections NPS 2-1/2 (DN 65) and Larger: Flanged copper alloy.

C. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.

1. Working-Pressure Rating: Minimum 250 psig (1725 kPa).
2. End Connections NPS 2 (DN 50) and Smaller: Threaded steel-pipe nipple.
3. End Connections NPS 2-1/2 (DN 65) and Larger: Flanged steel nipple.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.

1. Install in an accessible location to facilitate testing and servicing with the height between 12” and 60” above the floor or grade unless instructed otherwise by applicable code.
2. Locate backflow preventers in same room as connected equipment or system.
3. Install backflow preventers with an air gap drain cup provided by same manufacturer, located under the pressure differential section, and piped full size of the air gap to the nearest floor drain.
4. Do not install bypass piping around backflow preventers.

C. Install vacuum breakers on all outlets where hoses can be attached, such as laboratory faucets, service sinks, wall hydrant, etc.

D. Install temperature-actuated water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.

1. Install thermometers and water regulators if specified.
2. Install cabinet-type units recessed in or surface mounted on wall as specified.

E. Install Y-pattern strainers for water on supply side of each control valve, water pressure-reducing valve, solenoid valve, and pump.

F. Install water hammer arresters in water piping according to PDI-WH 201. Water hammer arresters, where concealed, shall be accessible by means of access doors/panels.

G. Install air vents at high points of water piping.

H. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.

I. Install drainage-type, trap-seal primer valves as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.

J. Install trap-seal primer systems with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

K. Install trap primers in accessible locations. Do not install trap primers in ceilings.

L. Install temperature and pressure relief valves in the shell of each domestic hot water generators, and as indicated on the drawings. Pipe the discharge connection from each valve to the drainage system through an open drain.

M. Install integral spring check on all two-handle faucets where hoses can be attached.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties.

3.3 FLEXIBLE CONNECTOR INSTALLATION

A. Install flexible connectors in suction and discharge piping connections to each domestic water pump and in suction and discharge manifold connections to each domestic water booster pump.

B. Install bronze-hose flexible connectors in copper domestic water tubing.

C. Install stainless-steel-hose flexible connectors in steel domestic water piping.

3.4 WATER METER INSTALLATION

A. Install water meters according to AWWA M6.

B. Provide water sample test ports in conjunction with installation of water meters in both new constructions and renovations. Exact locations will be determined by MSU T.B. Simon Power Plant through MSU PDC Construction Representative.

C. Install turbine-type water meters with shutoff valve on water-meter inlet. Install valve on water-meter outlet and valved bypass around meter unless prohibited by authorities having jurisdiction.

3.5 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1. Pressure vacuum breakers.
2. Reduced-pressure-principle backflow preventers.
3. Carbonated-beverage-machine backflow preventers.
4. Reduced-pressure-detector, fire-protection backflow-preventer assemblies.
5. Water pressure-reducing valves.
6. Calibrated balancing valves.
7. Primary, thermostatic, water mixing valves.

8. Supply-type, trap-seal primer valves.
9. Trap-seal primer systems.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.6 FIELD QUALITY CONTROL

A. Perform the following tests and prepare test reports:

1. Test each pressure vacuum breaker and reduced-pressure-principle backflow preventer according to authorities having jurisdiction and the device's reference standard.

B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.7 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.

B. Set field-adjustable flow set points of balancing valves.

C. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

END OF SECTION 221119

SECTION 221316 - SANITARY WASTE AND VENT PIPING

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 for soil, waste, and vent piping inside the building:

1. Pipe, tube, and fittings.
2. Specialty pipe fittings.

B. Related Sections include the following:

1. Division 22 Section "Sanitary Sewerage Pumps."
2. Division 22 Section "Facility Sanitary Sewers."
3. Division 22 Section "Chemical Waste-Systems for Laboratory and Healthcare Facilities" for chemical-waste and vent piping systems.

1.3 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:

1. Soil, Waste, and Vent Piping: 10-foot head of water.

1.4 ACTION SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.

B. LEED Submittal:

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 PIPING MATERIALS

A. Comply with requirements in "Piping Applications" Article for applications of pipe, tube, fitting, and joining methods for specific services, service locations, and pipe sizes.

2.3 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. Heavy-Duty, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

a. ANACO-Husky; Series 4000.
b. Clamp-All Corp.

2. Standards: ASTM C 1277 and ASTM C 1540.
3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.4 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

B. PVC Socket Fittings: ASTM D 2665, socket type, made to ASTM D 3311, drain, waste, and vent patterns.

C. Adhesive Primer: ASTM F 656.

D. Solvent Cement: ASTM D 2564.

2.5 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Sanitary sewer piping outside the building is specified in Division 22 Section "Facility Sanitary Sewers."

B. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."

C. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.

D. Install cleanout fitting with closure plug inside the building in sanitary force-main piping.

E. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 22 Section "Common Work Results for Plumbing."

F. Install wall-penetration fitting at each service pipe penetration through foundation wall. Make installation watertight.

G. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

H. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of cast iron increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

I. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:

1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

J. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

K. Install PVC soil and waste drainage and vent piping according to ASTM D 2665.

L. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.2 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."

B. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.

C. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.3 VALVE INSTALLATION

A. General valve installation requirements are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

B. Backwater Valves: Install backwater valves in piping subject to sewage backflow.

1. Horizontal Piping: Horizontal backwater valves. Use normally closed type, unless otherwise indicated.
2. Floor Drains: Drain outlet backwater valves, unless drain has integral backwater valve.
3. Install backwater valves in accessible locations.
4. Backwater valve are specified in Division 22 Section "Sanitary Waste Piping Specialties."

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger and support devices and installation specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

1. Vertical Piping: MSS Type 8 or Type 42, clamps.
2. Install individual, straight, horizontal piping runs:

    a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
    c. Longer than 100 Feet (30 m), if Indicated: MSS Type 49, spring cushion rolls.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support horizontal piping and tubing within 12 inches (300 mm) of each fitting, valve, and coupling.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch (10 mm) minimum rods.

E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
2. NPS 3 (DN 80): 60 inches (1500 mm) with 1/2-inch (13-mm) rod.
3. NPS 4 and NPS 5 (DN 100 and DN 125): 60 inches (1500 mm) with 5/8-inch (16-mm) rod.
4. NPS 6 (DN 150): 60 inches (1500 mm) with 3/4-inch (19-mm) rod.
5. NPS 8 to NPS 12 (DN 200 to DN 300): 60 inches (1500 mm) with 7/8-inch (22-mm) rod.

F. Install supports for vertical cast-iron soil piping every 15 feet (4.5 m).

G. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 48 inches (1200 mm) with 3/8-inch (10-mm) rod.
2. NPS 3 (DN 80): 48 inches (1200 mm) with 1/2-inch (13-mm) rod.
3. NPS 4 and 5 (DN 100 and 125): 48 inches (1200 mm) with 5/8-inch (16-mm) rod.
4. NPS 6 (DN 150): 48 inches (1200 mm) with 3/4-inch (19-mm) rod.
5. NPS 8 to NPS 12 (DN 200 to DN 300): 48 inches (1200 mm) with 7/8-inch (22-mm) rod.

H. Install supports for vertical PVC piping every 48 inches (1200 mm).

I. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.5 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:

1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Install horizontal backwater valves with cleanout cover flush with floor.
5. Comply with requirements for backwater valves cleanouts and drains specified in Division 22 Section "Sanitary Waste Piping Specialties."
6. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 (DN 65) and larger.

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

3.6 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.7 FIELD QUALITY CONTROL

A. Drainage system shall be inspected and tested in accordance with State of Michigan Plumbing Code.

B. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.

2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

C. Re-inspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for re-inspection.

D. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

E. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot (30 kPa) head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg (250 Pa). Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

3.8 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.9 PIPING SCHEDULE

A. Aboveground, soil and waste piping shall be any of the following:

1. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel couplings; and hubless-coupling joints.
2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

B. Aboveground, vent piping shall be any of the following:

1. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel couplings; and hubless-coupling joints.
2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

END OF SECTION 221316

SECTION 224000 - PLUMBING FIXTURES

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. Faucets

B. Related Sections include the following:

1. Division 22 Section "Emergency Plumbing Fixtures."
2. Division 22 Section "Drinking Fountains and Water Coolers."

1.3 DEFINITIONS

A. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.

B. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.

C. Solid Surface: Nonporous, homogeneous, cast-polymer-plastic material with heat-, impact-, scratch-, and stain-resistance qualities.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For flushometer valves and electronic sensors to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"[**; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act";**] for plumbing fixtures for people with disabilities.

B. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.

C. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

D. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

E. Comply with the following applicable standards and other requirements specified for plumbing fixtures:

1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
2. Vitreous-China Fixtures: ASME A112.19.2M.
3. Water-Closet, Flushometer Tank Trim: ASSE 1037.

F. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:

1. Faucets: ASME A112.18.1.
2. Hose-Connection Vacuum Breakers: ASSE 1011.
3. Hose-Coupling Threads: ASME B1.20.7.
4. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
5. NSF Potable-Water Materials: NSF 61.
6. Pipe Threads: ASME B1.20.1.
7. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
8. Supply Fittings: ASME A112.18.1.
9. Brass Waste Fittings: ASME A112.18.2.

G. Comply with the following applicable standards and other requirements specified for bathtub bathtub/shower and shower faucets:

1. Backflow Protection Devices for Hand-Held Showers: ASME A112.18.3M.
2. Combination, Pressure-Equalizing and Thermostatic-Control Antiscald Faucets: ASSE 1016.
3. Faucets: ASME A112.18.1.

4. Hand-Held Showers: ASSE 1014.
5. High-Temperature-Limit Controls for Thermal-Shock-Preventing Devices: ASTM F 445.
6. Hose-Coupling Threads: ASME B1.20.7.
7. Manual-Control Antiscald Faucets: ASTM F 444.
8. Pipe Threads: ASME B1.20.1.
9. Pressure-Equalizing-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.
10. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
11. Thermostatic-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.

H. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:

1. Atmospheric Vacuum Breakers: ASSE 1001.
2. Brass and Copper Supplies: ASME A112.18.1.
3. Manual-Operation Flushometers: ASSE 1037.
4. Brass Waste Fittings: ASME A112.18.2.
5. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.

I. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Flexible Water Connectors: ASME A112.18.6.
2. Hose-Coupling Threads: ASME B1.20.7.
3. Off-Floor Fixture Supports: ASME A112.6.1M.
4. Pipe Threads: ASME B1.20.1.
5. Plastic Toilet Seats: ANSI Z124.5.
6. Supply and Drain Protective Shielding Guards: ICC A117.1.

PART 2 - PRODUCTS

2.1 GENERAL

A. The earthenware of all fixtures must be unmarked, true and level. Vitreous ware shall be warranted not to craze, discolor or scale.

B. All faucets and exposed traps, fittings, trim, connections, etc., for fixtures, shall be of polished chromium plated brass unless specified otherwise.

2.2 LABORATORY FAUCETS

A. Laboratory cold and hot water faucets shall be deck mounted, chromium plated brass mixing faucets. Faucets shall have a rigid gooseneck spout with integral, non-removable vacuum breaker, and serrated nozzle. Handles shall have colored plastic inserts:

1. Cold Water: Dark Green
2. Hot Water: Red

B. Laboratory pure water faucets shall be deck mounted, chromium plated brass, with tin lining and self-closing valves. Faucets shall have a rigid gooseneck spout and serrated nozzle. Handles shall have colored plastic inserts labeled "pure water."

C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Chicago Faucets Model No. 930 (hot & cold water) or Model 969 (pure water),
2. Barnstead.
3. Wolverine Brass.
4. T & S Brass.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.

B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.

B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.

1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.

C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.

D. Install wall-mounting fixtures with tubular waste piping attached to supports.

E. Install counter-mounting fixtures in and attached to casework.

F. Install fixtures level and plumb according to roughing-in drawings.

G. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

1. Exception: Use ball valves if supply stops are not specified with fixture. Valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

H. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

I. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.

J. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.

K. Install tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.

L. Install toilet seats on water closets.

M. Install trap-seal liquid in dry urinals.

N. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

O. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.

P. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

Q. Install shower flow-control fittings with specified maximum flow rates in shower arms.

R. Install traps on fixture outlets.

1. Exception: Omit trap on fixtures with integral traps.
2. Exception: Omit trap on indirect wastes, unless otherwise indicated.

S. Install escutcheons at piping wall and ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."

T. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant unless indicated otherwise. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

U. Install fixtures complete with all supply, soil, waste and vent piping connections; together with all fittings, fastening devices, cocks, valves and appurtenances required to effect complete and serviceable installations.

V. Caulk all restroom fixtures wall and floor-mounted with latex caulk. Do not use silicone.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

1. Supply Risers: Formed metal nosepiece with insert or formed nosepiece with insert gasket by Brass Craft or approved equal. Rubber gasket type compression fitting is not acceptable.
2. Supply Stops: Brasscraft KT series ¼ turn ball stop, polished chrome-plated, stuffing box or loose-key, straight or angle style with compression or FIP inlet and compression outlet by Brass Craft or approved equal.

3.4 FIELD QUALITY CONTROL

A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.

B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

E. Install fresh batteries in sensor-operated mechanisms.

3.5 ADJUSTING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Adjust water pressure at faucets and flushometer valves to produce proper flow and stream.

C. Replace washers and seals of leaking and dripping faucets and stops.

D. Install fresh batteries in sensor-operated mechanisms.

3.6 CLEANING

A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:

1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
2. Remove sediment and debris from drains.

B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.7 PROTECTION

A. Provide protective covering for installed fixtures and fittings.

B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 224000

SECTION 224500 - EMERGENCY PLUMBING FIXTURES

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 emergency plumbing fixtures:

1. Eye/face wash equipment.
2. Water-tempering equipment.

B. Related Sections include the following:

1. Division 22 Section "Domestic Water Piping Specialties" for backflow preventers.
2. Division 22 Section "Sanitary Waste Piping Specialties" for floor drains.
3. Division 22 Section "Domestic Water Filtration Equipment" for water filters.

1.3 DEFINITIONS

A. Accessible Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.

B. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.

C. Tepid: Moderately warm.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include flow rates and capacities, furnished specialties, and accessories.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For emergency plumbing fixtures to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. ANSI Standard: Comply with ANSI Z358.1, "Emergency Eyewash and Shower Equipment."

B. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

C. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.

PART 2 - PRODUCTS

2.1 EYE/FACE WASH EQUIPMENT

A. Eye/Face Wash Equipment:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Haws Corporation.
b. Speakman Company.
c. WaterSaver Faucet Co.; FE750

2. Description: Wall mounted with two fine spray outlet heads, stainless steel receptor, and stay-open ball valve activated by epoxy coated cast aluminum flag handle. Each outlet head shall have including removable delrin spray cover, polyurethane filter, self-regulating flow control, and float-off dust cover. Aerated outlets will not be accepted. Include emergency sign.

2.2 WATER-TEMPERING EQUIPMENT

A. Hot- and Cold-Water, Water-Tempering Equipment:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Lawler Manufacturing Co., Inc.

b. Leonard Valve Company.
c. Powers, a Watts Industries Co.
d. Speakman Company.
e. Apollo Valves by Conbraco Industries, Inc.

2. Description: Factory-fabricated, hot- and cold-water-tempering equipment with thermostatic mixing valve.

a. Thermostatic Mixing Valve: Designed to provide 85 deg F tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus 5 deg F throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, controls, metal piping, and corrosion-resistant enclosure.
b. Supply Connections: For hot and cold water.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before plumbed emergency plumbing fixture installation. Review actual locations with MSU Environmental Health and Safety.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EMERGENCY PLUMBING FIXTURE INSTALLATION

A. Assemble emergency plumbing fixture piping, fittings, control valves, and other components.

B. Install fixtures level and plumb.

C. Fasten fixtures to substrate.

D. Install dielectric fitting in supply piping to fixture if piping and fixture connections are made of different metals. Dielectric fittings are specified in Division 22 Section "Domestic Water Piping."

E. Install thermometers in supply and outlet piping connections to water-tempering equipment. Thermometers are specified in Division 22 Section "Meters and Gages for Plumbing Piping."

F. Install indirect waste piping on drain outlet of emergency equipment receptors that are indicated to be indirectly connected to drainage system. Comply with requirements for waste piping specified in Division 22 Section "Sanitary Waste and Vent Piping."

G. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."

H. Emergency Eyewash / Drench Hose Units: Locate spray outlet heads no more than 12" horizontal distance from the edge of the countertop, between 33" and 45" vertical distance from the surface on which the user stands and at least 6" from the wall or the nearest obstruction.

I. Emergency Showers: Pull rod handle shall not be higher than 69" from the surface on which the user stands. Showerhead shall be between 82" and 96" from the surface on which the user stands.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect hot- and cold-water-supply piping to hot- and cold-water, water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures. Comply with requirements for hot- and cold-water piping specified in Division 22 Section "Domestic Water Piping."

C. Indirectly connect emergency plumbing fixture receptors without trapped drain outlet to sanitary or storm drainage piping.

D. Where installing piping adjacent to emergency plumbing fixtures, allow space for service and maintenance of fixtures.

3.4 IDENTIFICATION

A. Install equipment nameplates or equipment markers on emergency plumbing fixtures and equipment and equipment signs on water-tempering equipment. Comply with requirements for identification materials specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.5 FIELD QUALITY CONTROL

A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities and temperatures.

B. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

C. Prepare test and inspection reports.

3.6 ADJUSTING

A. Adjust or replace fixture flow regulators for proper flow.

B. Adjust equipment temperature settings.

END OF SECTION 224500

SECTION 226113 - COMPRESSED-AIR PIPING FOR LABORATORY FACILITIES

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. Compressed-air piping and specialties for nonmedical laboratory facilities, designated "laboratory air."

B. Related Sections include the following:

1. Division 22 Section "General-Service Compressed-Air Piping" for general-service compressed-air piping.
2. Division 22 Section "Compressed-Air Equipment for Laboratory Facilities" for laboratory air compressors.

1.3 SUBMITTALS

A. Product Data: For the following:

1. Compressed-air valves and valve boxes.

1.4 QUALITY ASSURANCE

A. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. ASME Compliance:

1. Comply with ASME B31.1, "Power Piping," for laboratory compressed-air piping operating at more than 150 psig (1035 kPa).
2. Comply with ASME B31.9, "Building Services Piping," for laboratory compressed-air piping operating at 150 psig (1035 kPa) or less.

1.5 PROJECT CONDITIONS

A. Interruption of Existing Laboratory Compressed-Air Service(s): Do not interrupt laboratory compressed-air 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 Owner no fewer than two days in advance of proposed interruption of laboratory compressed-air service(s).
2. Do not proceed with interruption of laboratory compressed-air service(s) without Owner's written permission.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Copper Medical Gas Tube: ASTM B 819, Types K and L, seamless, drawn temper, that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in green for Type K tube and in blue for Type L tube.

1. General Requirements for Copper Fittings: Manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.
2. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, with dimensions for brazed joints.
3. Copper Unions: ASME B16.22 or MSS SP-123, wrought copper or cast-copper alloy.

B. Memory-Metal Couplings: Cryogenic compression fitting made of ASTM F 2063, nickel-titanium, shape-memory alloy, and that has been manufacturer cleaned, purged, and sealed for oxygen service according to CGA G-4.1.

C. Copper Water Tube: ASTM B 88, Type M (ASTM B 88M, Type C), seamless, drawn temper.

1. Copper Fittings: ASME B16.18, cast-copper or ASME B16.22, wrought-copper, solder-joint pressure type.

2.2 JOINING MATERIALS

A. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

B. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.3 VALVES

A. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.

B. Ball Valves: MSS SP-110, 3-piece body, brass or bronze.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Conbraco Industries, Inc.
    b. NIBCO INC.

2. Pressure Rating: 300 psig (2070 kPa) minimum.
3. Ball: Full-port, chrome-plated brass.
4. Seats: PTFE or TFE.
5. Stem: Blowout proof with PTFE or TFE seal.
6. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

C. Check Valves: In-line pattern, bronze.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Conbraco Industries, Inc.

2. Pressure Rating: 300 psig (2070 kPa) minimum.
3. Operation: Spring loaded.
4. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

D. Zone Valves: MSS SP-110, 3-piece-body, brass or bronze ball valve with gage.

1. Pressure Rating: 300 psig (2070 kPa) minimum.
2. Ball: Full-port, chrome-plated brass.
3. Seats: PTFE or TFE.
4. Handle: Lever type with locking device.
5. Stem: Blowout proof with PTFE or TFE seal.
6. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
7. Pressure Gage: Manufacturer installed on one copper-tube extension.

E. Pressure Regulators: Bronze body and trim; spring-loaded, diaphragm-operated relieving type; manual pressure-setting adjustment; rated for 250-psig (1725-kPa) minimum inlet pressure; and capable of controlling delivered air pressure within 0.5 psig for each 10-psig (5.0 kPa for each 100-kPa) inlet pressure.

F. Manual drain valve.

2.4 FLEXIBLE PIPE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Flex-Hose Co., Inc.
2. Hyspan Precision Products, Inc.
3. Metraflex, Inc.
4. Universal Metal Hose; a Hyspan Co.

B. Description: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.

1. Working-Pressure Rating: 200 psig (1380 kPa) minimum.
2. End Connections: Threaded copper pipe or plain-end copper tube.

PART 3 - EXECUTION

3.1 PREPARATION

3.2 PIPING APPLICATIONS

A. Connect new tubing to existing tubing with memory-metal couplings.

B. Laboratory Air Piping: Use the following piping materials for each size range:

1. NPS 2 (DN 50) and Smaller: Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.

C. Drain Piping: Use the following piping materials:

1. Copper water tube, cast- or wrought-copper fittings, and soldered joints.

3.3 PIPING INSTALLATION

A. Refer to Division 22 Section “Common Work Results for Plumbing” for basic installation requirements.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of compressed-air piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Comply with ASSE Standard #6010 for installation of compressed-air piping.

D. Install piping adjacent to equipment and specialties to allow service and maintenance.

E. Install air and drain piping with 1 percent slope downward in direction of flow.

F. Install nipples, unions, special fittings, and valves with pressure ratings same as or higher than system pressure rating used in applications below unless otherwise indicated.

G. Install eccentric reducers, if available, where compressed-air piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.

H. Install branch connections to compressed-air mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.

I. Install thermometer and pressure gage on discharge piping from each air compressor and on each receiver. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping."

J. Install compressed-air service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.

K. Connect compressed-air piping to air compressors and to compressed-air outlets and equipment requiring compressed-air service.

L. Install unions in copper compressed-air tubing adjacent to each valve and at final connection to each piece of equipment, machine, and specialty.

3.4 VALVE INSTALLATION

A. Install shutoff valve at each connection to and from compressed-air equipment and specialties.

B. Install check valves to maintain correct direction of compressed-air flow from compressed-air equipment.

C. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.

D. Install zone valves and gages in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.

E. Install safety valves on compressed-air receivers where required by NFPA 99 and where recommended by specialty manufacturers.

F. Install pressure regulators on compressed-air piping where reduced pressure is required.

G. Install automatic drain valves on equipment, specialties, and piping with drain connection. Run drain piping to floor drain so contents spill over or into it.

H. Install flexible pipe connectors in discharge piping of each air compressor.

3.5 JOINT CONSTRUCTION

A. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter. Continuously purge joint with oil-free dry nitrogen during brazing.

B. Soldered Joints: Apply ASTM B 813, water-flushable flux to tube end. Join copper tube and fittings according to ASTM B 828.

C. Memory-Metal Coupling Joints: Join new copper tube to existing tube according to procedures developed by fitting manufacturer for installation of memory-metal coupling joints.

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices.

B. Vertical Piping: MSS Type 8 or 42, clamps.

C. Individual, Straight, Horizontal Piping Runs:

1. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel, clevis hangers.
2. Longer Than 100 Feet (30 m): MSS Type 43, adjustable, roller hangers.

D. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for trapeze hangers.

E. Base of Vertical Piping: MSS Type 52, spring hangers.

F. Support horizontal piping within 12 inches (300 mm) of each fitting and coupling.

G. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.

H. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1/4 (DN 8): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
2. NPS 3/8 and NPS 1/2 (DN 10 and DN 15): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
3. NPS 3/4 (DN 20): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
4. NPS 1 (DN 25): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.

I. Install supports for vertical copper tubing every 10 feet (3 m).

3.7 LABELING AND IDENTIFICATION

A. Install identifying labels and devices for nonmedical laboratory compressed-air piping, valves, and specialties. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.8 FIELD QUALITY CONTROL FOR COMPRESSED-AIR PIPING IN NONMEDICAL LABORATORY FACILITIES

A. Perform tests and inspections of compressed-air piping in nonmedical laboratory facilities and prepare test reports.

B. Tests and Inspections:

1. Piping Leak Tests for Compressed-Air Piping: Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry nitrogen to pressure of 50 psig (345 kPa) above system operating pressure, but not less than 150 psig (1035 kPa). Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
2. Repair leaks and retest until no leaks exist.
3. Inspect filters and pressure regulators for proper operation.

3.9 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain medical compressed-air alarm systems. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 226113

SECTION 230500 - COMMON WORK RESULTS FOR HVAC

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. Piping materials and installation instructions common to most piping systems.
2. Dielectric fittings.
3. Mechanical sleeve seals.
4. Sleeves.
5. Escutcheons.
6. Grout.
7. HVAC demolition.
8. Equipment installation requirements common to equipment sections.
9. Concrete bases.
10. Supports and anchorages.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.
2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Transition fittings.
2. Dielectric fittings.
3. Mechanical sleeve seals.
4. Escutcheons.

B. Welding certificates.

1.5 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

D. Coordinate systems shutdown (water, fire protection, hot water heating, steam, chilled water, etc.) with MSU Project Manager/MSU Project Representative. Activation and shut down of existing systems shall be conducted by MSU personnel only.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 23 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.

   a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
   b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Solder Filler Metals: ASTM B 32, 95/5 lead-free alloys. Include water-flushable flux according to ASTM B 813.

E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

1. Manufacturers:

a. Perfection Corp.; Clearflow Dielectric Waterway.
b. Victaulic Co. of America.

2.5 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Manufacturers:

a. Link-Seal.
b. Metraflex Co.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Carbon steel. Include two for each sealing element.
4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.6 SLEEVES

A. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

2.7 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.

D. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw or spring clips, and chrome-plated finish.

E. One-Piece, Floor-Plate Type: Cast-iron floor plate.

F. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.8 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 HVAC DEMOLITION

A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.

B. Disconnect, demolish, and remove HVAC systems, equipment, and components indicated to be removed.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.

5. Equipment to Be Removed: Disconnect and cap services and remove equipment.
6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Piping shall not project beyond walls or steel lines nor shall it hang below slabs more than is absolutely necessary. Particular attention shall be paid to the required clearances.

F. Offset piping where required to avoid interference with other work, to provide greater headroom or clearance, or to conceal pipe more readily. Offsets shall be properly drained or trapped where necessary.

G. Provide swing joints and expansion bends wherever required to allow the piping to expand without undue stress to connections or equipment.

H. Exposed piping around fixtures or in other conspicuous places shall not show tool marks at fittings.

I. Isolate pipe from the building construction to prevent transmission of vibration to the structure and to eliminate noise.

J. Install piping such that any equipment connected to piping may be removed by disconnecting two (2) flanges or unions and removing only one or two pipe sections. All equipment shall have bolted or screwed flanges or unions at pipe connections.

K. Install fittings for changes in direction and branch connections. T-drill system for mechanically formed tee connections and couplings, and Victaulic hole cut piping system are not allowed.

L. Do not route piping through transformer vaults or above transformers, panelboards, or switchboards, including the required service space for this equipment, unless the piping is serving this equipment.

M. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

N. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

O. Install piping to permit valve servicing.

P. Install piping at indicated slopes.

Q. Install piping free of sags and bends.

R. Install piping to allow application of insulation.

S. Eccentric reducing couplings shall be provided in all cases where air or water pockets would otherwise occur due to a reduction in pipe size.

T. Cap and plug all openings in pipes during construction with suitable metal plugs or cap to keep out dirt and rubbish until equipment is connected.

U. Install drains, consisting of a tee fitting, NPS 3/4 full port-ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

V. Select system components with pressure rating equal to or greater than system operating pressure.

W. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:

1. New Piping:

    a. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
    b. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type and set screw.
    c. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type with concealed or exposed-rivet hinge and set screw or spring clips.
    d. Bare Piping in Equipment Rooms: One-piece, stamped-steel type with set screw or spring clips.
    e. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

2. Existing Piping: Use the following:

    a. Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.
    b. Insulated Piping: Split-plate, stamped-steel type with concealed or exposed-rivet hinge and spring clips.
    c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and spring clips.
    d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and set screw.
    e. Bare Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with concealed or exposed-rivet hinge and set screw or spring clips.
    f. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with set screw or spring clips.
    g. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.

X. All pipes extending through the roof shall be flashed with six pound lead flashing extending 6 inches beyond the pipe, welded to a lead sleeve extended up around the vent pipes, and rolled over into the pipe.

Y. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

1. Sleeves placed in floors shall be flush with the ceiling and shall have planed, square ends, extending 2 inches above the finished floor, unless otherwise specified or detailed.
2. Where sleeves pass through reinforced concrete floors, they shall be properly set in position before the concrete is poured, and shall be maintained in position by the Contractor until the concrete is set.
3. Sleeves placed in concrete beams shall be flush with the side of the beam and large enough to accommodate the bare pipe only. All other sleeves shall be of adequate size to accommodate pipe insulation undiminished in size.
4. Pipes passing through below grade perimeter walls or slabs on grade shall have the space between the pipe and sleeve sealed watertight.
5. Pipes passing through above grade floor slabs and masonry walls shall have the space between the pipe or insulation and the sleeve packed with non-asbestos wicking or other suitable, approved, non-combustible material.
6. Pipes passing through walls of Mechanical Equipment Rooms shall be made gas-tight by caulking the space between the pipe and sleeve with a fiber saturated with an approved type of plastic material.
7. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

Z. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Install steel pipe for sleeves smaller than 6 inches in diameter.

2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

AA. Verify final equipment locations for roughing-in.

BB. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.3 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.4 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install dielectric fittings to connect piping materials of dissimilar metals.

B. Unions shall be used in preference to couplings where their use will facilitate dismantling the pipe for maintenance.

C. Pipe sizes indicated shall be carried full size to equipment served. Any change of size to match equipment connection shall be made within one foot of the equipment. At temperature control valves with sizes smaller than connected lines, reduction shall be made immediately adjacent to valves.

D. No Uni-flange pipe adapters will be allowed.

3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

3.6 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.

3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.

B. Field Welding: Comply with AWS D1.1.

3.8 GROUTING

A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.

END OF SECTION 230500

SECTION 230519 - METERS AND GAGES FOR HVAC PIPING

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. Bimetallic-actuated thermometers
2. Thermowells.
3. Dial-type pressure gages.
4. Gage attachments.
5. Test plugs.
6. Sight flow indicators.
7. Flow Sensors.

B. Related Sections:

1. Division 23 Section "Steam and Condensate Heating Piping" for steam and condensate meters.

1.3 SUBMITTALS

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

B. Wiring Diagrams: For power, signal, and control wiring.

C. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

D. Warranties: Submit written special warranty as specified in this Section. Include contact information, description of coverage, and start date for each special warranty.

PART 2 - PRODUCTS

2.1 BIMETALLIC-ACTUATED THERMOMETERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ashcroft Inc.
2. Trerice, H. O. Co., EI Series
3. Weiss Instruments, Inc.

B. Standard: ASME B40.200.

C. Case: Sealed types; stainless steel with 3-inch (76-mm) nominal diameter.

D. External adjustment.

E. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F.

F. Connector Type(s): Union joint, adjustable angle, with unified-inch screw threads.

G. Connector Size: 1/2 inch (13 mm), with ASME B1.1 screw threads.

H. Stem: 0.25 or 0.375 inch (6.4 or 9.4 mm) in diameter; stainless steel.

I. Window: Plain glass or plastic.

J. Ring: Stainless steel.

K. Element: Bimetal coil.

L. Pointer: Dark-colored metal.

M. Accuracy: Plus or minus 1 percent of scale range.

2.2 DUCT-THERMOMETER MOUNTING BRACKETS

A. Description: Flanged bracket with screw holes, for attachment to air duct and made to hold thermometer stem.

2.3 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.

3. Material for Use with Copper Tubing: CNR or CUNI.
4. Material for Use with Steel Piping: CRES.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, (DN 15, DN 20, or NPS 25,) ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch (13, 19, and 25 mm), with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.4 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. AMETEK, Inc.; U.S. Gauge.
   b. Ashcroft Inc.
   c. Trerice, H. O. Co.
   d. Weiss Instruments, Inc.

2. Standard: ASME B40.100.
3. Case: Liquid-filled type(s); cast aluminum or drawn steel; 4-1/2-inch (114-mm) nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2 (DN 8 or DN 15), ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi (kPa).
8. Pointer: Dark-colored metal.
9. Window: Glass or plastic.
10. Ring: Metal.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.5 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2 (DN 8 or DN 15), ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.

B. Siphons: Loop-shaped section of brass pipe with NPS 1/4 or NPS 1/2 (DN 8 or DN 15) pipe threads.

C. Valves: Brass ball, with NPS 1/4 or NPS 1/2 (DN 8 or DN 15), ASME B1.20.1 pipe threads.

2.6 TEST PLUGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Flow Design, Inc.
2. Peterson Equipment Co., Inc.
3. Trerice, H. O. Co.
4. Weiss Instruments, Inc.

B. Description: Test-station fitting made for insertion into piping tee fitting.

C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

D. Thread Size: NPS 1/4 (DN 8) or NPS 1/2 (DN 15), ASME B1.20.1 pipe thread.

E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F (3450 kPa at 93 deg C).

F. Core Inserts: Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber.

2.7 SIGHT FLOW INDICATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Dwyer Instruments, Inc.
2. Emerson Process Management; Brooks Instrument.
3. Ernst Co., John C., Inc.
4. Ernst Flow Industries.
5. Penberthy; A Brand of Tyco Valves & Controls - Prophetstown.

B. Description: Piping inline-installation device for visual verification of flow.

C. Construction: Bronze or stainless-steel body, with sight glass and ball, flapper, or paddle wheel indicator, and threaded or flanged ends.

D. Minimum Pressure Rating: 125 psig (860 kPa).

E. Minimum Temperature Rating: 200 deg F (93 deg C).

F. End Connections for NPS 2 (DN 50) and Smaller: Threaded.

G. End Connections for NPS 2-1/2 (DN 65) and Larger: Flanged.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending one-third of pipe diameter and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install duct-thermometer mounting brackets in walls of ducts. Attach to duct with screws.

G. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

H. Install remote-mounted pressure gages on panel.

I. Install valve and snubber in piping for each pressure gage for fluids (except steam).

J. Install rising stem gate valve and syphon fitting in piping for each pressure gage for steam.

K. Install a pressure gauge, with a pulsation damper and rising stem gate valve, in the condensate pump discharge piping.

L. Install a single pressure gauge for each chilled water pump, condenser water pump, and hot water heating pump. Each gauge shall be installed with two minimum ½" sensor lines complete with thread-o-lets or soc-o-lets, nipples, brass body ball valves and reducers. One sensor line shall be connected to the pump discharge piping and the other to the suction piping.

M. Install test plugs in piping tees.

N. Install flow indicators in piping systems in accessible positions for easy viewing.

O. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.

P. Install flowmeter elements in accessible positions in piping systems.

Q. Install wafer-orifice flowmeter elements between pipe flanges.

R. Install differential-pressure-type flowmeter elements, with at least minimum straight lengths of pipe, upstream and downstream from element according to manufacturer's written instructions.

S. Install permanent indicators on walls or brackets in accessible and readable positions.

T. Install connection fittings in accessible locations for attachment to portable indicators.

U. Install thermometers in the following locations:

1. Inlet and outlet of each hydronic boiler.
2. Two inlets and two outlets of each chiller.
3. Inlet and outlet of each hydronic coil in air-handling units.
4. Two inlets and two outlets of each hydronic heat exchanger.
5. Inlet and outlet of each thermal-storage tank.
6. Outside-, return-, supply-, and mixed-air ducts.
7. Entering and leaving sides of each heating and cooling coil in the air handling units.
8. Hot deck and cold deck.

V. Install pressure gages in the following locations:

1. Inlet and discharge of each pressure-reducing valve.
2. Inlet and outlet of each chiller chilled-water and condenser-water connection.
3. Suction and discharge of each pump.

W. Install flow sensors in the following locations:

1. Chilled water and condenser water lines at chillers.
2. Hot water heating lines at convertors.
3. As indicated on the drawings.

3.2 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

3.3 ADJUSTING

A. After installation, calibrate meters according to manufacturer's written instructions.

B. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE

A. Thermometers for hydronic application shall be the following:

1. Bimetallic-actuated thermometers.

B. Thermometers for air-duct application shall be the following:

1. Bimetallic-actuated thermometers.

C. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Chilled-Water Piping: 0 to 100 deg F (Minus 20 to plus 50 deg C).

B. Scale Range for Condenser-Water Piping: 0 to 150 deg F (Minus 20 to plus 70 deg C).

C. Scale Range for Heating, Hot-Water Piping: 30 to 240 deg F (0 to plus 115 deg C).

D. Scale Range for Steam and Steam-Condensate Piping: 50 to 400 deg F (0 to 200 deg C).

E. Scale Range for Air Ducts: Minus 40 to plus 110 deg F (Minus 40 to plus 45 deg C).

3.6 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Chilled Water, Condenser Water, and Heating Hot Water Systems: 0 to twice the maximum service-fluid pressure expected.

B. Scale Range for LP Steam System: 0 to 30 psi.

C. Scale Range for MP Steam System: 0 to 60 psi.

D. Scale Range for HP Steam System: 0 to 125 psi.

E. Scale Range for Steam Condensate Return System: 0 to 50 psi.

END OF SECTION 230519

SECTION 230523 - GENERAL-DUTY VALVES FOR HVAC PIPING

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. Bronze ball valves.

B. Related Sections:

1. Division 23 HVAC piping Sections for specialty valves applicable to those Sections only.
2. Division 23 Section "Identification for HVAC Piping and Equipment" for valve tags and schedules.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

D. NRS: Nonrising stem.

E. OS&Y: Outside screw and yoke.

F. RS: Rising stem.

G. SWP: Steam working pressure.

1.4 SUBMITTALS

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

1.5 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.1 for power piping valves.
3. ASME B31.9 for building services piping valves.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set angle, gate, and globe valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to HVAC valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valve Actuator Types:

1. Gear Actuator: For quarter-turn valves NPS 8 (DN 200) and larger.
2. Handwheel: For valves other than quarter-turn types.

3. Handlever: For quarter-turn valves NPS 6 (DN 150) and smaller.
4. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 5 plug valves, for each size square plug-valve head.
5. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

E. Valves in Insulated Piping: With 2-inch (50-mm) stem extensions and the following features:
1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

F. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Grooved: With grooves according to AWWA C606.
3. Solder Joint: With sockets according to ASME B16.18.
4. Threaded: With threads according to ASME B1.20.1.

G. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Conbraco Industries, Inc.; Apollo Valves.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Hammond Valve.
d. Milwaukee Valve Company.
e. NIBCO INC.

2. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig (1035 kPa).
c. CWP Rating: 600 psig (4140 kPa).
d. Body Design: Two piece.
e. Body Material: Bronze.
f. Ends: Threaded.
g. Seats: PTFE or TFE.
h. Stem: Bronze.
i. Ball: Chrome-plated brass.
j. Port: Full.

B. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Conbraco Industries, Inc.; Apollo Valves.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Hammond Valve.
d. Milwaukee Valve Company.
e. NIBCO INC.

2. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig (1035 kPa).
c. CWP Rating: 600 psig (4140 kPa).
d. Body Design: Two piece.
e. Body Material: Bronze.
f. Ends: Threaded.
g. Seats: PTFE or TFE.
h. Stem: Stainless steel.
i. Ball: Stainless steel, vented.
j. Port: Full.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install chainwheels on operators for valves NPS 4 (DN 100) and larger and more than 96 inches (2400 mm) above floor. Extend chains to 60 inches (1520 mm) above finished floor.

F. Where service and accessibility is not an issue, install finned-tube radiation control valves and associated devices in the ceiling space.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Shutoff Service: Ball, butterfly, or gate valves.
2. Throttling Service except Steam: Globe or butterfly valves.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:

1. For Copper Tubing, NPS 2 (DN 50) and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
2. For Steel Piping, NPS 2 (DN 50) and Smaller: Threaded ends.
3. For Grooved-End Steel Piping except Steam and Steam Condensate Piping: Valve ends may be grooved.

3.5 CHILLED-WATER VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Ball Valves: Two piece, full port, bronze with bronze trim.

3.6 CONDENSER-WATER VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:
   1. Ball Valves: Two piece, full port, bronze with bronze trim.
   2. Bronze Swing Check Valves: Class 125, bronze disc.

3.7 HEATING-WATER VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

   1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
   2. Ball Valves: Two piece, full port, bronze with bronze trim.
   3. Bronze Swing Check Valves: Class 125, bronze disc.

END OF SECTION 230523

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

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. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Thermal-hanger shield inserts.
4. Equipment supports.

B. Related Sections:

1. Division 23 Section "Vibration Controls for HVAC Piping and Equipment" for vibration isolation devices.
2. Division 23 Section(s) "Metal Ducts" for duct hangers and supports.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. Provide all necessary hangers, rods, supports, concrete inserts, etc., and proper size angles, channels, or unistruts to support all piping in a manner allowing movement during expansion and contraction. These supporting structures shall not be overstressed. All piping shall be supported with approved hangers designed for vertical adjustment and capable of carrying normal loads in all conditions of operation.

1.5 SUBMITTALS

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

B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:

1. Trapeze pipe hangers.
2. Equipment supports.

C. Welding certificates.

1.6 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Manufacturers: Subject to compliance with the requirements, provide products by one of the following:

1. Clevis.
2. Fee and Mason.
3. Anvil.
4. PHD Manufacturing, Inc.
5. Hilti, Inc.

B. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.

4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of hot dip galvanized or cadmium plated.

C. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.2 THERMAL-HANGER SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. PHS Industries, Inc.
2. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.

B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig (688-kPa) or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig (688-kPa) ASTM C 552, Type II cellular glass with 100-psig (688-kPa) or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength.

D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

E. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.3 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.4 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

C. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

D. Install hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

E. Install lateral bracing with pipe hangers and supports to prevent swaying.

F. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 (DN 65) and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

G. Holes shall not be drilled or punched in beams and supporting members. Do not support piping from roof deck, other piping, ducts or equipment.

H. Hangers and supports shall also be provided at every change of direction and within 1' of any pipe fittings and valves.

I. Pipe hangers in fan rooms and in mechanical equipment rooms shall be provided with suitable vibration isolation units to eliminate noise transmission between the piping and the building structure.

J. Hanger components shall not be used for purposes other than for which they were designed.

K. Vertical runs of piping not subject to appreciable expansion shall be supported by approved wrought steel clamps or collars, securely clamped to the risers. Where required, spring supports and guides shall be provided.

L. Where negligible movement of pipe occurs at hanger locations, rod hangers may be used for suspended lines. For piping supported from below, bases, brackets or structural cross members may be used.

M. If the vertical angle of the hanger is greater than 4 degrees, a traveling device shall be provided for horizontal movement. For piping supported from below, rollers or roller carriages shall be used.

N. Where significant vertical movement of the pipe occurs at the hanger location, a resilient support shall be used. Spring Cushion Hangers may be used where vertical movement does not exceed 1/4".

O. On a riser subject to expansion, only one support of the rigid type shall be used.

P. Riser clamps shall have a positive means of engagement between the pipe and the clamp.

Q. Provide anchors, guides and restraints wherever necessary to support risers, to maintain pipe in position, and to properly distribute expansion.

R. Provide supplemental framing, angles, channels and beams where the anchor locations do not align with the building structure or where the intended loads exceed the structural framing maximum load carrying capacity.

S. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

T. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

U. Insulated Piping:

1. Attach clamps and spacers to piping.

    a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
    b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
    c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

   a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.

5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (40 mm).

3.4 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use only circular cross-section rod hangers to connect to building structural attachments to pipe support devices. Rod couplings are not acceptable.

D. Use of "C" clamps and beam clamps of "C" pattern and any modifications thereof is prohibited.

E. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

F. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

G. Use carbon-steel pipe hangers and supports and attachments for general service applications.

H. Use stainless-steel pipe hangers and stainless-steel or corrosion-resistant attachments for hostile environment applications.

I. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

J. Use padded hangers for piping that is subject to scratching.

K. Use thermal-hanger shield inserts for insulated piping and tubing.

L. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
2. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
3. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
4. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
5. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30 (DN 25 to DN 750), from two rods if longitudinal movement caused by expansion and contraction might occur.
6. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24 (DN 65 to DN 600), from single rod if horizontal movement caused by expansion and contraction might occur.
7. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 (DN 50 to DN 1050) if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
8. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 (DN 50 to DN 600) if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
9. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 (DN 50 to DN 750) if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

M. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24 (DN 24 to DN 600).
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) if longer ends are required for riser clamps.

N. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
2. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.

O. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
3. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
4. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
5. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
6. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.

P. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

END OF SECTION 230529

SECTION 230548 - VIBRATION CONTROLS FOR HVAC PIPING AND EQUIPMENT

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. Isolation pads.
2. Isolation mounts.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Amber/Booth Company, Inc.
2. Kinetics Noise Control.
3. Mason Industries
4. Vibration Eliminator Co., Inc.
5. Vibration Mountings & Controls, Inc.

B. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.

1. Resilient Material: Oil- and water-resistant neoprene.
2. Minimum Durometer of 40
3. Basis of Design: Mason Industries type W.

C. Mounts: Double-deflection type, with molded, oil-resistant rubber, hermetically sealed compressed fiberglass, or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.

1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.
3. Minimum Static Deflection of 0.35”
4. Basis of Design: Mason Industries type ND.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and wind-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

D. Spring hangers shall be used for all piping in equipment rooms or adjacent to noise-sensitive areas.

3.3 VIBRATION-CONTROL DEVICE INSTALLATION

A. Install vibration isolation devices in accordance with the manufacturer’s instructions.

B. Equipment Restraints:

1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).

C. Piping Restraints:

1. Comply with requirements in MSS SP-127.
2. Space lateral supports a maximum of 40 feet (12 m) o.c., and longitudinal supports a maximum of 80 feet (24 m) o.c.
3. Brace a change of direction longer than 12 feet (3.7 m).

D. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

E. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

F. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

G. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 FIELD QUALITY CONTROL

A. Refer to Division 23, Section “Testing, Adjusting, and Balancing for HVAC”.

3.5 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.6 HVAC VIBRATION-CONTROL DEVICE SCHEDULE

A. Comply with ASHRAE Handbook – HVAC Applications for vibration isolation selections and applications unless indicated otherwise.

END OF SECTION 230548

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

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. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Duct labels.
5. Stencils.
6. Valve tags.
7. Warning tags.

1.3 SUBMITTALS

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

B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

C. Valve numbering scheme.

D. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the requirements, provide products by one of the following:

1. Emed.
2. Marking Services Inc.
3. Seton Name Plate Co.

2.2 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: Brass, 0.032-inch (0.8-mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
3. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
4. Fasteners: Stainless-steel rivets or self-tapping screws.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) thick, and having predrilled holes for attachment hardware.
2. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
3. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
4. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
5. Fasteners: Stainless-steel rivets or self-tapping screws.
6. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number.

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch (A4) bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.3 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) thick, and having predrilled holes for attachment hardware.

B. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).

C. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).

D. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

E. Fasteners: Stainless-steel rivets or self-tapping screws.

F. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

G. Label Content: Include caution and warning information, plus emergency notification instructions.

2.4 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches (38 mm) high.

2.5 DUCT LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) thick, and having predrilled holes for attachment hardware.

B. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).

C. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).

D. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

E. Fasteners: Stainless-steel rivets or self-tapping screws self-tapping screws.

F. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

G. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches (38 mm) high.

2.6 STENCILS

A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1-1/4 inches (32 mm) for ducts; and minimum letter height of 3/4 inch (19 mm) for access panel and door labels, equipment labels, and similar operational instructions.

1. Stencil Material: Aluminum.
2. Stencil Paint: Exterior, gloss, alkyd enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.
3. Identification Paint: Exterior, alkyd enamel in colors according to ASME A13.1 unless otherwise indicated.

2.7 VALVE TAGS

A. Valve Tags: 1-1/2” diameter round with 3/16” top hole, stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) numbers.

1. Tag Material: Brass, 0.032-inch (0.8-mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire-link chain.
3. No painted tags will be accepted.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

C. Number sequences shall be from 1 thru 999 with top line legends as follow:

1.	Chilled Water Supply	CHWS
2.	Chilled Water Return	CHWR
3.	Condenser Water Supply	CS
4.	Condenser Water Return	CR
5.	High Pressure Steam	HPS
6.	Medium Pressure Steam	MPS
7.	Low Pressure Steam	LPS
8.	High Pressure Condensate	HPC
9.	Medium Pressure Condensate	MPC
10.	Low Pressure Condensate	LPC
11.	Pumped Condensate	PC
12.	Hot Water Heating Supply	HWHS
13.	Hot Water Heating Return	HWHR

2.8 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: 3 by 5-1/4 inches (75 by 133 mm) minimum.
2. Fasteners: Brass grommet and wire.
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

1. Motor Driven Equipment
2. Starters and Disconnect Switches
3. Booster Coils
4. Terminal Boxes
5. Control Devices

B. Locate equipment labels where accessible and visible.

C. Label exhaust fans with fan number and room number or numbers served.

3.3 PIPE LABEL INSTALLATION

A. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels with painted, color-coded bands or rectangles, complying with ASME A13.1, on each piping system.

1. Identification Paint: Use for contrasting background.
2. Stencil Paint: Use for pipe marking.

B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet (15 m) along each run. Reduce intervals to 25 feet (7.6 m) in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

C. Pipe Label Legends:

1. Heating and Air Conditioning

a. Chilled Water Supply
b. Chilled Water Return
c. Condenser Water Supply
d. Condenser Water Return
e. Energy Recovery
f. High Pressure Condensate
g. Medium Pressure Condensate
h. Low Pressure Condensate
i. High Pressure Steam (80 PSI and above)
j. Medium Pressure Steam (16 PSI to 79 PSI)
k. Low Pressure Steam (15 PSI and below)
l. Heating Water Supply
m. Heating Water Return
n. Condensate Drain

2. Refrigeration

    a. Refrigeration – Hot Gas
    b. Refrigeration – Liquid
    c. Refrigeration - Suction

3.4 DUCT LABEL INSTALLATION

A. Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:

1. Blue: For cold-air supply ducts.
2. Yellow: For hot-air supply ducts.
3. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.
4. ASME A13.1 Colors and Designs: For hazardous material exhaust.

B. Stenciled Duct Label Option: Stenciled labels, showing service and flow direction, may be provided instead of plastic-laminated duct labels, at Installer's option, if lettering larger than 1 inch (25 mm) high is needed for proper identification because of distance from normal location of required identification.

C. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50 feet (15 m) in each space where ducts are exposed or concealed by removable ceiling system.

3.5 VALVE-TAG INSTALLATION

A. All valves and regulators (except those directly serving equipment) shall be provided with a brass tag securely wired in place on the valve stem below the packing gland nut. Tags shall clearly indicate the part of system, or room name and/or number controlled by the valve.

B. Furnish four (4) hot-press laminated typewritten copies of valve schedule, giving valve number controlled by the valve and location of valve. One copy will be mounted on a directory board in the main mechanical room, and one copy will be placed in each of the three mechanical brochures.

C. Prepare separate directories and drawings for the plumbing, heating, and air conditioning systems showing system layout as installed, and giving the number, location, and purpose of each component. The Contractor shall contact the A/E before starting the directory to insure proper tagging and listing.

D. Where it is necessary to operate more than one valve to control a section of piping, this fact and the numbers of the secondary valves shall be noted on the directory.

E. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

F. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape: 1-1/2 inches (38 mm), round.
2. Valve-Tag Color: Natural.
3. Letter Color: Black.

3.6 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

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 testing, adjusting and balancing HVAC systems to provide design conditions as indicated by the associated drawings. This Section includes, but is not limited to the following:

1. Testing, adjusting and balancing of air and hydronic system fluid flow rates at the system and distribution system level to the indicated quantities according to tolerances specified herein. The following systems to be included:

    a. Air Systems:
        1) Constant-volume air systems.
        2) Variable-air-volume systems.
        3) Multizone systems.
        4) Induction-unit systems.

    b. Hydronic Piping Systems:
        1) Constant-flow hydronic systems.
        2) Variable-flow hydronic systems.
        3) Primary-secondary hydronic systems.

2. Measuring the electrical performance of HVAC equipment.
3. Verification that automatic control devices are functioning properly.
4. Measurement of sound levels as related to rotating mechanical equipment.
5. Vibration testing and analysis of all rotating equipment greater than or equal to 10 hp.
6. Measurement of duct leakage.
7. Reporting results of the activities and procedures specified in this Section.

B. The testing, adjusting and balancing of the air and hydronic systems shall be performed by an independent TAB contractor contracted directly by the Owner.

1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. Adjust: To regulate fluid flow rates and air patterns at the system or terminal level. At the system level an example would be reducing fan speed; at the terminal level an example would be changing a damper position.

C. Balance: To proportion air or water flows within the distribution system, including submains, branches and terminals with respect to design quantities.

D. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.

E. Independent: Not affiliated with or in employment of any Contractor.

F. NEBB: National Environmental Balancing Bureau.

G. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

H. Report Forms: Test data sheets for recording test data in logical order.

I. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.

J. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.

K. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

L. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

M. TAB: Testing, adjusting, and balancing.

N. TABB: Testing, Adjusting, and Balancing Bureau.

O. TAB Specialist: An entity engaged to perform TAB Work.

P. Testing, Adjusting and Balancing (TAB) Agent: The entity responsible for performing and reporting the TAB procedures.

Q. Terminal: A point where the controlled medium (fluid or energy) enters or leaves the distribution system.

1.4 INFORMATIONAL SUBMITTALS

A. Contract Documents Examination Report: Within 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.

B. Strategies and Procedures Plan: Within 60 days of Contractor's Notice to Proceed and prior to commencing work, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

C. Certified TAB reports.

D. Sample report forms, other than those standard forms from AABC, NEBB or TABB.

E. List of instruments and associated calibration reports to be used on project; at a minimum, this shall include the following information:

1. Instrument type and make (manufacturer and model number).
2. Serial number.
3. Application.
4. Dates of use.
5. Dates of calibration.

1.5 QUALITY ASSURANCE

A. Agent shall be an independent testing, adjusting and balancing professional services provider certified by AABC or NEBB and have a minimum of five years experience on projects of similar scope and complexity (unless waived by MSU Infrastructure Planning and Facilities / Planning, Design and Construction). Approved TAB Agent shall be considered from the following:

1. Absolut Balancing Company – South Lyon, MI.
2. Aerodynamics Inspecting Company – Dearborne, MI.
3. Air Flow Testing, Inc. – Lincoln Park, MI.
4. Enviro-Aire/Total Balance, Inc. – St. Clair Shores, MI.
5. Ener-Tech Testing, Holly, MI.
6. Hi-Tech Test and Balance – Freeland, MI.
7. International Test and Balance – Southfield, MI.
8. Mechanical Testing Services, Inc. – Grandville, MI.
9. Quality Air Service – Kalamazoo, MI.

B. TAB Conference: Meet with Commissioning Authority / MSU Planning, Design and Construction on approval of the TAB strategies and procedures plan. This will be carried out to develop a mutual understanding of the requirements for system configuration and scheduling. Require the participation of the TAB field supervisor, TAB technicians mechanical contractor, electrical contractor and controls contractor. Provide seven days' advance notice of scheduled meeting time and location.

1. Agenda Items:

a. The Contract Documents examination report.
b. The TAB plan.
c. Coordination and cooperation of trades and subcontractors.
d. Coordination of documentation and communication flow.

C. Certify TAB field data reports and perform the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.

D. TAB Report Forms: Use standard TAB contractor's forms approved by Commissioning Authority.

E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

1.6 PROJECT CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with [MSU PDC Project Representative / Owner] during TAB operations to minimize conflicts with Owner's operations.

1.7 COORDINATION

A. Provide seven days' advance notice for each test. Include scheduled test dates and times.

B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

C. Systems shall be fully operational prior to system balancing. If a commissioning program is in place, all startup, testing and verification (STV) procedures shall be complete prior to initiation of TAB activities.

D. Test, adjust, and balance the air systems before hydronic systems.

E. Construction Review: Provide onsite visit upon either completion of a commissioning program start-up phase or 100% controls completion and full system operability. Submit a "Systems Ready To TAB" checklist to [MSU CxS/CxA / MSU PDC] for completion by the appropriate installing contractors.

F. The mechanical contractor shall complete the installation and start all HVAC systems to ensure they are working properly, and shall perform all other items to assist the TAB contractor in performing the testing, adjusting, and balancing of the HVAC systems. Completion of a Systems Ready To TAB" checklist is required by the appropriate installing contractor prior to the beginning of TAB.

G. The mechanical contractor shall make any necessary changes to the impellers, motors, sheaves, belts, dampers as required by the TAB contractor at no additional cost to the owner. Adjustable pitch sheaves shall be replaced with fixed pitch sheaves after completing system balancing. Replaced sheaves and belts shall be disposed of by mechanical contractor.

H. The temperature control contractor shall complete the installation, and operate and test all control systems to ensure they are functioning properly as designed. The temperature control contractor shall assist the TAB contractor as needed to verify the operation and calibration of all temperature control systems. Completion of a Systems Ready To TAB" checklist is required by the appropriate installing contractor prior to the beginning of TAB.

I. Demonstration of mechanical equipment shall be performed by the mechanical contractor, or by factory trained manufacturer's representative as specified.

J. Provide instruments and technicians as required to verify readings under direction of [MSU Commissioning Services / Commissioning Authority]

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 TEST EQUIPMENT

A. Instrumentation shall be provided as necessary and appropriate to perform the work. The instrument shall be factory calibrated, and shall be used with the factory-determined application factors. When reasonable doubt of accuracy exists, recalibration of any or all instrumentation shall be performed as requested by the Commissioning Authority.

B. Proprietary test equipment shall be provided by the manufacturer of the equipment. The manufacturer's representative shall provide the equipment, demonstrate use of the equipment, and assist the TAB contractor or Commissioning Authority in the testing process.

C. Make instruments available to the [MSU Commissioning Services /Commissioning Authority] to facilitate TAB data verification during testing.

D. Test pressure taps, pressure gages, thermometers and wells shall be installed by the mechanical contractor as indicated or specified.

E. Flow measuring stations, flow-limiting devices and balancing valves shall be installed by the mechanical contractor as indicated or specified.

F. All manual volume dampers located above ceilings shall be outfitted with a ribbon of consistent color and type and installed by mechanical contractor for facilitation of locating dampers during TAB.

G. Any additional required pressure and flow taps, and thermometer wells in locations where permanent installation devices are not indicated or specified shall be provided by the mechanical contractor.

3.2 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in Division 23 Section "Metal Ducts" and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data including fan and pump curves.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

K. Examine strainers. Verify that mechanical contractor has replaced startup screens with permanent screens having indicated perforations.

L. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

N. Examine system pumps to ensure absence of entrained air in the suction piping; mechanical contractor to assist as necessary.

O. Temperature controls contractor shall aid in the examination of operating safety interlocks and controls on HVAC equipment.

P. Report deficiencies discovered before and during performance of TAB procedures to [MSU Commissioning Services / MSU PDC / the Commissioning Authority]. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.3 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Procedure shall include a project specific approach which integrates general methods as set forth by the AABC as per National Standards for Total System Balance and/or NEBB as per Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

C. Verify completion of the “Systems Ready to TAB” report. It shall include the following items:

1. Permanent electrical-power wiring is complete.
2. Hydronic systems are filled, clean, and free of air.
3. Automatic temperature-control systems are operational.
4. Equipment and duct access doors are securely closed.
5. Balance, smoke, and fire dampers are open.
6. Isolating and balancing valves are open and control valves are operational.
7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.4 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance", ASHRAE 111, NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" or SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, the mechanical contractor shall install test ports and duct access doors that comply with requirements in Division 23 Section "Air Duct Accessories."
2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 Section "HVAC Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Note in report, as applicable, all final settings of variable frequency drives for specified design conditions, the associated static pressures/differential pressures observed and the conditions under which the system was tested, adjusted and balanced.

E. Take and report testing and balancing measurements in inch-pound (IP) units.

3.5 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity as applicable. This plan shall be discussed and agreed upon with [MSU Commissioning Services / MSU PDC / the Commissioning Authority]. The final plan for diversity shall be reflected in the report by which it pertains.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling-unit components.

L. Verify that air duct system is sealed as specified in Division 23 Section "Metal Ducts."

3.6 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.

    a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.

2. Measure fan static pressures as follows to determine actual static pressure:

    a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
    b. Measure static pressure directly at the fan outlet or through the flexible connection.
    c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
    d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.

    a. Report the cleanliness status of filters and the time static pressures are measured.

4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
6. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in Division 23 Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.

7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Fan speed shall not be increased in access of manufacturer's maximum recommended RPM. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.

1. Measure airflow of submain and branch ducts.

a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure air outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.

1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.7 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a minimum set-point airflow with the remainder at maximum-airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Discuss plan to simulate diversity with [MSU CxS/CxA and MSU PDC] and document agreed upon procedure prior to beginning work.

B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Set outdoor-air dampers at minimum, and set return- and exhaust-air dampers at a position that simulates full-cooling load.
2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
3. Measure total system airflow. Coordinate with temperature control contractor to calibrate any airflow measuring devices installed in the air-handling systems. Adjust to within indicated airflow.
4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.

    a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.

6. Re-measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.

    a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

7. Upon completion of the above scope of work, place all variable air terminal units to full cooling mode, measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit. At this time, coordinate with the temperature controls contractor to verify that all variable air terminal unit dampers, namely the critical terminal unit damper, are near but less than 100% open. Adjust system to achieve this condition therefore optimizing energy consumption and validating design airflow conditions during requirements for full load.
8. Record final fan-performance data.

C. Pressure-Dependent, Variable-Air-Volume Systems without Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Balance variable-air-volume systems the same as described for constant-volume air systems.
2. Set terminal units and supply fan at full-airflow condition.

3. Adjust inlet dampers of each terminal unit to indicated airflow and verify operation of the static-pressure controller. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
4. Readjust fan airflow for final maximum readings.
5. Measure operating static pressure at the sensor that controls the supply fan if one is installed, and verify operation of the static-pressure controller.
6. Set supply fan at minimum airflow if minimum airflow is indicated. Measure static pressure to verify that it is being maintained by the controller.
7. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.

    a. If air outlets are out of balance at minimum airflow, report the condition but leave the outlets balanced for maximum airflow.

8. Measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.

    a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

D. Pressure-Dependent, Variable-Air-Volume Systems with Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Set system at maximum indicated airflow by setting the required number of terminal units at minimum airflow. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.
2. Adjust supply fan to maximum indicated airflow with the variable-airflow controller set at maximum airflow.
3. Set terminal units at full-airflow condition.
4. Adjust terminal units starting at the supply-fan end of the system and continuing progressively to the end of the system. Adjust inlet dampers of each terminal unit to indicated airflow. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
5. Adjust terminal units for minimum airflow.
6. Measure static pressure at the sensor.
7. Measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

3.8 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow.
2. Check liquid level in expansion tank.
3. Check makeup water-station pressure gage for adequate pressure for highest vent.
4. Check flow-control valves for specified sequence of operation, and set at indicated flow.
5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
6. Set system controls so automatic valves are wide open to heat exchangers.
7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.9 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

A. Measure water flow at pumps. Use the following procedures except for positive-displacement pumps:

1. Verify impeller size by operating the pump at maximum RPM with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.

    a. If impeller sizes must be adjusted to achieve pump performance, obtain approval from Architect and comply with requirements in Division 23 Section "Hydronic Pumps."

2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.

    a. Monitor motor performance during procedures and do not operate motors in overload conditions.

3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
4. Report flow rates that are not within plus or minus 10 percent of design.

B. Measure flow at all automatic flow control valves to verify that valves are functioning as designed.

C. Measure flow at all pressure-independent characterized control valves, with valves in fully open position, to verify that valves are functioning as designed.

D. Set calibrated balancing valves, if installed, at calculated presettings.

E. Measure flow at all stations and adjust, where necessary, to obtain first balance.

1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

F. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.

G. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:

1. Determine the balancing station with the highest percentage over indicated flow.
2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
3. Record settings and mark balancing devices.

H. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.

I. Measure the differential-pressure-control-valve settings existing at the conclusion of balancing.

J. Check settings and operation of each safety valve. Record settings.

3.10 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems. Once TAB is complete per the specified procedures above, note the final differential pressure output which indicates the design flow condition. Fully open the metering valve located at the pump discharge. Decrease speed at variable frequency drive until differential pressure matches that originally attained at design conditions.

3.11 PROCEDURES FOR PRIMARY-SECONDARY HYDRONIC SYSTEMS

A. Balance the primary circuit flow first and then balance the secondary circuits.

3.12 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.

4. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.13 PROCEDURES FOR CHILLERS

A. Balance water flow through each evaporator and condenser to within specified tolerances of indicated flow with all pumps operating. With only one chiller operating in a multiple chiller installation, do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design conditions:

1. Evaporator-water entering and leaving temperatures, pressure drop, and water flow.
2. For water-cooled chillers, condenser-water entering and leaving temperatures, pressure drop, and water flow.
3. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by chiller manufacturer.
4. Power factor if factory-installed instrumentation is furnished for measuring kilowatts.
5. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatts.
6. Capacity: Calculate in tons of cooling.
7. For air-cooled chillers, verify condenser-fan rotation and record fan and motor data including number of fans and entering- and leaving-air temperatures.

3.14 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans.

B. Measure entering- and leaving-air temperatures.

C. Record compressor data.

3.15 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.

1. Measure and record the operating speed, airflow, and static pressure of each fan.
2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
3. Check the refrigerant charge.

4. Check the condition of filters.
5. Check the condition of coils.
6. Check the condition of dampers.
7. Verify appropriate location of balancing devices such that accurate measurements can be attained and final TAB can be completed.
8. Check the operation of the drain pan and condensate-drain trap.
9. Check bearings and other lubricated parts for proper lubrication.
10. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.

B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:

1. New filters are installed.
2. Coils are clean and fins combed.
3. Drain pans are clean.
4. Fans are clean.
5. Dampers functioning properly.
6. Verify correct operation of existing measurement/balancing devices (eg, dampers, gauges, valves, etc.)
7. Bearings and other parts are properly lubricated.
8. Deficiencies noted in the preconstruction report are corrected.

C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.

1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.
2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
3. If calculations increase or decrease the air flow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.
4. Balance each air outlet.

3.16 TOLERANCES

A. Set HVAC system's air flow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
2. Air Outlets and Inlets: Plus or minus 10 percent.
3. Heating-Water Flow Rate: Plus or minus 10 percent.
4. Cooling-Water Flow Rate: Plus or minus 10 percent.

B. Adjust pumps to within 10% of design GPM at design temperature. Excess pump pressure shall be eliminated by trimming the pump impeller by the Mechanical Contractor (this shall be carried out by the mechanical contractor).

C. General rotating equipment maximum allowable self-excited, total unfiltered vibration velocity shall not exceed 0.15 inches per second peak to peak. Individual velocity amplitude peaks of filtered readings are not to exceed 0.10 inches per second peak to peak.

D. Direct drive pump maximum allowable self-excited, total unfiltered vibration velocity shall not exceed 0.10 inches per second peak to peak. Individual velocity amplitude peaks of filtered readings are not to exceed 0.05 inches per second peak to peak.

3.17 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices. Also, include system schematic diagrams consistently referenced with all equipment and test points, and preliminary test data.

B. Status Reports: Prepare [weekly] monthly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.18 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Upon verification and approval of draft reports, submit 1 complete set of final reports certified by the TAB contractor for the Architect and 2 sets for inclusion in operating and maintenance manuals. Bind report forms complete with schematic diagrams and data in reinforced, vinyl, 3-ring binder manuals.
2. As-built system schematic diagrams consistently referenced with all equipment and test points, and final test data.
3. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
4. Include a list of instruments used for procedures, along with proof of calibration.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Pump curves.
2. Fan curves.
3. Manufacturers' test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB contractor.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:

    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans and pump performance forms including the following:

    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Face and bypass damper settings at coils.
    e. Fan drive settings including settings and percentage of maximum pitch diameter.
    f. Inlet vane settings for variable-air-volume systems.
    g. Settings for supply-air, static-pressure controller.
    h. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Water and steam flow rates.

3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.
7. Position of balancing devices.

E. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

    a. System identification.
    b. Location.
    c. Make and type.
    d. Model number and size.
    e. Manufacturer's serial number.
    f. Arrangement and class.
    g. Sheave make, size in inches (mm), and bore.
    h. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).

2. Motor Data:

    a. Motor make, and frame type and size.
    b. Horsepower and rpm.
    c. Volts, phase, and hertz.
    d. Full-load amperage and service factor.
    e. Sheave make, size in inches (mm), and bore.
    f. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
    g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

    a. Total airflow rate in cfm (L/s).
    b. Total system static pressure in inches wg (Pa).
    c. Fan rpm.
    d. Discharge static pressure in inches wg (Pa).
    e. Suction static pressure in inches wg (Pa).
    f. VFD frequency setting (Hz) and associated 2/3 static pressure reading in inches wg corresponding to design airflow.

F. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

    a. System and air-handling-unit number.
    b. Location and zone.
    c. Traverse air temperature in deg F (deg C).
    d. Duct static pressure in inches wg (Pa).

e. Duct size in inches (mm).
f. Duct area in sq. ft. (sq. m).
g. Indicated air flow rate in cfm (L/s).
h. Indicated velocity in fpm (m/s).
i. Actual air flow rate in cfm (L/s).
j. Actual average velocity in fpm (m/s).
k. Barometric pressure in psig (Pa).
l. Percent of design achieved.

G. Air-Terminal-Device Reports:

1. Unit Data:

a. System and air-handling unit identification.
b. Location and zone.
c. Apparatus used for test.
d. Area served.
e. Make.
f. Number from system diagram.
g. Type and model number.
h. Size.
i. Effective area in sq. ft. (sq. m).

2. Test Data (Indicated and Actual Values):

a. Air flow rate in cfm (L/s).
b. Air velocity in fpm (m/s).
c. Preliminary air flow rate as needed in cfm (L/s).
d. Preliminary velocity as needed in fpm (m/s).
e. Final air flow rate in cfm (L/s).
f. Final velocity in fpm (m/s).
g. Space temperature in deg F (deg C).
h. Indicate final flow coefficient.
i. Percent of design achieved.

H. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:

a. System and air-handling-unit identification.
b. Location and zone.
c. Room or riser served.
d. Coil make and size.
e. Flowmeter type.

2. Test Data (Indicated and Actual Values):

    a. Air flow rate in cfm (L/s).
    b. Entering-water temperature in deg F (deg C).
    c. Leaving-water temperature in deg F (deg C).
    d. Water pressure drop in feet of head or psig (kPa).
    e. Entering-air temperature in deg F (deg C).
    f. Leaving-air temperature in deg F (deg C).
    g. Terminal flow measuring device (circuit setter, flow meter, etc.) make/model/size.
    h. Terminal flow measuring device water pressure drop (as required to determine terminal unit flow).
    i. Final setting of flow measuring device valve handle indicator.
    j. Percent of design achieved.

3.19 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
2. Check the following for each system:

    a. Measure airflow of at least 10 percent of air outlets.
    b. Measure water flow of at least 5 percent of terminals.
    c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
    d. Verify that balancing devices are marked with final balance position.
    e. Note deviations from the Contract Documents in the final report.

B. Final Inspection:

1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Architect.
2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of Architect.
3. Architect shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:

1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

D. Prepare test and inspection reports.

3.20 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

END OF SECTION 230593

SECTION 230700 - HVAC INSULATION

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. Insulation Materials:

    a. Calcium silicate.
    b. Cellular glass.
    c. Flexible elastomeric.
    d. Mineral fiber.
    e. Phenolic.
    f. Polyolefin.

2. Fire-rated insulation systems.
3. Insulating cements.
4. Adhesives.
5. Mastics.
6. Lagging adhesives.
7. Sealants.
8. Factory-applied jackets.
9. Field-applied fabric-reinforcing mesh.
10. Field-applied cloths.
11. Field-applied jackets.
12. Tapes.
13. Securements.
14. Corner angles.

B. Related Sections:

1. Division 22 Section "Plumbing Insulation."

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).

B. Qualification Data: For qualified Installer.

C. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

B. Protect insulation against dirt, water, and chemical and mechanical damage. Do not install damaged or wet insulation.

1.6 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Calcium Silicate:

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

    a. Industrial Insulation Group (The); Thermo-12 Gold.

2. Preformed Pipe Sections: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
3. Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
4. Prefabricated Fitting Covers: Comply with ASTM C 450 and ASTM C 585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

G. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells.

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

    a. Pittsburgh Corning Corporation; Foamglas Super K.

2. Block Insulation: ASTM C 552, Type I.
3. Special-Shaped Insulation: ASTM C 552, Type III.
4. Board Insulation: ASTM C 552, Type IV.
5. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.

6. Preformed Pipe Insulation with Factory-Applied ASJ-SSL: Comply with ASTM C 552, Type II, Class 2.
7. Factory fabricated shapes according to ASTM C 450 and ASTM C 585.

H. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

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

a. Aeroflex USA Inc.; Aerocel.
b. Armacell LLC; AP Armaflex.

I. Mineral-Fiber, Preformed Pipe Insulation:

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

a. Johns Manville; Micro-Lok.
b. Knauf Insulation; 1000 Pipe Insulation.
c. Owens Corning; Fiberglas Pipe Insulation.

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.

C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F (10 to 427 deg C).

C. Cellular-Glass, Phenolic, Polyisocyanurate, and Polystyrene Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F (minus 59 to plus 149 deg C).

D. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

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

a. Aeroflex USA Inc.; Aeroseal.
b. Armacell LCC; 520 Adhesive.

E. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

F. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

G. PVC Jacket Adhesive: Compatible with PVC jacket.

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

a. Dow Chemical Company (The); 739, Dow Silicone.
b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.

2.5 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

2.6 SEALANTS

A. Joint Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Permanently flexible, elastomeric sealant.
3. Service Temperature Range: Minus 100 to plus 300 deg F (Minus 73 to plus 149 deg C).
4. Color: White or gray.

B. FSK and Metal Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
4. Color: Aluminum.

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
4. Color: White.

2.7 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

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

   a. Johns Manville; Zeston.

2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White.
4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

   a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

5. Factory-fabricated tank heads and tank side panels.

D. Metal Jacket:

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

   a. Childers Products, Division of ITW; Metal Jacketing Systems.

2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.

   a. Factory cut and rolled to size.
   b. Finish and thickness are indicated in field-applied jacket schedules.
   c. Moisture Barrier for Indoor Applications: 1-mil thick, heat-bonded polyethylene and kraft paper.
   d. Moisture Barrier for Outdoor Applications: 3-mil thick, heat-bonded polyethylene and kraft paper.

e. Factory-Fabricated Fitting Covers:

1) Same material, finish, and thickness as jacket.
2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
3) Tee covers.
4) Flange and union covers.
5) End caps.
6) Beveled collars.
7) Valve covers.
8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.8 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Width: 3 inches (75 mm).
2. Thickness: 11.5 mils (0.29 mm).
3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Width: 3 inches (75 mm).
2. Thickness: 6.5 mils (0.16 mm).
3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.

1. Width: 2 inches (50 mm).
2. Thickness: 6 mils (0.15 mm).
3. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
4. Elongation: 500 percent.
5. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Width: 2 inches (50 mm).
2. Thickness: 3.7 mils (0.093 mm).
3. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.
4. Elongation: 5 percent.
5. Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.

2.9 SECUREMENTS

A. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch (38-mm) galvanized carbon-steel washer.

3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

   a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
   b. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
   c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

   a. Baseplate: Perforated, nylon sheet, 0.030 inch (0.76 mm) thick by 1-1/2 inches (38 mm) in diameter.
   b. Spindle: Nylon, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches (63 mm).
   c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

    a. Baseplate: Galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
    b. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
    c. Adhesive-backed base with a peel-off protective cover.

6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.

    a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.

C. Wire: 0.062-inch (1.6-mm) soft-annealed, stainless steel.

2.10 CORNER ANGLES

A. PVC Corner Angles: 30 mils (0.8 mm) thick, minimum 1 by 1 inch (25 by 25 mm), PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040 inch (1.0 mm) thick, minimum 1 by 1 inch (25 by 25 mm), aluminum according to ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105 or 5005; Temper H-14.

C. Stainless-Steel Corner Angles: 0.024 inch (0.61 mm) thick, minimum 1 by 1 inch (25 by 25 mm), stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304 or 316.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

1. Verify that systems and equipment to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches (50 mm) o.c.

    a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.

4. Manholes.
5. Handholes.
6. Cleanouts.

Q. Continue insulation vapor barrier through penetrations except where prohibited by code. It is essential that the integrity of the vapor barrier is maintained. Fasteners or other securing devices that may unintentionally penetrate or otherwise damage the vapor barrier are prohibited. Where fasteners must penetrate the vapor barrier, the vapor barrier shall be repaired with a patch or tape of the same materials.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches (50 mm) below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches (50 mm).

1. Comply with requirements in Division 07 Section "Penetration Firestopping"irestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches (50 mm).
2. Pipe: Install insulation continuously through floor penetrations.
3. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.5 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

A. Mineral Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of tank and vessel surfaces.
2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
3. Protect exposed corners with secured corner angles.
4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:

    a. Do not weld anchor pins to ASME-labeled pressure vessels.
    b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
    c. On tanks and vessels, maximum anchor-pin spacing is 3 inches (75 mm) from insulation end joints, and 16 inches (400 mm) o.c. in both directions.
    d. Do not overcompress insulation during installation.
    e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
    f. Impale insulation over anchor pins and attach speed washers.
    g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.

6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches (150 mm) from each end. Install wire or cable between two circumferential girdles 12 inches (300 mm) o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches (1200 mm) o.c. Use this network for securing insulation with tie wire or bands.
7. Stagger joints between insulation layers at least 3 inches (75 mm).
8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.

1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
2. Seal longitudinal seams and end joints.

3.6 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches (50 mm) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

E. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

F. All sectional pipe covering shall be neatly and tightly applied with unbroken lengths and with the ends of the sections firmly butted together. Longitudinal joints shall be on the least conspicuous side of the pipe and slightly staggered. Fiberglass cloth or other coating shall be lapped over all joints and well pasted or cemented down in a neat and inconspicuous manner.

G. Extend insulation through all sleeves in order to produce a continuous application.

H. Secure calcium silicate pipe insulation with stainless steel bands.

I. Insulation for piping shall be continuous through hangers and supports.

J. Provide insulation inserts and insulation protection shields at hanger or support locations.

K. Where a vapor barrier is not required on insulated piping in size less than 4" inch, hangers and supports may be attached directly to piping with insulation completely covering hanger or support and jacket sealed at support rod penetration. Do not use ring hangers on cold piping.

L. Where riser clamps are required to be attached directly to piping requiring vapor barrier, extend insulation and vapor barrier jacketing/coating around riser clamps.

M. Insulate all drip pockets, end caps, etc. on all lines, except where otherwise noted. Thickness of insulation, vapor barriers, jackets and finishes shall match adjacent piping.

3.7 CALCIUM SILICATE INSULATION INSTALLATION

A. Insulation Installation on Boiler Breechings and Ducts:

1. Secure single-layer insulation with stainless-steel bands at 12-inch (300-mm) intervals and tighten bands without deforming insulation material.
2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches (75 mm). Secure inner layer with wire spaced at 12-inch (300-mm) intervals. Secure outer layer with stainless-steel bands at 12-inch (300-mm) intervals.
3. On exposed applications without metal jacket, finish insulation surface with a skim coat of mineral-fiber, hydraulic-setting cement. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth. Overlap edges at least 1 inch (25 mm). Apply finish coat of lagging adhesive over glass cloth. Thin finish coat to achieve smooth, uniform finish.

B. Insulation Installation on Straight Pipes and Tubes:

1. Secure single-layer insulation with stainless-steel bands at 12-inch (300-mm) intervals and tighten bands without deforming insulation materials.
2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches (75 mm). Secure inner layer with wire spaced at 12-inch (300-mm) intervals. Secure outer layer with stainless-steel bands at 12-inch (300-mm) intervals.

3. Apply a skim coat of mineral-fiber, hydraulic-setting cement to insulation surface. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least 1 inch (25 mm). Apply finish coat of lagging adhesive over glass cloth or tape. Thin finish coat to achieve smooth, uniform finish.

C. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.
4. Finish flange insulation same as pipe insulation.

D. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed insulation sections of insulation are not available, install mitered sections of calcium silicate insulation. Secure insulation materials with wire or bands.
3. Finish fittings insulation same as pipe insulation.

E. Insulation Installation on Valves and Pipe Specialties:

1. Install mitered segments of calcium silicate insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
2. Install insulation to flanges as specified for flange insulation application.
3. Finish valve and specialty insulation same as pipe insulation.

3.8 CELLULAR-GLASS INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
4. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.9 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.10 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

E. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inches (450 mm) and smaller, place pins along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) o.c.
    b. On duct sides with dimensions larger than 18 inches (450 mm), place pins 16 inches (400 mm) o.c. each way, and 3 inches (75 mm) maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Impale insulation over pins and attach speed washers.
    f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch (13-mm) outward-clinching staples, 1 inch (25 mm) o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50 deg F (10 deg C) at 18-foot (5.5-m) intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches (75 mm).

5. Overlap unfaced blankets a minimum of 2 inches (50 mm) on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches (450 mm) o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- (150-mm-) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches (150 mm) o.c.

F. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inches (450 mm) and smaller, place pins along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) o.c.
    b. On duct sides with dimensions larger than 18 inches (450 mm), space pins 16 inches (400 mm) o.c. each way, and 3 inches (75 mm) maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch (13-mm) outward-clinching staples, 1 inch (25 mm) o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50 deg F (10 deg C) at 18-foot (5.5-m) intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches (75 mm).

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- (150-mm-) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches (150 mm) o.c.

3.11 FIELD-APPLIED JACKET INSTALLATION

A. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch (38-mm) laps at longitudinal seams and 3-inch- (75-mm-) wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches (300 mm) o.c. and at end joints.

3.12 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.

2. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
3. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.13 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return located in nonconditioned space.
4. Indoor, exposed return located in nonconditioned space.
5. Indoor, concealed, Type I, commercial, kitchen hood exhaust.
6. Indoor, exposed, Type I, commercial, kitchen hood exhaust.
7. Indoor, concealed oven and warewash exhaust.
8. Indoor, exposed oven and warewash exhaust.
9. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
10. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
11. Outdoor, concealed supply and return.
12. Outdoor, exposed supply and return.

B. Items Not Insulated:

1. Fibrous-glass ducts.
2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
3. Factory-insulated flexible ducts.
4. Factory-insulated plenums and casings.
5. Flexible connectors.
6. Vibration-control devices.
7. Factory-insulated access panels and doors.

3.14 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, supply-air duct insulation shall be one of the following:

1. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) thick and 0.75-lb/cu. ft. (24-kg/cu. m) nominal density.
2. Mineral-Fiber Board: 1-1/2 inches (38 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) nominal density.

B. Concealed, return-air duct insulation shall be one of the following:

1. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) thick and 0.75-lb/cu. ft. (24-kg/cu. m) nominal density.
2. Mineral-Fiber Board: 1-1/2 inches (38 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) nominal density.

C. Concealed, outdoor-air duct insulation shall be one of the following:

1. Mineral-Fiber Board: 2 inches (50 mm) thick and 2-lb/cu. ft. (48-kg/cu. m) nominal density.

D. Concealed, exhaust-air duct insulation between isolation damper and penetration of building exterior shall be one of the following:

1. Mineral-Fiber Board: 2 inches (50 mm) thick and 2-lb/cu. ft. (48-kg/cu. m) nominal density.

E. Exposed, supply-air duct insulation shall be one of the following:

1. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) thick and 0.75-lb/cu. ft. (12-kg/cu. m) nominal density.
2. Mineral-Fiber Board: 1-1/2 inches (38 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) nominal density.

F. Exposed, supply-air plenum insulation shall be one of the following:

1. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) thick and 0.75-lb/cu. ft. (12-kg/cu. m) nominal density.
2. Mineral-Fiber Board: 1-1/2 inches (38 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) nominal density.

3.15 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Hot water heating piping inside radiation, convectors, or cabinet heater enclosures.
2. Steam traps.
3. Control valves except for chilled water.
4. Condenser water piping.
5. Cooling tower water piping.
6. Fire protection piping.
7. Underground piping.
8. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

C. Insulate cold pipes conveying fluids below ambient temperature with vapor retardant jackets with self sealing laps.

1. Chilled Water.
2. Condensate Drain.
3. Refrigerant Suction.

D. PVC jackets shall be installed on insulated piping in conjunction with fitting covers to provide a total sealed system as required by USDA and FDA for applications in food and pharmaceutical facilities.

3.16 INDOOR PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water below 60 Deg F (16 Deg C):

1. All Pipe Sizes: Insulation shall be one of the following:

a. Flexible Elastomeric: 1 inch thick.
b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
c. Polyolefin: 1 inch thick.

B. Chilled Water and Brine, 40 Deg F (5 Deg C) and below:

1. NPS 6 and Smaller: Insulation shall be one of the following:

a. Cellular Glass: 1-1/2 inches (38 mm) thick.
b. Mineral-Fiber, Preformed Pipe, Type I: 1 inch (25 mm) thick.
c. Phenolic: 1 inch (25 mm) thick.

2. NPS 8 and Larger: Insulation shall be one of the following:

a. Cellular Glass: 3 inches thick.
b. Mineral-Fiber, Preformed Pipe, Type I: 3 inches thick.
c. Phenolic: 3 inches thick.

C. Chilled Water and Brine, above 40 Deg F (5 Deg C):

1. All sizes: Insulation shall be one of the following:

a. Flexible Elastomeric: 1 inch (25 mm) thick.
b. Mineral-Fiber, Preformed Pipe, Type I: 1 inch (25 mm) thick.
c. Polyolefin: 1 inch (25 mm) thick.

D. Heating-Hot-Water Supply and Return, 200 Deg F (93 Deg C) and below:

1. NPS 1-1/4 and Smaller: Insulation shall be one of the following:

a. Mineral-Fiber, Preformed Pipe, Type I: 1-1/2 inch thick.

2. NPS 1-1/2 and Larger: Insulation shall be one of the following:

a. Mineral-Fiber, Preformed Pipe, Type I: 2 inches thick.

E. Refrigerant Suction and Hot-Gas Piping:

1. NPS 6 and smaller: Insulation shall be one of the following:

a. Cellular Glass: 1 inches thick.
b. Flexible Elastomeric: 1 inch thick.
c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
d. Phenolic: 1 inch thick.
e. Polyolefin: 1 inch thick.

3.17 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Refrigerant Suction and Hot-Gas Piping:

1. All Pipe Sizes: Insulation shall be one of the following:

a. Cellular Glass: 2.5 inches (50 mm) thick.
b. Flexible Elastomeric: 2.5 inches (50 mm) thick.
c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2.5 inches (50 mm) thick.
d. Phenolic: 2.5 inches (50 mm) thick.
e. Polyolefin: 2.5 inches (50 mm) thick.

3.18 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Ducts and Plenums, Concealed:

1. None.

D. Ducts and Plenums, Exposed: Vertical ductwork and plenums in mechanical equipment rooms and in finished spaces shall be provided with a jacket to a height of 10' above finished floor. Horizontal ductwork and plenums within 10’ above finished floor in mechanical equipment rooms and in finished spaces shall be completely provided with a jacket.

1. PVC: 20 mils (0.5 mm) thick.
2. Aluminum, Smooth: 0.016 inch (0.41 mm) thick.

E. Piping, Concealed:

1. None.

F. Piping, Exposed: Vertical piping in mechanical equipment rooms and in finished spaces shall be provided with a jacket to a height of 10' above finished floor. Horizontal piping within 10’ above finished spaces shall be completely provided with a jacket.

1. PVC: 20 mils (0.5 mm) thick.
2. Aluminum, Smooth: 0.016 inch (0.41 mm) thick.

3.19 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:

1. None.

D. Piping, Exposed:

1. Aluminum, Smooth with Z-Shaped Locking Seam: 0.024 inch (0.61 mm) thick.
2. Stainless Steel, Type 304 or 316, Smooth 2B Finish with Z-Shaped Locking Seam: 0.016 inch (0.41 mm) thick.

END OF SECTION 230700

SECTION 230800 - COMMISSIONING OF HVAC

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 commissioning process requirements for HVAC&R systems, assemblies, and equipment.

B. Related Sections:

1. Division 01 Section "General Commissioning Requirements" for general commissioning process requirements.

C. Owner will engage the Commissioning Authority under separate contract.

1.3 DEFINITIONS

A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.

B. AExA: Commissioning representative of the Architect/Engineer.

C. CxA: Commissioning Authority.

D. CxM: Commissioning Manager. The commissioning representative of the CM, appointed by the CM to manage and lead the commissioning effort on behalf of the CM.

E. CxR: Commissioning Representatives. Members of the Construction Manager's (CM) staff, contractor's, sub-contractors', manufacturers' and suppliers' staff, Owner's staff, Architect/Engineer's staff, or Owner's independent contractor assigned to participate in the commissioning process.

F. HVAC&R: Heating, Ventilating, Air Conditioning, and Refrigeration.

G. TAB: Testing, Adjusting and Balancing.

H. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.4 CONTRACTOR'S RESPONSIBILITIES

A. Perform commissioning tests at the direction of the CxA.

B. Attend construction phase controls coordination meeting.

C. Attend testing, adjusting, and balancing review and coordination meeting.

D. Participate in HVAC&R systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.

E. Provide information requested by the CxA for final commissioning documentation.

F. Mechanical Contractor CxR shall submit approved equipment data sheets on systems to be commissioned to the CxA for review; these will include, but not limited to, the following:

1. Fans.
2. Terminal units.
3. Chillers.
4. Heat exchangers.
5. Balancing valves.
6. Coils.
7. Dehumidifiers.
8. Condensing Units

G. Control Contractor CxR shall submit all approved equipment data sheets, approved control drawings and approved sequence of operations to the CxA.

H. TAB Contractor CxR shall submit certification documentation, TAB procedures plan, and preliminary project layout (which shall include an inventory of required flow rates for each air and hydronic system).

1.5 CxA'S RESPONSIBILITIES

A. Provide Project-specific construction checklists and commissioning process test procedures for actual HVAC&R systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.

B. Direct commissioning testing.

C. Verify testing, adjusting, and balancing of Work are complete.

D. Provide test data, inspection reports, and certificates in Systems Manual.

1.6 COMMISSIONING DOCUMENTATION

A. Provide the following information to the CxA for inclusion in the commissioning plan:

1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for HVAC&R systems, assemblies, equipment, and components to be verified and tested.
4. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
5. Certificate of readiness certifying that HVAC&R systems, subsystems, equipment, and associated controls are ready for testing.
6. Test and inspection reports and certificates.
7. Corrective action documents.
8. Testing, adjusting, and balancing reports.
9. Laser alignment reports.
10. Vibration testing and analysis reports.
11. Completion report of pipe cleaning, flushing hydrostatic testing and chemical water treatment.

B. The CxA shall provide and include the following documentation:

1. Commissioning plan
2. Pre-installation checklists
3. Pre-startup verification checklists (installation and pre-startup phases)
4. Startup testing and verification checklists (startup phase)
5. Functional performance testing plan with procedures and checklists for each series of tests. Submittals shall include samples of data reporting sheets that will be part of the reports.
6. Final commissioning report

1.7 SUBMITTALS

A. Certificates of readiness.

B. Certificates of completion of installation, prestart, and startup activities.

1.8 SYSTEMS TO BE COMMISSIONED

A. HVAC&R systems and associated control systems:

1. Air Handling Systems.
2. HVAC Zone Control Systems

3. Chilled Water Systems.
4. Hot Water Heating Systems.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 PRE-INSTALLATION VERIFICATION (PIV)

A. CxR for respective trade as indicated on PIV form will complete this scope of work; a sample PIV form for each equipment type has been included in Appendix 1 of this specification.

B. Review approved submittals for equipment included in systems to be commissioned.

C. Prior to the installation of each piece of equipment, verify that equipment arriving on site is consistent with that required.

D. The CxA shall carry out a 20% PIV sampling of each piece of equipment.

3.2 PRE-STARTUP VERIFICATION (PSV)

A. Prior to the installation of each piece of equipment, verify that equipment arriving on site is consistent with that required (ie, verify that the PIV for each piece of equipment has been completed and accepted)

B. CxR for respective trade as indicated on PSV form will complete this scope of work; a sample PSV form for each equipment type has been included in Appendix 1 of this specification.

C. Certify that HVAC&R systems, subsystems, and equipment have been installed according to the Contract Documents.

D. Certify that HVAC&R instrumentation and control systems have been installed, connected, calibrated and are ready for start-up procedures.

E. Inspect and verify the position of each device and interlock identified on checklists.

3.3 STARTUP TESTING AND VERIFICATION (STV)

A. Prior to the startup of each piece of equipment, verify that equipment installed is consistent with that required (ie, verify that the PSV for each piece of equipment has been completed and accepted)

B. Certify that HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.

C. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

D. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.

E. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.4 TESTING, ADJUSTING AND BALANCING (TAB) VERIFICATION

A. Testing, adjusting and balancing shall be carried out in direct contract with the Owner.

B. Prior to performance of TAB Work, provide copy of completed system readiness checklists, preliminary report (comprehensive project layout in electronic format), and certification documentation to the CxA.

C. Notify the CxA at least 10 days in advance of testing and balancing Work, and provide access for the CxA to witness testing and balancing Work.

D. Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC&R systems at the direction of the CxA.

1. The CxA will notify testing and balancing Contractor 10 days in advance of the date of field verification. Notice will not include data points to be verified.
2. The testing and balancing Contractor shall use the same instruments (by model and serial number) that were used when original data were collected.
3. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.
4. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

E. Vibration and Sound Tests: Upon completion of TAB Work, the Owner will provide technicians, instrumentation, tools, and equipment to test performance of vibration isolation and seismic controls. Notify CxA at least 10 days prior to testing.

3.5 FUNCTIONAL PERFORMANCE TESTING REQUIREMENTS (FPT)

A. Certify that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.

B. Prior to the functional performance testing of each piece of equipment, verify that equipment has been correctly brought online and TAB report has been accepted (ie, verify that the STV for each piece of equipment has been completed and accepted)

C. Certify that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.

D. All members of the Cx team shall provide technicians, instrumentation, and tools as required in the respective FPT test format (see Appendix 1 for CxR requirements) to perform commissioning test at the direction of the CxA.

E. Scope of HVAC&R testing shall include entire HVAC&R installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. Testing shall include measuring capacities and effectiveness of operational and control functions.

F. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

G. The CxA along with the HVAC&R Subcontractor, testing and balancing Subcontractor, and HVAC&R Instrumentation and Control Subcontractor shall prepare detailed testing plans, procedures, and checklists for HVAC&R systems, subsystems, and equipment.

H. Tests will be performed using design conditions whenever possible.

I. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

J. The CxA may direct that set points be altered when simulating conditions is not practical.

K. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.

L. If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

M. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.6 HVAC&R SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

A. Boiler Testing and Acceptance Procedures: Testing requirements are specified in Division 23 boiler Sections. Provide submittals, test data, inspector record, and boiler certification to the CxA.

B. HVAC&R Instrumentation and Control System Testing: Field testing plans and testing requirements are specified in Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls." Assist the CxA with preparation of testing plans.

C. Pipe system cleaning, flushing, hydrostatic tests, and chemical treatment requirements are specified in Division 23 piping Sections. HVAC&R Contractor shall prepare a pipe system cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the CxA. Plan shall include the following:

1. Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector, showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and chemical treatment plan.
2. Description of equipment for flushing operations.
3. Minimum flushing water velocity.
4. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.

D. Refrigeration System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of chillers, cooling towers, refrigerant compressors and condensers, heat pumps, and other refrigeration systems. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.

E. HVAC&R Distribution System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of air, steam, and hydronic distribution systems; special exhaust; and other distribution systems, including HVAC&R terminal equipment and unitary equipment.

F. Vibration and Sound Tests: Provide technicians, instrumentation, tools, and equipment to test performance of vibration isolation and seismic controls.

END OF SECTION 230800

SECTION 230913 - INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

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. Control piping, tubing and wiring.
2. Pneumatic control devices.
3. Electric controls devices.
4. Control air compressors, dryers, and pressure regulation stations.

B. Related Sections include the following:

1. Division 23 Section 230519 "Meters and Gages for HVAC Piping", for measuring equipment that relates to this Section.

2. Division 23 Section 230923 “Direct Digital Controls for HVAC”, for building automation controls related to this Section.

1.3 SUBMITTALS

A. Shop Drawings: Include performance data, components and accessories, wiring diagrams, dimensions, weights and loadings, field connections, and required clearances.

B. Field quality-control test reports.

C. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Maintenance instructions and lists of spare parts for each type of control device and compressed-air station.
2. Interconnection wiring diagrams with identified and numbered system components and devices.
3. Keyboard illustrations and step-by-step procedures indexed for each operator function.

4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
5. Calibration records and list of set points.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.

1.6 COORDINATION

A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following:

1. Honeywell.
2. Johnson Controls.
3. Siemens.

2.2 ELECTRICAL AND INTERLOCKS

A. Control Contractor shall furnish and mount electrical relays, switches, solenoids, transformers, etc., that are part of the control contract, and Electrical Contractor shall make the electrical interconnections as shown on control drawings. Electrical interconnections between controls and items of equipment shall be made by Electrical Contractor.

2.3 RELAYS AND SWITCHES

A. Accessory pneumatic and electric relays and switches shall be furnished as required to complete the control functions. Relays shall energize control system on equipment start, interface between pneumatic and electrical system, modify control air pressures, or increase system capacity of controllers. Switches shall provide high or low temperature or pressure safety limits or alarms, or change proportional to two position control. Input and output ports shall have suitable pressure gauges. P.E. switches shall be furnished with neon pilot lamps.

B. Fire alarm and trouble relays shall be wired to a normally closed set of contacts for reporting of status to the Energy Management Control System cabinet where applicable.

2.4 ACTUATORS

A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.

B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.

1. Manufacturers: Subject to compliance with the requirements, provide products by one of the following:

    a. Belimo Aircontrols (USA), Inc.
    b. Siemens

2. Valves: Size for torque required for valve close off at maximum pump differential pressure.
3. Coupling: V-bolt and V-shaped, toothed cradle.
4. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
5. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.

2.5 CONTROL VALVES

A. Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.

B. Fluid control valves shall be single seated, straight through, globe with renewable hardened seats and high lift contoured stainless steel plugs and seats, allowing tight shutoff. Valves shall have modified linear control characteristic for steam valve service, and equal percentage characteristic for water service. Valves 2 inches and smaller shall have threaded bronze bodies, and valves 2-1/2 inches and larger in size shall have flanged cast iron bodies. Stem packing shall be spring loaded, self adjusting Teflon cones. Valve operators shall be rolling neoprene diaphragm style, either normally open or normally closed as required. Electronic valve operators will be allowed.

C. Valves shall have metal actuators rather than plastic, and copper tubing pneumatic connections.

D. Hydronic system globe valves shall have the following characteristics:

1. NPS 2 and Smaller: Single seated, straight through, Class 125 threaded bronze body.
2. NPS 2-1/2 and Larger: Single seated, straight through, globe, Class 125 flanged bronze body.
3. Internal Construction: Renewable hardened seats and high lift contoured stainless steel plugs and seats allowing tight shutoff, spring loaded stem packing with self adjusting Teflon cones.
4. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.
5. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of total system (pump) head for two-way valves and 100 percent of pressure differential across valve or 100 percent of total system (pump) head.

E. Butterfly Valves:

1. Butterfly valves used as automatic isolation valves on heating hot water and chilled water systems shall be of lug style with cast iron body, ANSI Class 125, 316 stainless steel shaft and disc, and EPDM seat; and be provided with 120 VAC or 24 VAC electric actuator, with 2 limit switches for valve position feedback, and operator wheel for manual override of valve position in NEMA 4 enclosure.

2.6 TIME CLOCKS

A. When DDC control is not utilized or an existing pneumatic system within a building is to be extended a time clock shall be furnished and installed to start and stop the controlled equipment.

B. Clock shall have a 7-day, 365-day programming capability with a minimum of 18 setpoints and momentary feature, 15A SPDT contact, manual override, and battery carry-over.

C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Paragon model EC71/18S, for 120V, 60 Hz, 1 Ph.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. No pneumatic control line will be run through a control cabinet unless it is connected to a control device within that cabinet.
2. Only copper control tubing shall be used to connect to steam or hot water control valves.
3. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation.

B. Control Devices:

1. Low temperature freeze protection thermostats shall be installed downstream of the heating coils in HVAC units.
2. All thermostats shall be field calibrated and verified.
3. Outdoor air sensors shall be installed on the north or west walls/equipment, and provided with sun and damage guards.
4. Immersion sensors shall be provided with immersion wells.
5. Install averaging elements in ducts and plenums in crossing or zigzag pattern.
6. Installer shall validate correct duct area is programmed into Air Flow Station prior to Air Balance.
7. Airflow Measuring Stations shall be installed per Manufacturer’s recommendations. Each manufacturer has different recommendations.

C. Special Equipment: Install in accordance with manufacturer's instructions and recommendations. All control instruments, valves, etc., shall be carefully adjusted and set for proper operating of the equipment served as noted herein or as required by the equipment manufacturer's instructions and recommendations.

D. Install automatic dampers according to Division 23 Section "Air Duct Accessories."

E. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.

F. Install hydronic instrument wells, valves, and other accessories according to Division 23 Section "Hydronic Piping."

G. Install steam and condensate instrument wells, valves, and other accessories according to Division 23 Section "Steam and Condensate Heating Piping."

H. Install duct volume-control dampers according to Division 23 Sections specifying air ducts.

I. Install labels and nameplates to identify control components according to Division 23 Section "Identification for HVAC Piping and Equipment."

3.2 FIELD QUALITY CONTROL

A. Provide field supervision, and calibration and start up service.

B. Upon completion of the work, the Contractor shall instruct the Owner's Operating Engineer and acquaint him with all of the operating characteristics of all equipment installed by him including the TCS and all other systems, at the same time operating each and every system individually for a period of two days, unless otherwise specified. During this two day period the building's Operations Manual shall be used for reference.

3.3 ADJUSTING

A. Calibrating and Adjusting:

1. Provide diagnostic and test instruments for calibration and adjustment of system.
2. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

B. Adjust initial temperature and humidity set points.

END OF SECTION 230913

SECTION 230923 – DIRECT DIGITAL CONTROL SYSTEM FOR HVAC

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 a complete and functional direct digital Energy Management Control System (EMCS) as specified herein. The EMCS Contractor shall have total system responsibility for the installation including the following:

1. Non-BACnet Installations: Furnish and install all software, hardware, data base, conduit, wire, cable, building level network control units, floor level network control units and required connections for a complete and functional system to monitor and control points as specified, including software and data base generation, loading, debugging, and start-up.

2. Furnish and install all network cabling, conduits, network switches, routers for a complete and functional network system, ending at the facility's top-level building network switch, or at the nearest existing building level controllers as determined by Owner. Standard mode of connection shall be Ethernet or BACnet over IP unless approved otherwise by Owner.
    a. Coordinate with IPF project manager and MSU IT Services – Network Services to get necessary ethernet drops installed in the required spaces. All networking for the primary control panels should be on the MSU IT managed network.
    b. On completion of the project, provide a network riser diagram identifying each drop and where it is terminated within the MSU IT managed network.
    c. Secondary communication done over ethernet, from the primary control panels and terminal devices should be installed by the controls contractor following standard ethernet installation practices.
    d. Each drop should be tagged at each end to identify where the other end of the drop is located.
3. Generation of color graphic displays at the native existing graphic terminal in Central Control for each mechanical system connected to the system. Graphics to include all dynamic point data information associated with each major mechanical system and setpoints.
4. Provide complete hardware and software documents, shop drawings, operating and maintenance manuals and classroom training of operators and maintenance personnel at the site. Provide as-built control drawings in CAD format to Owner.

5. Provide a dedicated power supply to each controller cabinet and communications interface. Provide manufacturers recommended grounding to each controller cabinet, and dedicated 120V, 20A circuit with locking clip on breaker. Clearly label circuit in panel.
6. Provide an uninterruptable power supply (UPS) for all direct digital control systems supporting laboratory and/or animal systems. UPS to be manufactured by SOLA HD, series DIN RAIL AC UPS, model SDU 850-5, or approved equal.
7. Accomplish acceptance tests, including point-to-point verification, with alarming verification including messages for all critical alarm and life safety points. Typical points requiring messaged alarming include but are not limited to:
    a. Control air compressor
    b. 24 hour fans and pumps (i.e. Freeze Protection)
    c. Critical temperature and humidity control areas (i.e. Archiving/Museum)
    d. Critical pressure control areas and systems (i.e. Laboratories and Lab Systems)
    e. Critical systems (i.e. Fire and Security)
    f. State/Federally regulated areas (i.e. Animal Areas)
8. Provide connections for all electrical devices provided by the EMCS contractor to the controllers.
    a. Provide proper marking and identification of all devices, wiring, and controls. Equipment labels should indicate device name, address, room location, etc.
    b. Controllers and panel enclosures marked with panel number/instance number and IP address.
    c. Layout/as-built wiring diagram of control panel put inside a protective sleeve and secure inside the control panel.
    d. Control wires labeled to indicate which I/O terminals they are connected to.
9. Schedule all non-24 hour equipment in accordance with generally approved University guidelines for energy usage and in accordance with the Owner. Non-24 hour equipment shall be scheduled as soon as practical to avoid excessive use of University resources prior to turnover to the University.
10. Provide any additional support that may be required to facilitate full integration of all control devices, including hardware communication troubleshooting with 3rd party devices (Variable Frequency Drives, packaged controllers, etc).
11. Demolition Requirements: Demolition shall include removal of all associated control components (sensors, switches, etc.), wiring, and database at the front end (point definitions, programming, etc.)
12. Guarantee.

B. The EMCS Contractor shall bid directly to and be contracted directly by the General Contractor or Construction Manager.

C. Related Sections include the following:

1. Division 23 Section "Meters and Gages for HVAC Piping" for measuring equipment that relates to this Section.

1.3 DEFINITIONS

A. DDC: Direct digital control.

B. I/O: Input/output.

C. RTD: Resistance temperature detector.

1.4 ACCEPTABLE CONTRACTORS

A. System integration shall be based on the existing architecture for a cohesive control system. Work to be performed only by the following contractors:
   1. Siemens
   2. BCI

1.5 SYSTEM DESCRIPTION

A. The temperature control system shall be of the DDC type, connected to the University's present Energy Monitoring and Control System.

B. BACnet implementation shall be completely based on ANSI/ASHRAE Standard 135-2001, BACnet, and is to control all listed equipment using native BACnet-compliant components. Non BACnet-compliant or proprietary equipment or systems (including gateways) shall not be acceptable and are specifically prohibited. Any device designated to act as a BACnet Broadcast Management Device (BBMD) shall be designed for and dedicated to that purpose and shall not be utilized to control any other aspect of the building system.

C. System controllers connected to floor level (BACnet MS/TP) devices shall perform all necessary MS/TP network routing to facilitate network efficiency and reduce communication and control lag. When system controllers cannot perform this function, dedicated BACnet MS/TP routing hardware shall be provided.

D. All materials and equipment used shall be standard components, regularly manufactured for Siemens Building Control Systems and shall not be custom designed especially for this project. All components shall have been thoroughly tested and proven in actual use, and shall include, but not be limited to:

   1. Controller cabinets with all electronics and transducers, including on-board communications capability and database memory battery back-up. Provide latest revision firmware and largest available memory board.
   2. Communications interface devices.
   3. Printed circuit assemblies, point modules.
   4. Auxiliary device enclosures.
   5. Control and status relays.
   6. Current transformers.
   7. Thermowells (Mechanical Contractor shall install wells furnished by the EMCS contractor)
   8. Temperature and pressure transmitters.
   9. Water flow sensors and transmitters.
   10. Electric to pneumatic transducers.

11. Pneumatic to electric transducers, standard shall be 0 to 20 psi unless noted otherwise, include brass fittings on all pneumatic devices.
12. Power supplies to controller cabinets, transducers, and other control devices.

1.6 SUBMITTALS

A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.

B. Shop Drawings:

1. Submit complete shop drawings of the proposed EMCS for approval including sequence of operation, valve ranges, DDC logical points and physical addresses, typical system information such as fan CFM, voltage, FLA, HP, GPM, etc.
2. Submit complete shop drawings of the proposed EMCS system for approval including, but not be limited to the following:

    a. I/O point summary with recommended set points, start/stop times, time delays, etc.
    b. Operator and hardware point numbers, logical names and user names.
    c. Controller unit schematic wiring, layout sheet including logical point names, valve ranges, etc.
    d. Fan and mechanical system schematic diagrams showing EMCS sensor locations, including valve ranges, CFM, voltage, FLA, GPM and areas served.
    e. One-line diagrams for sensors, control points, and terminations, including labeling to controller cabinets, with all components, signal values, and cables.
    f. Terminal cabinets, including labeled terminal blocks.
    g. Connections to existing loops, controls, and panels.
    h. Internal and external wiring of relays and contacts.
    i. Schematic of all major equipment provided.
    j. Operator, maintenance, and software programming manuals.
    k. Spare parts list and prices.
    l. Complete sequence of operation, description, control logic flow diagrams, and completed programming sheets in manual form for each mechanical system controlled.

3. All manufacturer's drawings, catalog cuts, and specifications shall be properly identified with the Engineer's project number and title. Each piece of equipment shall be properly identified as to its location and equipment number. Verify Equipment numbering with the Owner.
4. SUBMITTALS data relevant to panel schedules and other pertinent equipment information requiring approval prior to field installation shall be forwarded from the EMCS Contractor. Upon receipt of approval, the EMCS Contractor shall proceed with installation, set-up, calibration and check out of the various control and monitoring systems. At the completion of components and systems installation the Contractor shall request in writing that the Owner inspect and approve satisfactory operation as specified under "Acceptance Procedure".

C. As-built Drawings:

1. At the completion of the project as-built drawings shall be submitted to the Owner, showing conduit size and location, cable and wire identification, panel and sensor locations, and device layouts with panels, branch circuit numbers, and wiring diagrams for each type of typical field point wiring and for each specific variation, and network riser diagram identifying each drop and where it is terminated within the MSU IT managed network.
2. Furnish 3 sets of neatly drawn as-built diagrams of the temperature control systems, complete with sequence of operations, valve ranges, cabinet layout sheets, point logical names and physical addresses. One set to be mounted in plastic covers located in control cabinets in the field, two sets to be delivered to Construction Representative for Archives and records. One set of AutoCAD as-built drawings on CDROM shall be furnished to Design Representative to be delivered to Engineering and Architectural Services. File naming convention shall be as determined by Owner.
3. EMCS Contractor is to keep a current marked-up copy of as-built drawings on site at all times once installation started.

D. Operations and Maintenance Manuals:

1. The system shall be provided with complete maintenance and operation instructions including, but not limited to the following:

    a. Complete electronic schematic wiring diagrams for printed circuit boards, DDC Controller cabinets and other equipment included in these Specifications.
    b. Complete instruction set in manual form for operation of the system.
    c. Complete instruction set in manual form for adding and deleting of points and interface device panels including all relevant parameters such as descriptor inputs, point types, change-of-state type, functions, etc.
    d. Complete diagnostic and trouble shooting procedures set in manual form.
    e. Complete instruction set in manual form for all software and firmware.

2. Any updates to firmware, software, and hardware shall be fully documented at or before the time of delivery.

E. Warranties: Submit written special warranty as specified in this Section. Include contact information, description of coverage, and start date for each special warranty.

1.7 INPUT/OUTPUT SUMMARY FORM

A. The following I/O Summary Form is a sample form illustrating the typical information required of the various building systems. Any device connected to the EMS that is also controlled by some local device (e.g.: light switch, P.E., high limit stat, twist timer, etc.) must be defined as an DI point. Provide dry contact from local device to digital input at controller and programming necessary to accomplish sequence of operation.

B. Typical control points connected to the EMCS system are as follows (see drawings for I/O diagrams):

1. HVAC/H&V Systems:

   a. Supply fan (status and control).
   b. Return fan (status and control where fan is not interlocked w/supply).
   c. Mixed air temperature.
   d. Heating coil temperature.
   e. Cooling coil temperature.
   f. Discharge air temperature.
   g. Return air temperature.
   h. Return air relative humidity.
   i. Damper control.
   j. Steam valve control.
   k. Cooling coil control.
   l. Humidifier control.
   m. Space humidity sensor (where humidity control is critical).
   n. At least one space temperature sensor per system or zone.
   o. VAV - Static Pressure Sensors.
   p. VAV - Variable Frequency Drive Remote Enable/Disable through LAN connection.
   q. VAV - Variable Frequency Drive status through LAN connection.
   r. Flow stations on VAV systems.
   s. Twist timer for after hours operation (when required by Department).

2. Hot Water Heating Systems:

   a. Hot water heating pump (status and control).
   b. Hot water heating supply temperature (at each convertor).
   c. Hot water heating return temperature (at each convertor).
   d. Hot water heating common supply temperature.
   e. Hot water heating common return temperature.
   f. Steam valve control.

3. Chilled Water Systems:

   a. Absorption chiller (status and control)
   b. Chilled water supply temperature.
   c. Chilled water return temperature.
   d. Condenser water supply temperature.
   e. Condenser water return temperature.
   f. Chilled water supply temperature reset.
   g. Chilled water pump status.
   h. Condenser water pump status.
   i. Cooling tower fan status.
   j. Valve control on loop systems.
   k. Cooling tower VFD when applicable(enable/disable/speed/status).
   l. Primary chilled water supply temperature.

m. Primary chilled water return temperature.
n. Secondary chilled water supply temperature.
o. Secondary chilled water return temperature.
p. Variable flow systems to include pressure sensors and flow measurement.

4. Snow Melting Systems:

a. Enable/Disable and system status.
b. Pump Status.
c. Hot Water Supply.
d. Hot Water Return.
e. Steam valve control.
f. Sidewalk moisture/temperature sensor.

5. Miscellaneous Building Systems:

a. Outdoor air temperature.
b. Temperature control air compressor low pressure alarm.
c. Fire (trouble circuit).
d. Fire (fire alarm circuit).
e. Domestic hot water temperature.
f. Steam condensate flow meter (pulse accumulator).
g. Steam condensate conductivity (alarm).
h. Steam condensate temperature.
i. Cooling tower water treatment conductivity (alarm).
j. Cooling tower water treatment PH (alarm).
k. Domestic water flow meter (pulse accumulator).
l. Electric meter(s) (pulse accumulator).
m. Exhaust fans (status and control) including:

1) Toilet exhaust.
2) Laundry exhaust.
3) General exhaust.
4) Snack bar exhaust.
5) Kitchen hood exhaust.
6) Serving hood exhaust.
7) Dish washer hood exhaust.

n. Sump pit (high water alarm).
o. Emergency generator status.
p. Microprocessor fault indication.
q. Building steam shutoff valve (include adequate space temperature points to calculate the proper O.A. temperature to open and close the steam valve in order to maintain 68^{o} (winter) and 78^{o} (summer) building temperatures.
r. Street light control and status.

1.8 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with ASHRAE Standard 135 for DDC system components.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.

B. System Software: Update to latest version of software at Project completion.

C. Salvaged Materials and Components: Existing control components (Building Controllers, Application Specific / Advanced Application Controllers, Point Expansion Components, etc) when removed from the field as part of a controls replacement or upgrade shall be returned to the owner for reuse or recycling at the owner's discretion.

1.10 COORDINATION

A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.

B. Coordinate supply of conditioned electrical branch circuits for control units.

C. Coordinate final room numbers with MSU PDC and equipment numbers with MSU Maintenance Services.

D. Coordinate controller addresses with Maintenance Services/Central Control.

1.11 WARRANTY

A. The EMCS system shall be guaranteed for a period of two years after final approval by the Owner. The guarantee shall be provided for a completely installed system, including all components, parts, and assemblies of the EMCS. The guarantee shall cover parts, materials, and labor to locate and correct any defects in materials or workmanship.

B. The Contractor shall initiate the warranty period by formally transmitting to the Owner commencement notification of the period for the system and devices accepted. The warranty period begins when these devices are formally accepted by the Owner (refer to ACCEPTANCE PROCEDURE below).

C. Contact information shall be provided for quick service engineering assistance concerning hardware and software problems. There shall be provisions made for getting manufacturer certified diagnostic and repair personnel on the scene quickly should the need arise. There shall also be a software expert familiar with the software of this machine who can be easily contacted.

D. This system shall be inspected by the EMCS Contractor for a four hour period once each month during the warranty period to run diagnostic tests and also provide maintenance instructions to the operating personnel.

E. The EMCS Contractor shall give the Owner 24 hours prior notification of each maintenance trip during the contract guarantee period. In addition, the Contractor shall furnish the Owner and Engineer a written record of each maintenance trip, number of employees present, time involved, and work accomplished.

F. Owner shall be able to make changes to data base, when prior data base is stored on disk in case of error in change, without affecting or voiding warranty.

1.12 MAINTENANCE

A. The EMCS Contractor shall provide and maintain on site at MSU working spare parts for the EMCS system during the warranty period including DDC Controllers, communication boards, networking components, modules, sensors, floor level (subnet) devices, transformers, etc. MSU will be custodian of these spare parts and shall be authorized to utilize them in performing first level maintenance. The EMCS Contractor shall refurbish/replace spare parts in exchange for failed items.

PART 2 - PRODUCTS

2.1 CURRENT SENSORS (TRANSFORMERS)

A. Current sensors used for monitoring motor operation shall be sized according to motor horsepower. The output shall be compatible with the EMCS field device with necessary interfacing transducers provided.

B. The current sensors shall have mounting brackets for attachment to the motor starter enclosure.

C. Manufacturers: Veris model 921, or approved equal.

2.2 CURRENT SENSING RELAYS

A. Current sensing relays shall be used for monitoring motor operation, and sized according to motor HP.

B. Manufacturers: Veris model 908 or RIB Model RIBXGTA.

2.3 TEMPERATURE DETECTORS

A. Temperature detectors shall be wire wound or thin film platinum resistance type sensors, or 10K Ohm thermistor type, referenced at 77 degree F, either having a minimum accuracy of $\pm$ 0.5° F over the noted range. All sensors of a particular category shall be of the same type and manufacturer.
   1. 10K Ohm thermistors shall only be allowed as point type sensors at the zone/room level control.

B. Resistance Temperature Detectors (RTD) shall be two-wire type Platinum RTD and shall be provided with local 4-20 MA signal conditioning tranducers shall be provided. The sensing bulb shall be copper or stainless steel. The minimum temperature range for all sensors will be 20 °F. to 120 °F with an accuracy of $\pm$ 0.6° F for a single point duct and immersion sensor and +/-2 °F for continuous averaging sensors in air when matched to the 4-20mA trasmitter. Sensors shall have a maximum time constant of three seconds per degree change. Sensors shall not require recalibration at any time. Where required, linearizing, ranging, and resistance change versus temperature curve interpretations shall be made by software programming at the CPU or Controller. Minimum room temperature sensor range is 40-90 degree F. Wider range may be required for special applications.

C. Temperature detectors shall be either stem or tip sensitive types. Sensors installed outdoors, in piping systems, and in corrosive environments shall be hermetically sealed in type 316 stainless steel enclosures, with all joints and closures Heliarc welded. Soldering or brazing is not approved. Entire assembly, including external trim, shall be a watertight, vibration proof, heat resistant unit.

D. Sensing elements installed in piping systems shall be provided with separable wells constructed of type 316 stainless steel. Elements shall be inserted into the wells with appropriate heat transfer compound.

E. Sensors installed outdoors shall be of weatherproof construction, protected from sunlight and wind effects with a stainless steel protective shield.

F. All air handler and duct mounted temperature sensors shall be of the averaging type, with 8’, 12’, 16’, 24’, 50’ 80’ or 100’ long sensing elements. The averaging element shall have a continuous element sensor along the entire length. Averaging elements shall be installed across the full air flow area in a serpentine fashion, on rigid supports designed specifically for mounting of such elements. The averaging element shall be protected against vibration and wear at each point of contact with the element supports. Strain on the element shall be relieved at the junction box to prevent tension on the internal electrical connections. A minimum sensor density of 1’ per 1 sq. ft. of coil is required.
   1. If more than 100’ of sensor is required for coil coverage, then multiple, non-overlapping sensors of the same length shall be permitted and wired as separate inputs to the controller.

G. Rigid stem 304 stainless steel averaging sensors will be allowed where duct size is smaller than 3' square.

2.4 STATIC PRESSURE TRANSMITTERS

A. Static pressure transmitters shall be industrial quality, capable of transmitting 4-20mA analog output signal proportional to differential (static) pressure input signals. Transmitter shall have a minimum 1% accuracy rating over the range of the device, zero and span adjustment, and stainless steel case.

B. Manufacturers: Setra Model C264, or approved equal.

2.5 ELECTRONIC TO PNEUMATIC TRANSDUCERS

A. Accessories: In-line filter, dual valve and gauge.

B. Manufacturers: Model EPC2GFS style by Advanced Control Technologies, Inc, or approved equal.

2.6 DAMPER END SWITCHES

A. Damper end switches shall be two position, encapsulated non-mercury style mounted on the shaft arm, SPDT, unless noted otherwise. Where electronic actuators are used end switches provided with actuator will be allowed upon prior approval by owner.

2.7 EMCS CABLE

A. All EMCS cable shall be installed in conduit except as listed below when approved by Owner prior to award of contract. EMCS cable shall comply with manufacturer's recommendations. Separate raceway systems shall be supplied for Class I and Class II circuits.
   1. The following may use cable tray, j-hook, or other wire management device in lieu of conduit.
      a. RS-485 network cabling on non-life safety devices.
      b. Low voltage control wiring outside of mechanical rooms on non-life safety devices.

B. Data transmission trunk cables and equipment grounding procedures shall meet the latest FCC guidelines (FCC rules, part 15, subpart J) for electromagnetic field generation.

C. No splicing of RS-485 or RS-232 data cabling shall be allowed. Communication trunk shall be installed per manufacturers recommendation for operation at 19,200 baud or higher, continuous daisy chain with no tees and trunk terminators installed where appropriate. All communication and analog input wiring shall be AWG size as recommended by manufacturer with teflon jacket.

D. Splicing of temperature sensor cable is not allowed.

E. Splicing of binary status or command cable shall take place at the field cabinet or motor starter only.

2.8 DDC CONTROLLERS

A. Controllers shall be complete assemblies consisting of modular hardware including power supply, microcomputer, input/output modules, termination modules, and battery (where applicable). Battery (if applicable) shall be non-rechargeable lithium with 10 year life, and be capable of supporting all memory within the control unit if the house power to the unit is interrupted or lost for a minimum of 60 days total down time.

B. Controllers shall be furnished as newest revision level with largest available memory configuration unless prior approval by Owner. Verify controller type to be used in design with Owner. Most recent revision firmware shall be supplied unless otherwise noted. Point extension/slave devices shall NOT be utilized in the design without prior approval by the Owner. Each controller shall be provided with 10% spare point capacity. All controllers shall be provided with floor level (subnet) network capability and H-O-A switches at the output points unless approved otherwise by the Owner.

C. All points from a given mechanical system shall reside in the same controller.

D. Each Controller cabinet shall be able to monitor the following types of inputs:

Analog Inputs	Digital [Binary] Inputs
4-20 mA	Dry contact closure
0-10 VDC	Pulse accumulator
1000 ohm [10K Ohm]	

E. Controller cabinets shall directly control pneumatic and electronic actuators and control devices. Each control unit shall be capable of providing the following control outputs:

Analog Outputs	Digital [Binary] Outputs
4-20 mA	Motor starters, sizes 1 to 4
0-10 VDC	

F. All temperature control functions shall be executed within the same DDC Controller. Loop control shall be executed via direct digital control algorithms. The user shall be able to customize control strategies and sequences of control, and shall be able to define appropriate control loop algorithms and choose the optimum loop parameters for loop control. Upon Owner request the EMCS shall demonstrate stable loop control by utilizing test cabinet simulation program and trending the data. Control loops shall support any of the following control modes:

1. Two position (on-off, slow-fast, etc.)
2. Proportional (P)
3. Proportional plus integral (PI)
4. Proportional, integral, plus derivative (PID)

G. It shall be possible to fully create, modify, or remove control algorithms within a specific DDC Controller while it is operating and performing other control functions. Input for these changes may be made directly into the DDC Controller or via the network. Each control loop shall be fully user definable in terms of:

1. Sensors/actuators that are part of the control strategy.
2. Control mode.
3. Gain.
4. Control action.
5. Sampling time.

H. DDC Controllers shall be able to share point information such that control sequences or control loops executed at one control unit may receive input signals from sensors connected to other DDC Controllers within the network. If the network communication link fails or the other DDC Controller malfunctions, the control loop shall continue to function using the last value received from the Controller.

I. The system shall permit the generation of job-specific control strategies that can be activated in any of the following ways:

1. Continuously.
2. At a particular time of day.
3. On a pre defined date.
4. When a specific measured or controlled variable reads a selected value or state.
5. When a piece of equipment has run for a certain period of time.

J. Upon a loss of commercial power to any DDC Controller, the other units within the network shall not be affected and the loss of operation of that unit shall be reported at the designated operator's terminal. All control strategies and energy management routines defined for the DDC Controller shall be retained during power failure via the internal battery for a minimum of eight (8) hours. Upon resumption of commercial power the control unit shall resume full operation without operator intervention. The unit shall also automatically reset its clock such that proper operation of timed sequences is possible without the need for manual reset of the clock.

K. Location of DDC Controller cabinets shall be approved by the Owner prior to installation.

1. DDC controller cabinets and controller accessory cabinets are not to be used as a conduit path or electrical raceway. This includes packaged equipment controller cabinets, custom installed controller cabinets and zone level controller cabinets.
2. Provide electrical trough enclosure above all DDC system level controller cabinets and controller accessory cabinets.

L. Enclose and install control devices and equipment such that they will not be subject to vibration, excessive temperature, dirt, moisture, or other harmful effects or conditions beyond their rated limitations. If devices must be located so as to be subjected to conditions beyond their recommended or rated limitations, provide the necessary protective enclosures or furnish the equipment constructed of materials and features capable of withstanding the adverse conditions. Controls and devices subject to wetting or to the weather shall be corrosion resistant weather tight enclosures.

M. DDC programs shall follow MSU standard form and shall include discrete sections of code that are not intermingled with other sections of control, per the following:

1. Increment line numbers by 10 or more. First line number shall be greater than or equal to 10, last line number shall be less than or equal to 32000.
2. Place all time-based commands (e.g. WAIT, TOD, SAMPLE, LOOP) such that they are evaluated each pass through the program.
3. Include comments describing each section of code.
4. Section A shall include all diagnostic, power return, emergency point and other related code.
5. Section B shall include all equipment schedules.
6. Section C shall include all DDC and other equipment control.
7. Section D shall include all two-speed sequencing, alarm delays, alarm limits and miscellaneous code, and odd month determination.
8. Each DDC program shall include the alarm indicators code in Section A. Each DDC program shall include code in Section E that initialize the run time totals on all equipment defined for totalization.
9. Any air handling unit with a heating coil controlled through DDC shall include programming which places the unit in special operation on discharge sensor failure to prevent freezing of the heating and cooling coils.
10. Each controller cabinet shall include only as many programs as is necessary for programming modularity and ease of troubleshooting. If device operation is such that the existence of multiple programs within a single control has an effect on system performance or control timing, the presence of these multiple programs must receive prior approval by the Owner. Multiple programs , if present, shall be independent in functionality and shall not perform similar or identical functions (i.e. Start/Stop, Time of Day, etc). Each program shall be tested utilizing a test cabinet simulation to verify program functions properly, prior to loading in field cabinet.

N. Hot Water Heating Systems designed with 100% backup shall alternate pump/converter operation based on Odd/Even month per MSU standard programming. If a pump fails to operate, the backup pump shall be commanded on and a critical messaging output shall be sent to the appropriate destination workstation or printer (refer to item 1.2.A.6).

O. Point database entry shall follow these conventions:

1. Descriptors: AI: use range of device, e.g. 20-120; AO: use range of device and normal position of device, e.g. NC 3-15 (normally closed 3 to 15 PSI); DO: use valid commands, e.g. ON OFF: DI use word STATUS.

2. Alarmability: All alarmable points shall be displayed at each console screen on all applicable systems and the system event printer in MSU Central Control.
3. Critical Alarming: Include Critical Alarm messaging notification with necessary configuration and files tested for accuracy.
4. Change of Value Limit: No less than 2% and no greater than 10% of range of device.
5. Engineering Units: DEG F, AMPS, PPM, IN WC, PCT RH, PSI, CFM, GPM, etc.
6. Command String and State Descriptors: These two shall typically match each other. Some common entries are ON/OFF, ENABLE/OFF, OPEN/CLOSE, FAST/OFF/SLOW, ON/OFF/AUTO.
7. Totalization: All points that indicate the run-time of a piece of equipment shall be included in this summary with time totalized per hour.
8. Contact State Descriptor: Fire alarm and fire trouble points: use a period for both states. Control air compressor: use a period for the normal state and LOW for the off-normal state. Avoid using the words NORMAL and ALARM as state descriptors for alarmable points. Return to Normal Printouts: Yes, in all instances. Critical Alarms shall not report their return to normal state to via a message to the critical massaging output device unless approved by the Owner.
9. Naming convention shall follow MSU Standard and approved through Central Control.
    a. Definitions:
        1) BLDG: Building abbreviation provided by Central Control.
        2) SYS: System abbreviation, e.g., HW=Hot Water Heating, CHW=Chilled Water, HVAC or HV=Air Delivery Systems (AHU is NOT allowed) or RM: System abbreviation for room level unit
        3) #: Unit or room number shown on construction documents or approved by Central Control.
        4) DESC: Point/equipment description, e.g., VAV, CAV, FCU, FTR.
    b. Building System Format: Shall use either spaces or underscore (_) between name sections and shall be in the following order: BLDG_SYS_#_DESC
    c. Room Level Controller Format: Shall use either spaces or underscore (_) between name sections and shall be in the following order: BLDG_RM_#_DESC

2.9 ADVANCED APPLICATION CONTROLLERS

A. Each DDC controller shall be able to extend its performance and capacity through the Use of floor level (subnet), advanced application controllers (AAC).

B. Each AAC shall operate as a stand-alone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each AAC shall be a microprocessor-based, multi-tasking, real-time digital control processor, and fully programmable.

C. Terminal Box Controllers - Provide control of individual pieces of equipment including, but not limited to, the following:

1. Variable air volume (VAV) boxes.
2. Constant air volume (CAV) boxes.
3. Unit Conditioners.
4. Unit Ventilators.

D. Controllers shall include all point inputs and outputs necessary to perform the specified control sequences.

E. Each controller performing space temperature control shall be provided with a matching room temperature sensor. Each room temperature sensor shall be provided with a terminal jack to be used to connect a portable operator’s terminal to control and monitor AAC points, setpoint adjustment dial, temperature indicator, and override switch.

F. A dedicated power source and separate isolation transformer for each AAC Power Trunk shall be provided. Transformer shall be mounted in a separate auxiliary enclosure.

2.10 APPLICATION SPECIFIC CONTROLLERS

A. Application specific controllers (ASCs) shall NOT be utilized unless approved by the Owner prior to project bid.

2.11 ELECTRONIC ACTUATORS

A. Unless approved otherwise by the Owner, all actuation shall be electronic.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install engraved laminated plastic nameplates under each instrument in the control panel to designate its function.

B. All devices connecting to EMCS such as contactors, motor starters, electric pneumatic transducers, pressure electric transducers, resistance temperature detectors, relays, terminal box controllers, etc., shall be marked with the same point number used on the shop drawing SUBMITTALS for the system so as to identify the point and its function for University field service personnel. Marking shall be done with gummed paper tags installed on the surfaces that have been steel wool cleaned and sprayed with clear enamel for waterproofing.

C. Wire shall be color coded according to the Construction Representative's directions.

D. Dedicated circuits shall be installed in branch lighting panels to serve controller cabinets. Circuit breakers shall be equipped with locking clips, and shall be clearly identified.

E. All Controller Cabinets and auxiliary enclosures shall be supplied with engraved phenolic nameplates permanently attached identifying their field cabinet number, area, fan systems controlled, etc.

F. Special equipment shall be installed in accordance with manufacturer's instructions and recommendations of Service Engineer where specified or required. All control instruments, valves, etc., shall be carefully adjusted and set for proper operating of the equipment served as noted herein or as required by the equipment manufacturer's instructions and recommendations.

3.2 FIELD QUALITY CONTROL

A. Upon completion of the work, the EMCS Contractor shall instruct the Owner's Operating Engineer and acquaint him with all of the operating characteristics of all equipment installed by him including the EMCS and all other systems, at the same time operating each and every system individually for a period of two days, unless otherwise specified. During this two day period the building's Operations Manual shall be used for reference.

B. During system commissioning and at such time acceptable performance of the installed system hardware and software has been established, the Contractor shall provide on-site operator instruction to the Owner's operating personnel. Operator instruction during normal working hours will be performed by competent contractor representatives familiar with the computer's software, hardware, and accessories.

C. At a time mutually agreed upon during system commissioning as stated above, the EMCS Contractor shall give an absolute minimum 24 hours of instruction to the Owner's designated personnel on the operation of all equipment included in the project. Operator orientation of the automation system will include, but not be limited to equipment functions, commands, advisories, appropriate operator intervention required in responding to the system's operation, and any other training needed in the operation of the system. An Owner's manual prepared for this project by the Contractor will be used in addition to the instruction. Six (6) manuals shall be provided.

D. Additional instruction time as deemed necessary by the Owner shall be provided by the Contractor as an extra service, and will be paid for in accordance with the State Prevailing Wage Rates for Engineers and Technicians.

3.3 ACCEPTANCE PROCEDURE

A. SUBMITTALS data relevant to point index, functions limits, sequences, interlocks, power fail/restarts, logs, software routines and associated parameters, and other pertinent information for the operating system and data base shall be forwarded from the EMCS contractor to the Owner.

B. Approved data base will be entered into the central computer, debugged, and down line loaded to Controllers. Prior to on-line operation a complete demonstration and readout of the computer command shall be performed in the presence of the Owner. In addition, a printout of the data base generated for all points shall be reviewed with the Owner by the EMCS contractor. Modification to the data base shall be made by the EMCS contractor as directed by the Owner.

C. All points shall be verified prior to "punch-out" for correct and accurate correspondence between the CRT data display and actual field location and equipment operation.

D. The Contractor shall maintain dated and initialed calibration and verification sheets and provide a copy to the Owner. Include verification of enhanced alarming with messages for all points selected by the Owner. Typical points with messages include control air compressors, 24 hour fans and pumps, critical systems and animal areas. Point verification sheets can be obtained in Central Control.

E. Upon successful completion of system generation the Owner shall be requested in writing to inspect and approve the satisfactory operation of the EMCS, sub-systems, and accessories.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls.

END OF SECTION 230923

SECTION 232113 – HYDRONIC PIPING

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 pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:

1. Hot-water heating piping.
2. Chilled-water piping.
3. Condensate-drain piping.
4. Air-vent piping.
5. Safety-valve-inlet and -outlet piping.

B. Related Sections include the following:

1. Division 23 Section "Hydronic Pumps" for pumps, motors, and accessories for hydronic piping.

1.3 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the minimum working pressure and temperature.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
2. Air control devices.
3. Hydronic specialties.

B. Shop Drawings: Detail the piping layout, fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

B. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01.

C. Piping materials shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 COPPER PIPE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L (ASTM B 88M, Type B).

B. Wrought-Copper Fittings: ASME B16.22.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Anvil International, Inc.
b. Grinnell.
c. Victaulic Company of America.

2. Grooved-End Copper Fittings: ASTM B 75 (ASTM B 75M), copper tube or ASTM B 584, bronze casting.
3. Grooved-End-Tube Couplings: Rigid pattern, unless otherwise indicated; gasketed fitting. Ductile-iron housing with keys matching pipe and fitting grooves, prelubricated EPDM gasket rated for minimum 230 deg F (110 deg C) for use with housing, and steel bolts and nuts.

2.2 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; type, grade, and wall thickness as indicated in Part 3 "Piping Applications" Article.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in Part 3 "Piping Applications" Article.

C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in Part 3 "Piping Applications" Article.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 "Piping Applications" Article.

E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in Part 3 "Piping Applications" Article.

F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

G. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.
2. End Connections: Butt welding.
3. Facings: Raised face.

H. Grooved Mechanical-Joint Fittings and Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Anvil.
   b. Grinnell.
   c. Victaulic Company of America.

2. Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47/A 47M, Grade 32510 malleable iron; ASTM A 53/A 53M, Type F, E, or S, Grade B fabricated steel; or ASTM A 106, Grade B steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
3. Couplings: Ductile- or malleable-iron housing and synthetic rubber gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
4. Gasket material for water service up to 200 deg F shall be EPDM rubber, grade E.

I. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

2.3 VALVES

A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 23 Section "General-Duty Valves for HVAC Piping."

B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Division 23 Section "Instrumentation and Control for HVAC."

C. Bronze, Calibrated-Orifice, Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Armstrong Pumps, Inc.
   b. Bell & Gossett Domestic Pump; a division of ITT Industries.
   c. Flow Design Inc.
   d. Griswold Controls.
   e. Nexus Valve.
   f. Taco.
   g. Tour & Anderson; available through Victaulic Company of America.

2. Body: Bronze, ball or plug type with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
4. Plug: Resin.

5. Seat: PTFE.
6. End Connections: Threaded or socket.
7. Pressure Gage Connections: Integral seals for portable differential pressure meter.
8. Handle Style: Lever, with memory stop to retain set position.
9. CWP Rating: Minimum 125 psig (860 kPa).
10. Maximum Operating Temperature: 250 deg F (121 deg C).

D. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Armstrong Pumps, Inc.
    b. Bell & Gossett Domestic Pump; a division of ITT Industries.
    c. Flow Design Inc.
    d. Griswold Controls.
    e. Nexus Valve.
    f. Taco.
    g. Tour & Anderson; available through Victaulic Company of America.

2. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
4. Stem Seals: EPDM O-rings.
5. Disc: Glass and carbon-filled PTFE.
6. Seat: PTFE.
7. End Connections: Flanged or grooved.
8. Pressure Gage Connections: Integral seals for portable differential pressure meter.
9. Handle Style: Lever, with memory stop to retain set position.
10. CWP Rating: Minimum 125 psig (860 kPa).
11. Maximum Operating Temperature: 250 deg F (121 deg C).

E. Diaphragm-Operated, Pressure-Reducing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Armstrong Pumps, Inc.
    b. Bell & Gossett Domestic Pump; a division of ITT Industries.
    c. Conbraco Industries, Inc.
    d. Spence Engineering Company, Inc.
    e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Body: Bronze or brass.
3. Disc: Glass and carbon-filled PTFE.
4. Seat: Brass.
5. Stem Seals: EPDM O-rings.

6. Diaphragm: EPT.
7. Low inlet-pressure check valve.
8. Inlet Strainer: Removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.
10. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

F. Diaphragm-Operated Safety Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Armstrong Pumps, Inc.
    b. Bell & Gossett Domestic Pump; a division of ITT Industries.
    c. Conbraco Industries, Inc.
    d. Spence Engineering Company, Inc.
    e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Body: Bronze or brass.
3. Disc: Glass and carbon-filled PTFE.
4. Seat: Brass.
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.
7. Wetted, Internal Work Parts: Brass and rubber.
8. Inlet Strainer: Removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.
10. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

G. Automatic Flow-Control Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Flow Design Inc.
    b. Griswold Controls.
    c. Nexus Valve.

2. Body: Brass or ferrous metal.
3. Piston and Spring Assembly: Stainless steel, tamper proof, self cleaning, and removable.
4. Combination Assemblies: Include bronze or brass-alloy ball valve.
5. Identification Tag: Marked with zone identification, valve number, and flow rate.
6. Size: Same as pipe in which installed.
7. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations.

8. Minimum CWP Rating: 175 psig (1207 kPa).
9. Maximum Operating Temperature: 250 deg F (121 deg C).

2.4 AIR CONTROL DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Amtrol, Inc.
2. Armstrong Pumps, Inc.
3. Bell & Gossett Domestic Pump; a division of ITT Industries.
4. Spirotherm.
5. Taco.

B. Manual Air Vents:

1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. Operator: Screwdriver or thumbscrew.
4. Inlet Connection: NPS ½ (DN 15).
5. Discharge Connection: NPS 1/8 (DN 6).
6. CWP Rating: 150 psig (1035 kPa).
7. Maximum Operating Temperature: 225 deg F (107 deg C).
8. Basis of Design: Bell & Gossett No. 4V.

C. Automatic Air Vents:

1. Body: Bronze or cast iron.
2. Internal Parts: Nonferrous.
3. Operator: Noncorrosive metal float.
4. Inlet Connection: NPS ½ (DN 15).
5. Discharge Connection: NPS ¼ (DN 8).
6. CWP Rating: 150 psig (1035 kPa).
7. Maximum Operating Temperature: 240 deg F (116 deg C).
8. Basis of Design: Bell & Gossett No. 87.

2.5 HYDRONIC PIPING SPECIALTIES

A. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.

3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig (860 kPa).

B. Stainless-Steel Bellow, Flexible Connectors:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Flex-Hose Co.
   b. Mason Industries.
   c. Metraflex.
   d. Twin City Hose.
   e. US Hose Corporation; Series 401M.

2. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
3. End Connections: Threaded or flanged to match equipment connected.
4. Performance: Capable of 3/4-inch (20-mm) misalignment.
5. CWP Rating: 150 psig (1035 kPa).
6. Maximum Operating Temperature: 250 deg F (121 deg C).

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Hot-water heating piping, aboveground, NPS 2 (DN 50) and smaller, shall be the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
2. Schedule 40 steel pipe; Class 125, cast-iron fittings; cast-iron flanges and flange fittings; and threaded joints.

B. Hot-water heating piping, aboveground, NPS 2-1/2 (DN 65) and larger, shall be any of the following:

1. Schedule 40 type E or S grade B black steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
2. Grooved, mechanical-joint fittings and couplings are not allowed for hot-water heating piping.

C. Chilled-water piping, aboveground, NPS 2 (DN 50) and smaller, shall be the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
2. Schedule 40 steel pipe; Class 125 cast-iron or 150 malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints.

D. Chilled-water piping, aboveground, NPS 2-1/2 (DN 65) and larger, shall be any of the following:

1. Schedule 40 type E or S grade B black steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
2. Schedule 40 type E or S grade B black steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.

E. Condenser-water piping, aboveground, NPS 2 (DN 50) and smaller, shall be the following:

1. Schedule 40 steel pipe; Class 125 cast-iron or 150 malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints.

F. Condenser-water piping, aboveground, NPS 2-1/2 (DN 65) and larger, shall be any of the following:

1. Schedule 40 type E or S grade B black steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
2. Schedule 40 type E or S grade B black steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.

G. Condensate-Drain Piping:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
2. The diameter of the condensate drain line must be equal to or greater than the exit diameter of the drain seal device, but not less than 1-1/2". The line length should be the minimum possible, following the shortest path to the condensate disposal area. It should include the least possible number of elbows.
3. The line must be sloped away from the drain seal at a rate of no less than 1/8-inch per foot.
4. Drain line supports must be fixed solidly in place and provided at intervals that ensure that an uniform slope is maintained, and that any dips formed in the line do not trap condensate and debris; Maximum 3' intervals for PVC, and 6' intervals for copper.

H. Grooved Piping:

1. Grooved pipe connections may be used only for services as listed above and only within the building in accessible locations. Mechanical chases and wall cavities are not considered accessible. Locations shall be approved by PDC project mechanical engineer.
2. The use of mechanical grooved pipe connections will not relieve the Contractor from providing the vibration isolation as specified in Division 23 Section “Vibration Controls for HVAC Piping and Equipment” and as indicated on drawings. Credit for the inherent flexibility of grooved pipe connections when used for expansion joints and flexible pipe connectors may be allowed upon specific application by the Contractor. Include proposed application and layout, and supporting calculations for the intended service.
3. Victaulic Flexible Couplings Style 77 installed per manufacturer’s recommendation may be used in lieu of metal hose flexible connectors.

I. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.

J. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.

3.2 VALVE APPLICATIONS

A. Install shutoff-duty valves at all zones, risers, control valves, each branch connection to supply mains, and at supply connection to each piece of equipment. Use ball valves for 2” in sizes and smaller, and butterfly valves for 2-1/2” in sizes and larger. Valves shall be easily accessible from floor, located not higher than 10' above floor finish.

B. Install throttling-duty valves at each branch connection to return main.

C. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.

D. Install check valves at each pump discharge and elsewhere as required to control flow direction.

E. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; and pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

F. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

3.3 PIPING INSTALLATIONS

A. Refer to Division 23 Section “Common Work Results for HVAC” for basic installation requirements.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install drains, consisting of a tee fitting, NPS 3/4 (DN 20) ball valve, and short NPS 3/4 (DN 20) threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

D. Water piping system shall be installed in such a manner that the entire systems can be completely drained. Particular care shall be exercised to avoid air and water pockets in piping.

E. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

F. Pitch piping up in the direction of flow to a high point containing an air vent or a runout up to a room terminal unit. Install manual air vent at high points in piping systems and terminal units.

G. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

H. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the top of the main pipe with a 45-degree for the horizontal plane. Never below horizontal. Follow standard details for proper venting points (chilled water coils, HHW coils, finned tube, unit heaters, reheat, etc.). For up-feed risers, connect the branch to the top of the main pipe.

I. Hole cut piping, pressfit, and plain end piping systems will not be accepted.

J. Reducing couplings, snap-joint couplings, and Vic-boltless couplings are not acceptable.

K. Install valves according to Division 23 Section "General-Duty Valves for HVAC Piping."

L. Install unions in piping, NPS 2 (DN 50) and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

M. Install flanges in piping, NPS 2-1/2 (DN 65) and larger, at final connections of equipment and elsewhere as indicated.

N. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 (DN 20) nipple and ball valve in blowdown connection of strainers NPS 2 (DN 50) and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2 (DN 50).

O. Identify piping as specified in Division 23 Section "Identification for HVAC Piping and Equipment."

3.4 HANGER AND SUPPORT INSTALLATION

A. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet (6 m) long.
2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet (6 m) or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet (6 m) or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

B. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4 (DN 20): Maximum span, 7 feet (2.1 m); minimum rod size, 1/4 inch (6.4 mm).
2. NPS 1 (DN 25): Maximum span, 7 feet (2.1 m); minimum rod size, 1/4 inch (6.4 mm).
3. NPS 1-1/2 (DN 40): Maximum span, 9 feet (2.7 m); minimum rod size, 3/8 inch (10 mm).
4. NPS 2 (DN 50): Maximum span, 10 feet (3 m); minimum rod size, 3/8 inch (10 mm).
5. NPS 2-1/2 (DN 65): Maximum span, 11 feet (3.4 m); minimum rod size, 3/8 inch (10 mm).
6. NPS 3 (DN 80): Maximum span, 12 feet (3.7 m); minimum rod size, 3/8 inch (10 mm).
7. NPS 4 (DN 100): Maximum span, 14 feet (4.3 m); minimum rod size, 1/2 inch (13 mm).

C. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4 (DN 20): Maximum span, 5 feet (1.5 m); minimum rod size, 1/4 inch (6.4 mm).
2. NPS 1 (DN 25): Maximum span, 6 feet (1.8 m); minimum rod size, 1/4 inch (6.4 mm).
3. NPS 1-1/2 (DN 40): Maximum span, 8 feet (2.4 m); minimum rod size, 3/8 inch (10 mm).
4. NPS 2 (DN 50): Maximum span, 8 feet (2.4 m); minimum rod size, 3/8 inch (10 mm).
5. NPS 2-1/2 (DN 65): Maximum span, 9 feet (2.7 m); minimum rod size, 3/8 inch (10 mm).
6. NPS 3 (DN 80): Maximum span, 10 feet (3 m); minimum rod size, 3/8 inch (10 mm).

D. Support vertical runs at roof, at each floor, and at 10-foot (3-m) intervals between floors.

3.5 PIPE JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Steel Pipe:

1. All welding shall be done in accordance with the ANSI B-31.1 and the ASME welding code.
2. Pipe ends on welded pipe lines shall be suitably beveled to permit butt-welding.
3. All welds shall be of sound metal thoroughly fused to the base metal and penetrating to the bottom of the joints.
4. Use welding bends in changing pipe directions. Mitered joints will not be accepted.
5. Welders shall be experienced in the type of work to be done. Any welder, who, in the opinion of the Architect/Engineer or Construction Representative, is not competent to perform the work required, shall be dismissed from the job. At no time shall any welder not approved by the Architect/Engineer be allowed to weld pipe on the project.
6. All welders shall be certified under the procedure of the ANSI B-31.1 and the ASME Welding Code, Section 9, for the thickness and type of high pressure piping and equipment they work on. Tests shall be conducted by Hartford Insurance Co., or equivalent certifying agency. The Engineer shall be sent a copy of the certification of all welders employed on the project.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

I. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings.

3.6 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

B. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Manual vents at heat-transfer coils and elsewhere as required for air venting.

C. Install expansion tanks on the floor. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system Project requirements.

3.7 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install ports for pressure gages and thermometers at coil inlet and outlet connections according to Division 23 Section "Meters and Gages for HVAC Piping."

3.8 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. All piping shall be cleaned before installation, and flushed after the installation and before startup. When grease and oil are used in the piping assembly a cleaning agent shall be introduced into the system while cleaning and circulated throughout the system as prescribed by a qualified water treatment company. After the system is completely flushed a certificate of cleaning shall be issued by the responsible party. All equipment and cleaning agents shall be supplied by an approved water treatment company such as H.V. Burton Company, Aurora Specialty Chemisties or approved equal.
4. Before cleaning begins remove any instruments which may be damaged by the cleaning procedure. After cleaning is complete and system is drained, all strainers shall be cleaned or replaced and startup screens removed. Instruments that were removed shall be put back into operating mode.
5. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
6. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.

4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

END OF SECTION 232113

SECTION 232300 - REFRIGERANT PIPING

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 refrigerant piping used for food preservation and air-conditioning applications.

1.3 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-410A:

1. Suction Lines for Air-Conditioning Applications: 300 psig (2068 kPa).
2. Suction Lines for Heat-Pump Applications: 535 psig (3689 kPa).
3. Hot-Gas and Liquid Lines: 535 psig (3689 kPa).

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for the following:

1. Thermostatic expansion valves.
2. Solenoid valves.
3. Hot-gas bypass valves.
4. Filter dryers.
5. Strainers.
6. Pressure-regulating valves.

B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.
1. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.8 PRODUCT STORAGE AND HANDLING

A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

1.9 COORDINATION

A. Coordinate size and location of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B) or ASTM B 280, Type ACR.

B. Wrought-Copper Fittings: ASME B16.22.

C. Wrought-Copper Unions: ASME B16.22.

D. Silver Solder: Cadmium-free high-silver alloy consisting of at least 45% silver.

E. Brazing Filler Metals: Phosphorus/copper/silver alloy consisting of 15% silver.

F. Flexible Connectors:

1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
2. End Connections: Socket ends.
3. Offset Performance: Capable of minimum 3/4-inch (20-mm) misalignment in minimum 7-inch- (180-mm-) long assembly.
4. Pressure Rating: Factory test at minimum 500 psig (3450 kPa).
5. Maximum Operating Temperature: 250 deg F (121 deg C).

2.2 VALVES AND SPECIALTIES

A. Diaphragm Packless Valves:

1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
3. Operator: Rising stem and hand wheel.
4. Seat: Nylon.
5. End Connections: Socket, union, or flanged.
6. Working Pressure Rating: 500 psig (3450 kPa).
7. Maximum Operating Temperature: 275 deg F (135 deg C).

B. Packed-Angle Valves:

1. Body and Bonnet: Forged brass or cast bronze.
2. Packing: Molded stem, back seating, and replaceable under pressure.
3. Operator: Rising stem.
4. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
5. Seal Cap: Forged-brass or valox hex cap.
6. End Connections: Socket, union, threaded, or flanged.
7. Working Pressure Rating: 500 psig (3450 kPa).
8. Maximum Operating Temperature: 275 deg F (135 deg C).

C. Check Valves:

1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
3. Piston: Removable polytetrafluoroethylene seat.
4. Closing Spring: Stainless steel.
5. End Connections: Socket, union, threaded, or flanged.
6. Maximum Opening Pressure: 0.50 psig (3.4 kPa).
7. Working Pressure Rating: 500 psig (3450 kPa).
8. Maximum Operating Temperature: 275 deg F (135 deg C).

D. Service Valves:

1. Body: Forged brass with brass cap including key end to remove core.
2. Core: Removable ball-type check valve with stainless-steel spring.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Copper spring.
5. Working Pressure Rating: 500 psig (3450 kPa).

E. Solenoid Valves: Comply with ARI 760 and UL 429; listed and labeled by an NRTL.

1. Body and Bonnet: Plated steel.
2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch (16-GRC) conduit adapter, and [**24**] [**115**] [**208**]-V ac coil.
6. Working Pressure Rating: 400 psig (2760 kPa).
7. Maximum Operating Temperature: 240 deg F (116 deg C).

F. Safety Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.

1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
2. Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Seat Disc: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Working Pressure Rating: 400 psig (2760 kPa).
6. Maximum Operating Temperature: 240 deg F (116 deg C).

G. Thermostatic Expansion Valves: Comply with ARI 750.

1. Body, Bonnet, and Seal Cap: Forged brass or steel.
2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Packing and Gaskets: Non-asbestos.
4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
5. Superheat: Adjustable.
6. Reverse-flow option (for heat-pump applications).
7. End Connections: Socket, flare, or threaded union.

H. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.

1. Body, Bonnet, and Seal Cap: Ductile iron or steel.
2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Packing and Gaskets: Non-asbestos.
4. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
5. Seat: Polytetrafluoroethylene.
6. Equalizer: Internal.

7. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch (16-GRC) conduit adapter, and [**24**] [**115**] [**208**]-V ac coil.
8. End Connections: Socket.
9. Throttling Range: Maximum 5 psig (34 kPa).
10. Working Pressure Rating: 500 psig (3450 kPa).
11. Maximum Operating Temperature: 240 deg F (116 deg C).

I. Straight-Type Strainers:

1. Body: Welded steel with corrosion-resistant coating.
2. Screen: 100-mesh stainless steel.
3. End Connections: Socket or flare.
4. Working Pressure Rating: 500 psig (3450 kPa).
5. Maximum Operating Temperature: 275 deg F (135 deg C).

J. Angle-Type Strainers:

1. Body: Forged brass or cast bronze.
2. Drain Plug: Brass hex plug.
3. Screen: 100-mesh monel.
4. End Connections: Socket or flare.
5. Working Pressure Rating: 500 psig (3450 kPa).
6. Maximum Operating Temperature: 275 deg F (135 deg C).

K. Moisture/Liquid Indicators:

1. Body: Forged brass.
2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
3. Indicator: Color coded to show moisture content in ppm.
4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
5. End Connections: Socket or flare.
6. Working Pressure Rating: 500 psig (3450 kPa).
7. Maximum Operating Temperature: 240 deg F (116 deg C).

L. Replaceable-Core Filter Dryers: Comply with ARI 730.

1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated charcoal.
4. End Connections: Socket.
5. Access Ports: NPS 1/4 (DN 8) connections at entering and leaving sides for pressure differential measurement.
6. Maximum Pressure Loss: 2 psig (14 kPa).
7. Working Pressure Rating: 500 psig (3450 kPa).
8. Maximum Operating Temperature: 240 deg F (116 deg C).

M. Permanent Filter Dryers: Comply with ARI 730.

1. Body and Cover: Painted-steel shell.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated charcoal.
4. End Connections: Socket.
5. Access Ports: NPS 1/4 (DN 8) connections at entering and leaving sides for pressure differential measurement.
6. Maximum Pressure Loss: 2 psig (14 kPa).
7. Working Pressure Rating: 500 psig (3450 kPa).
8. Maximum Operating Temperature: 240 deg F (116 deg C).

N. Mufflers:

1. Body: Welded steel with corrosion-resistant coating.
2. End Connections: Socket or flare.
3. Working Pressure Rating: 500 psig (3450 kPa).
4. Maximum Operating Temperature: 275 deg F (135 deg C).

O. Receivers: Comply with ARI 495.

1. Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
2. Comply with UL 207; listed and labeled by an NRTL.
3. Body: Welded steel with corrosion-resistant coating.
4. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.
5. End Connections: Socket or threaded.
6. Working Pressure Rating: 500 psig (3450 kPa).
7. Maximum Operating Temperature: 275 deg F (135 deg C).

P. Liquid Accumulators: Comply with ARI 495.

1. Body: Welded steel with corrosion-resistant coating.
2. End Connections: Socket or threaded.
3. Working Pressure Rating: 500 psig (3450 kPa).
4. Maximum Operating Temperature: 275 deg F (135 deg C).

2.3 REFRIGERANTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Atofina Chemicals, Inc.
2. DuPont Company; Fluorochemicals Div.
3. Honeywell, Inc.; Genetron Refrigerants.
4. INEOS Fluor Americas LLC.

B. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Suction Lines for Conventional Air-Conditioning Applications: Copper, Type L (B) or ACR, drawn-temper tubing and wrought-copper fittings with brazed or silver soldered joints.

B. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type L (B) or ACR, drawn-temper tubing and wrought-copper fittings with brazed or silver soldered joints.

C. Safety-Relief-Valve Discharge Piping: Copper, Type L (B) or ACR, drawn-temper tubing and wrought-copper fittings with brazed or silver soldered joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

A. Install diaphragm packless valves in suction and discharge lines of compressor.

B. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.

C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

D. Except as otherwise indicated, install diaphragm packless valves on inlet and outlet side of filter dryers.

E. Install a full-sized, three-valve bypass around filter dryers.

F. Install thermostatic expansion valves as close as possible to distributors on evaporators.

1. Install valve so diaphragm case is warmer than bulb.
2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

G. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.

H. Install moisture/liquid indicators in liquid line in close proximity of the receiver outlet and at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

I. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:

1. Solenoid valves.
2. Thermostatic expansion valves.
3. Compressor.

J. Install filter dryers in liquid line between compressor and thermostatic expansion valve, and in the suction line at the compressor.

K. Install receivers sized to accommodate pump-down charge.

L. Install flexible connectors at compressors.

3.3 PIPING INSTALLATION

A. Refer to Division 23 Section “Common Work Results for HVAC” for basic installation requirements.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.

C. Install refrigerant piping according to ASHRAE 15.

D. Refer to Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls" for solenoid valve controllers, control wiring, and sequence of operation.

E. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

F. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Division 08 Section "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

G. Install refrigerant piping in protective conduit where installed belowground.

H. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

I. Slope refrigerant piping as follows:

1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.

2. Install horizontal suction lines with a uniform slope downward to compressor.
3. Install traps and double risers to entrain oil in vertical runs.
4. Liquid lines may be installed level.

J. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

K. Prior to brazing and soldering, fill piping with dry grade nitrogen. Continue to flow nitrogen through piping at a rate of 20 fpm while piping is being heated to prevent oxidation of inside of piping and fittings.

L. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

M. Identify refrigerant piping and valves according to Division 23 Section "Identification for HVAC Piping and Equipment."

N. Install sleeves for piping penetrations of walls, ceilings, and floors.

O. Install sleeve seals for piping penetrations of concrete walls and slabs.

P. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.4 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."

D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."

3.5 HANGERS AND SUPPORTS

A. Hanger, support, and anchor products are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet (6 m) long.
2. Roller hangers and spring hangers for individual horizontal runs 20 feet (6 m) or longer.

3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet (6 m) or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Cushioned-clamp hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:

1. NPS 1/2 (DN 15): Maximum span, 60 inches (1500 mm); minimum rod size, 1/4 inch (6.4 mm).
2. NPS 5/8 (DN 18): Maximum span, 60 inches (1500 mm); minimum rod size, 1/4 inch (6.4 mm).
3. NPS 1 (DN 25): Maximum span, 72 inches (1800 mm); minimum rod size, 1/4 inch (6.4 mm).

D. Support multifloor vertical runs at least at each floor.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.

    a. Fill system with nitrogen to the required test pressure.
    b. System shall maintain test pressure within 2% at the manifold gage throughout duration of test. Pressure test duration shall not be less than 4 hours.
    c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
    d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.
    e. At the request of the Owner’s Representative, the Contractor shall cut open the refrigerant piping for inspection during site visits to verify the use of dry nitrogen as indicated in Section 3.3 above. Up to 4 locations may be selected at random by the Owner’s Representative. If evidence of non-compliance is discovered the affected piping shall be removed until clean piping is confirmed. If significant contamination is encountered at more than 4 locations the entire system will be considered to be contaminated. All affected piping shall be replaced and/or repaired at the Contractor’s expense.

3.7 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers (67 Pa). If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig (14 kPa).
4. Charge system with a new filter-dryer core in charging line.

3.8 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:

1. Open shutoff valves in condenser water circuit.
2. Verify that compressor oil level is correct.
3. Open compressor suction and discharge valves.
4. Open refrigerant valves except bypass valves that are used for other purposes.
5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 232300

SECTION 233113 - METAL DUCTS

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. Single-wall rectangular ducts and fittings.
2. Double-wall rectangular ducts and fittings.
3. Single-wall round and flat-oval ducts and fittings.
4. Double-wall round and flat-oval ducts and fittings.
5. Sheet metal materials.
6. Sealants and gaskets.
7. Hangers and supports.

B. Related Sections:

1. Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Division 23 Section "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article unless otherwise indicated.

B. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.4 SUBMITTALS

A. Product Data: For each type of the following products:

1. Sealants and gaskets.

B. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment and vibration isolation.

C. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including the following:

    a. Lighting fixtures.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.
    e. Access panels.
    f. Perimeter moldings.

D. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Standing seams T-15, angle reinforced standing seams T-16, welded flange T-21, reinforced welded flange T-21a, companion angles T-22, and formed-on flanges T-25a (TDC) and T-25b (TDF)
2. Use of drives slip seams on sides is acceptable for unreinforced ducts.
3. Use of tie rodded reinforcement alternative is not acceptable.

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. All longitudinal seams on flat sides shall be of the grooved seam L-3.
2. All longitudinal corner seams shall be of the Pittsburgh lock L-1.

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Smooth radius with at least one splitter vane and square throat R/W equal to 0.5 or higher.

2. Mitered and Tee-shape elbows with turning vanes are acceptable where space restrictions dictate.
3. Select 45 degree entry tees, conical or bell mouth tees, or wyes. Straight tap connections will not be accepted.

E. As an option, Ductmate proprietary duct connection systems may be used with permission of the Architect/Engineer. Refer to the manufacturer guidelines for sheet gauge, intermediate reinforcement size and spacing, and joint reinforcements.

2.2 DOUBLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. McGill AirFlow LLC.

B. Rectangular Ducts: Fabricate ducts with indicated dimensions for the inner duct.

C. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

D. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

E. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

F. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F (0.039 W/m x K) at 75 deg F (24 degree C) mean temperature.
2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
3. Coat insulation with antimicrobial coating.
4. Cover insulation with polyester film complying with UL 181, Class 1.

G. Interstitial Insulation: Flexible elastomeric duct liner complying with ASTM C 534, Type II for sheet materials, and with NFPA 90A or NFPA 90B.

1. Maximum Thermal Conductivity: 0.25 Btu x in./h x sq. ft. x deg F (0.034 W/m x K) at 75 deg F (24 degree C) mean temperature.

H. Inner Duct: Minimum 0.028-inch (0.7 mm) solid sheet steel.

I. Formed-on Transverse Joints (Flanges): Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Traverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

J. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Lindab Inc.
b. McGill AirFlow LLC.
c. SEMCO Incorporated.

B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).

C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse Joints in Ducts Larger Than 60 Inches (1524 mm) in Diameter: Flanged.
2. Lap at least 2 inches in direction of air flow and securely fastened with screws through the lap on center spacing not to exceed 2 ½ inches.

D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Fabricate round ducts larger than 90 (2286 mm) inches in diameter with butt-welded longitudinal seams.
2. Fabricate flat-oval ducts larger than 72 inches (1830 mm) in width (major dimension) with butt-welded longitudinal seams.

E. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

F. Elbows: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," unless otherwise indicated.

1. Smooth radius stamped elbows for 8" ducts and smaller. 5-piece segmented elbows for 9" duct and larger.
2. Elbows shall have a centerline radius at least equal to 1.0 times the duct diameter. Mitered elbow will not be accepted.

2.4 DOUBLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Lindab Inc.
2. McGill AirFlow LLC.
3. SEMCO Incorporated.

B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension) of the inner duct.

C. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.

1. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

    a. Transverse Joints in Ducts Larger Than 60 Inches (1524 mm) in Diameter: Flanged.

2. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

    a. Fabricate round ducts larger than 90 (2286 mm) inches in diameter with butt-welded longitudinal seams.
    b. Fabricate flat-oval ducts larger than 72 (1830 mm) inches in width (major dimension) with butt-welded longitudinal seams.

3. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Inner Duct: Minimum 0.028-inch (0.7 mm) solid sheet steel.

E. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F (0.039 W/m x K) at 75 deg F (24 degree C) mean temperature.
2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
3. Coat insulation with antimicrobial coating.
4. Cover insulation with polyester film complying with UL 181, Class 1.

2.5 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G90 (Z275).
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. PVC-Coated, Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G90 (Z275).
2. Minimum Thickness for Factory-Applied PVC Coating: 4 mils (0.10 mm) thick on sheet metal surface of ducts and fittings exposed to corrosive conditions, and minimum 1 mil (0.025 mm) thick on opposite surface.
3. Coating Materials: Acceptable to authorities having jurisdiction for use on ducts listed and labeled by an NRTL for compliance with UL 181, Class 1.

D. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.

E. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.

F. Aluminum Sheets: Comply with ASTM B 209 (ASTM B 209M) Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

G. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

H. Tie Rods: Galvanized steel, 1/4-inch (6 mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10 mm) minimum diameter for lengths longer than 36 inches (900 mm).

2.6 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width: 3 inches (76 mm).
3. Sealant: Modified styrene acrylic.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 degree C).
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.

C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
10. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
11. VOC: Maximum 395 g/L.
12. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive or negative.
13. Service: Indoor or outdoor.
14. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.

E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

2.7 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Hot-dipped galvanized steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round and flat-oval ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch (25 mm), plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches (38 mm).

K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section "Air Duct Accessories" for fire and smoke dampers.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

M. Use fabricated fittings for all changes in directions, sizes, shapes and connections.

N. Locate ducts parallel and perpendicular to building lines; avoid diagonal runs except as otherwise indicated.

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing.

1. Install hangers and supports within 24 inches (610 mm) of each elbow and within 48 inches (1200 mm) of each branch intersection.
2. Install hangers at duct joints on either 8 or 10 foot centers, and at every change of direction.
3. Support ductwork directly from the building structure; not from the other ducts, piping, equipment, or roof deck.
4. Holes shall not be drilled or punched in beams and supporting members.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet (5 m).

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Division 23 Section "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.

C. Duct system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.7 START UP

A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

3.8 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

B. Supply Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:

a. Pressure Class: Positive 2-inch wg (500 Pa).
b. Minimum SMACNA Seal Class: C.

2. Ducts Connected to Constant-Volume Air-Handling Units:

a. Pressure Class: Positive 3-inch wg (750 Pa).
b. Minimum SMACNA Seal Class: B.

3. Ducts Connected to Variable-Air-Volume Air-Handling Units:

a. Pressure Class: Positive 4-inch wg (1000 Pa).
b. Minimum SMACNA Seal Class: A.

C. Return Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:

   a. Pressure Class: Positive or negative 2-inch wg (500 Pa).
   b. Minimum SMACNA Seal Class: C.

2. Ducts Connected to Air-Handling Units:

   a. Pressure Class: Positive or negative 3-inch wg (750 Pa).
   b. Minimum SMACNA Seal Class: B.

D. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:

   a. Pressure Class: Negative 3-inch wg (750 Pa).
   b. Minimum SMACNA Seal Class: B if negative pressure, and A if positive pressure.

2. Ducts Connected to Air-Handling Units:

   a. Pressure Class: Positive or negative 3-inch wg (750 Pa).
   b. Minimum SMACNA Seal Class: B if negative pressure, and A if positive pressure.

3. Ducts Connected to Commercial Kitchen Hoods: Comply with NFPA 96.

   a. Type 304, stainless-steel sheet.
   b. Welded seams and joints.
   c. Pressure Class: Positive or negative 3-inch wg (750 Pa).
   d. Minimum SMACNA Seal Class: Welded seams, joints, and penetrations.
   e. SMACNA Leakage Class: 3.

4. Ducts Connected to Dishwasher Hoods:

   a. Type 304, stainless-steel sheet.
   b. Welded seams and flanged joints with watertight EPDM gaskets.
   c. Pressure Class: Positive or negative 3-inch wg (750 Pa).
   d. Minimum SMACNA Seal Class: Welded seams, joints, and penetrations.
   e. SMACNA Leakage Class: 3.

5. Ducts Connected to Fans Exhausting Laboratory and Process (ASHRAE 62.1, Class 3 and 4) Air:

   a. Type 316, stainless-steel sheet.
   b. Seams: Factory machine formed spiral lock type.

c. Elbows and Fittings: Continuous-welded construction. Elbows shall have a centerline radius equal to 1.5 times the duct diameter.
d. Pressure Class: Positive or negative 6-inch wg (1500 Pa).
e. Minimum SMACNA Seal Class: Welded seams, joints, and penetrations.
SMACNA Leakage Class: 3.

6. Ducts Connected to Perchloric Acid Hoods:

a. Materials: Welded stainless steel type 316 or flame retardant polypropylene.
b. Provide complete washdown and drain system.
c. Sealants, Gaskets, and Lubricants: acid resistant and nonreactive with perchloric acid.

7. Ducts Connected to Radioisotope Hoods:

a. Materials: Stainless steel type 304.

E. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel.

2. PVC-Coated Ducts:

a. Exposed to Airstream: Match duct material.
b. Not Exposed to Airstream: Match duct material.

3. Stainless-Steel Ducts:

a. Exposed to Airstream: Match duct material.
b. Not Exposed to Airstream: Galvanized.

F. Double-Wall Duct Interstitial Insulation:

1. Supply Air Ducts: 1 inches thick.
2. Return Air Ducts: 1 inches thick.

G. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

a. Velocity 1000 fpm (5 m/s) or Lower:

1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
2) Mitered Type RE 4 without vanes.

b. Velocity 1000 to 1500 fpm (5 to 7.6 m/s):

1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

c. Velocity 1500 fpm (7.6 m/s) or Higher:

1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."

a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
1) Radius-to Diameter Ratio: 1.5.

b. Round Elbows, 12 Inches (305 mm) and Smaller in Diameter: Stamped or pleated.
c. Round Elbows, 14 Inches (356 mm) and Larger in Diameter: Standing seam or welded.

H. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connections."

a. Rectangular Main to Rectangular Branch: 45-degree entry.
b. Rectangular Main to Round Branch: Spin in.

2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.

    a. Velocity 1000 fpm (5 m/s) or Lower: 90-degree tap.
    b. Velocity 1000 to 1500 fpm (5 to 7.6 m/s): Conical tap.
    c. Velocity 1500 fpm (7.6 mm) or Higher: 45-degree lateral.

END OF SECTION 233113

SECTION 233300 - AIR DUCT ACCESSORIES

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. Manual volume dampers
2. Flange connectors
3. Remote damper operators
4. Duct-mounted access doors
5. Duct access panel assemblies
6. Flexible connectors
7. Flexible ducts
8. Duct accessory hardware

B. Related Sections:

1. Division 28 Section "Fire Detection and Alarm" for duct-mounted fire and smoke detectors.

1.3 SUBMITTALS

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

1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.

B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:

a. Special fittings
b. Manual volume damper installations
c. Control damper installations

d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators
e. Wiring Diagrams: For power, signal, and control wiring

C. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.

D. Source quality-control reports.

E. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with AMCA 500-D testing for damper rating.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G90 (Z275)
2. Exposed-Surface Finish: Mill phosphatized

C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304.

D. Aluminum Sheets: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

E. Extruded Aluminum: Comply with ASTM B 221 (ASTM B 221M), Alloy 6063, Temper T6.

F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

G. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

2.2 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Air Balance Inc.; a division of Mestek, Inc.
    b. Greenheck Fan Corporation
    c. Louvers and Dampers; a division of Mestek, Inc.
    d. McGill AirFlow LLC
    e. Nailor Industries Inc.
    f. Ruskin Company

2. Standard leakage rating, with linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. Frames:

    a. Hat-shaped, galvanized-steel channels, 0.064-inch (1.62 mm) minimum thickness.
    b. Mitered and welded corners.
    c. Flanges for attaching to walls and flangeless frames for installing in ducts.

5. Blades:

    a. Multiple or single blade.
    b. Parallel- or opposed-blade design.
    c. Stiffen damper blades for stability.
    d. Galvanized-steel, 0.064 (1.62 mm) inch thick.

6. Blade Axles: Galvanized steel.
7. Bearings:

    a. Oil-impregnated bronze or molded synthetic.
    b. Dampers in ducts with pressure classes of 3-inch (750 Pa) wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

8. Tie Bars and Brackets: Galvanized steel.

B. Jackshaft:

1. Size: 1-inch (25 mm) diameter.
2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

C. Damper Hardware:

1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch (2.4 mm) thick zinc-plated steel, and a 3/4-inch (19 mm) hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

2.3 FLANGE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ductmate Industries, Inc.
2. Nexus PDQ; Division of Shilco Holdings Inc.
3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

C. Material: Galvanized steel.

D. Gage and Shape: Match connecting ductwork.

2.4 DUCT-MOUNTED ACCESS DOORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. American Warming and Ventilating; a division of Mestek, Inc.
2. Ductmate Industries, Inc.
3. Flexmaster U.S.A., Inc.
4. Greenheck Fan Corporation
5. McGill AirFlow LLC
6. Nailor Industries Inc.

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; 7-2 (7-2M), "Duct Access Doors and Panels," and 7-3, "Access Panels - Round Duct."

1. Door:

a. Double wall, rectangular.
b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
c. Vision panel.
d. Hinges and Latches: 1-by-1-inch (25-by-25-mm) butt or piano hinge and cam latches.
e. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Number of Hinges and Locks:

a. Access Doors Less Than 12 Inches (300 mm) Square: No hinges and two sash locks.
b. Access Doors up to 18 Inches (460 mm) Square: Two hinges and two sash locks.
c. Access Doors up to 24 by 48 Inches (600 by 1200 mm): Three hinges and two compression latches with outside and inside handles.
d. Access Doors Larger than 24 by 48 Inches (600 by 1200 mm): Four hinges and two compression latches with outside and inside handles.

2.5 DUCT ACCESS PANEL ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ductmate Industries, Inc.
2. Flame Gard, Inc.
3. 3M

B. Labeled according to UL 1978 by an NRTL.

C. Panel and Frame: Minimum thickness 0.0528-inch (1.3-mm) carbon steel.

D. Fasteners: Carbon steel. Panel fasteners shall not penetrate duct wall.

E. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F (1093 deg C).

F. Minimum Pressure Rating: 10-inch wg (2500 Pa), positive or negative.

2.6 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ductmate Industries, Inc.
2. Ventfabrics, Inc.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches (89 mm) wide attached to 2 strips of 2-3/4-inch- (70-mm-) wide, 0.028-inch- (0.7-mm-) thick, galvanized sheet steel or 0.032-inch- (0.8-mm-) thick aluminum sheets. Provide metal compatible with connected ducts.

A. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd. (880 g/sq. m).
2. Tensile Strength: 480 lbf/inch (84 N/mm) in the warp and 360 lbf/inch (63 N/mm) in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).

2.7 FLEXIBLE DUCTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Flexmaster U.S.A., Inc.; Type 8M
2. McGill AirFlow LLC

B. Acoustical, Insulated, Flexible Duct: UL 181, Class 1, CPE inner film supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.

1. Pressure Rating: 10-inch wg (2500 Pa) positive and 1.0-inch wg (250 Pa) negative.
2. Maximum Air Velocity: 4000 fpm (20 m/s).
3. Temperature Range: Minus 10 to plus 160 deg F (Minus 23 to plus 71 deg C).
4. Insulation R-value: Comply with ASHRAE/IESNA 90.1.

C. Flexible Duct Connectors:

1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches (75 through 460 mm), to suit duct size.

2.8 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts.

1. Install steel volume dampers in steel ducts.
2. Install aluminum volume dampers in aluminum ducts.
3. Do not use extractors, splitter-type dampers, and register or diffuser dampers for volume control.
4. Locate volume dampers at least two diameters from a fitting and as far as possible from outlets.

E. Set dampers to fully open position before testing, adjusting, and balancing.

F. Install test holes at fan inlets and outlets and elsewhere as indicated.

G. Install fire and smoke dampers according to UL listing.

H. Connect ducts to duct silencers rigidly.

I. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. On both sides of duct coils.
2. Upstream and downstream from duct filters.
3. At outdoor-air intakes and mixed-air plenums.
4. At drain pans and seals.
5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
7. At each change in direction and at maximum 50-foot (15-m) spacing.
8. Upstream from turning vanes.
9. Upstream or downstream from duct silencers.
10. Control devices requiring inspection.
11. Upstream from flow measuring stations.
12. Upstream from steam humidifiers.
13. In duct below roof ventilators or fans to service dampers.
14. Elsewhere as indicated.

J. Install access doors with swing against duct static pressure.

K. Access Door Sizes:

1. One-Hand or Inspection Access: 8 by 5 inches (200 by 125 mm).
2. Two-Hand Access: 12 by 6 inches (300 by 150 mm).
3. Head and Hand Access: 18 by 10 inches (460 by 250 mm).
4. Head and Shoulders Access: 21 by 14 inches (530 by 355 mm).
5. Body Access: 25 by 14 inches (635 by 355 mm).
6. Body plus Ladder Access: 25 by 17 inches (635 by 430 mm).

L. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

M. Install flexible connectors to connect ducts to equipment.

N. For fans developing static pressures of 5-inch wg (1250 Pa) and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

O. Connect diffusers or light troffer boots to ducts with maximum 60-inch (1500-mm) lengths of flexible duct clamped or strapped in place.

P. Connect flexible ducts to metal ducts with draw bands.

Q. Install duct test holes where required for testing and balancing purposes.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.
5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 233300

SECTION 233600 - AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1.
   2. Fan-powered air terminal units.
   3. Shutoff, single-duct air terminal units.

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance: Hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".

1.4 SUBMITTALS

A. Product Data: For each type of the following products, including rated capacities, furnished specialties, sound-power ratings, and accessories.

   1. Air terminal units.

B. Shop Drawings: For air terminal units. Include plans, elevations, sections, details, and attachments to other work.

   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Wiring Diagrams: For power, signal, and control wiring.
   3. Hangers and supports, including methods for duct and building attachment and vibration isolation.

C. Field quality-control reports.

D. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Instructions for resetting minimum and maximum air volumes.
2. Instructions for adjusting software set points.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

1.6 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. Fan-Powered-Unit Filters: Furnish one spare filter(s) for each filter installed.

PART 2 - PRODUCTS

2.1 SHUTOFF, SINGLE-DUCT AIR TERMINAL UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Anemostat Products; a Mestek Company.
2. Environmental Technologies, Inc.
3. Krueger.
4. Price Industries.
5. Titus.
6. Trane; a business of American Standard Companies.
7. Tuttle & Bailey.

B. Configuration: Pressure independent, volume-damper assembly inside unit casing with control components inside a protective metal shroud. At an inlet velocity of 2000 fpm, the differential static pressure for any size of unit shall not exceed 0.10" wg for the base unit, or 0.25" wg with attenuator added. Unit sound ratings shall not exceed scheduled NC requirements.

C. Casing: 0.034-inch (0.85-mm) steel, single wall.

1. Casing Lining: Adhesive attached, 1/2-inch- (13-mm-) thick, polyurethane foam insulation complying with UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
3. Air Outlet: S-slip and drive connections.
4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

D. Volume Damper: Galvanized steel with shaft rotating in Delrin self-lubricating bearings.

1. Maximum Damper Leakage: ARI 880 rated, 2 percent of nominal airflow at 3-inch wg (750-Pa) inlet static pressure.
2. 90 deg rotation from full open to full closed.
3. Mark on the end shaft to indicate the damper place position.
4. Include build-in stop to prevent overstroking.
5. Seal against a closed cell foam gasket.

E. Attenuator Section: 0.034-inch (0.85-mm) steel sheet.

1. Lining: Adhesive attached, 1/2-inch- (13-mm-) thick, polyurethane foam insulation complying with UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

F. Multioutlet Attenuator Section: Outlets with collars, each with locking butterfly balancing damper.

G. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm), and rated for a minimum working pressure of 200 psig (1380 kPa) and a maximum entering-water temperature of 220 deg F (104 deg C). Include manual air vent and drain valve.

H. Direct Digital Controls: Bidirectional damper operators and microprocessor-based controller and room sensor. Control devices are specified in Division 23 Section "Instrumentation and Control for HVAC" and shall have the following features:

1. Controller, 24V control transformer, and electronic damper operators: Furnished by the Temperature Control Contractor and installed by the Terminal Unit Manufacturer.
2. Damper Actuator: Designed for field conversion from normally open to normally closed, or vice versa, without relocating the actuator, changing parts or adding relays.

3. Average velocity sensor: Read zero differential pressure when the unit is closed. Air flow limiter is not acceptable.
4. Terminal Unit Controller: Pressure-independent, variable-air-volume controller with electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes, and reset for air flow between minimum and maximum cataloged cfm.

2.2 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electro-galvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Air Terminal Unit Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

D. Trapeze and Riser Supports: Steel shapes and plates for units with steel casings; aluminum for units with aluminum casings.

2.3 SOURCE QUALITY CONTROL

A. Factory Tests: Test assembled air terminal units according to ARI 880.

1. Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

B. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

3.2 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes and for slabs more than 4 inches (100 mm) thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes and for slabs less than 4 inches (100 mm) thick.

C. Hangers Exposed to View: Threaded rod and angle or channel supports.

D. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.3 CONNECTIONS

A. Install piping adjacent to air terminal unit to allow service and maintenance.

B. Hot-Water Piping: In addition to requirements in Division 23 Section "Hydronic Piping," connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union or flange.

C. Connect ducts to air terminal units according to Division 23 Section "Metal Ducts."

D. Make connections to air terminal units with flexible connectors complying with requirements in Division 23 Section "Air Duct Accessories."

3.4 IDENTIFICATION

A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Division 23 Section "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Air terminal unit will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.6 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
3. Verify that controls and control enclosure are accessible.
4. Verify that control connections are complete.
5. Verify that nameplate and identification tag are visible.
6. Verify that controls respond to inputs as specified.

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

END OF SECTION 233600

SECTION 233713 - DIFFUSERS, REGISTERS, AND GRILLES

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. Ceiling diffusers.
2. Ceiling linear slot outlets.
3. Registers and grilles.

B. Related Sections:

1. Division 08 Section "Louvers and Vents" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
2. Division 23 Section "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated, include the following:

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following:

1. Anemostat Products; a Mestek company.
2. Carnes.

3. Krueger.
4. Nailor Industries Inc.
5. Price Industries.
6. Titus.
7. Tuttle & Bailey.

2.2 GENERAL REQUIREMENTS

A. Air inlets and outlets shall be tested in accordance with ASHRAE 70.

B. Throw, horizontal distance from the diffuser to the point where the theoretical centerline velocity is 50 feet per minute, shall not exceed the horizontal distance between the diffuser and the nearest wall, or half the horizontal distance between ceiling diffusers.

2.3 CEILING DIFFUSERS

A. Rectangular and Square Ceiling Diffusers:

1. Devices shall be specifically designed for variable-air-volume flows.
2. Material: Steel.
3. Finish: Baked enamel, white.
4. Face Style: Three cone.
5. Pattern: Adjustable.
6. Dampers: Not required.
7. Equal to Anemostat Model EPLA.

B. Critical Environment Diffuser:

1. Low velocity.

2.4 REGISTERS AND GRILLES

A. Supply Air Bar Grille:

1. Material: Steel.
2. Finish: Baked enamel, white.
3. Face Blade Arrangement: Adjustable. Vertical spaced 3/4 inch (19 mm) apart.
4. Rear Blade Arrangement: Adjustable. Horizontal spaced 3/4 inch (19 mm) apart.
5. Frame: 1-1/4 inches (32 mm) wide.
6. Mounting: Countersunk screw, concealed, or lay in as scheduled.

B. Return Air Bar Grille:

1. Material: Steel.
2. Finish: Baked enamel, white.

3. Face Blade Arrangement: 45 degree fixed horizontal spaced 3/4 inch (19 mm) apart.
4. Frame: 1-1/4 inches (32 mm) wide.
5. Mounting: Countersunk screw, concealed, or lay in as scheduled.

2.5 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713

SECTION 234100 - PARTICULATE AIR FILTRATION

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. Pleated panel filters.
2. Self-supported pocket filters.
3. Front- and rear-access filter frames.
4. Side-service housings.
5. Filter gages.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include dimensions; operating characteristics; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; efficiency and test method; fire classification; furnished specialties; and accessories for each model indicated.

B. Shop Drawings: For air filters. Include plans, elevations, sections, details, and attachments to other work.

1. Show filter rack assembly, dimensions, materials, and methods of assembly of components.
2. Include setting drawings, templates, and requirements for installing anchor bolts and anchorages.
3. Wiring Diagrams: For power, signal, and control wiring.

C. Operation and Maintenance Data: For each type of filter and rack to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance:

1. Comply with applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality"; Section 5 - "Systems and Equipment"; and Section 7 - "Construction and Startup."
2. Comply with ASHRAE 52.2 for MERV for methods of testing and rating air-filter units.

C. Comply with NFPA 90A and NFPA 90B.

1.5 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. Provide one complete set(s) of filters for each filter bank.

PART 2 - PRODUCTS

2.1 PLEATED PANEL FILTERS

A. Description: Factory-fabricated, self-supported, extended-surface, pleated, panel-type, disposable air filters with holding frames.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. AAF International.
b. Airguard.
c. Camfil Farr.
d. Flanders-Precisionaire.

B. Filter Unit Class: UL 900, Class 2.

C. Media: Cotton and synthetic fibers coated with nonflammable adhesive.
1. Media shall be coated with an antimicrobial agent.
2. Separators shall be bonded to the media to maintain pleat configuration.
3. Welded wire grid shall be on downstream side to maintain pleat.
4. Media shall be bonded to frame to prevent air bypass.
5. Support members on upstream and downstream sides to maintain pleat spacing.

D. Filter-Media Frame: Cardboard frame with perforated metal retainer with metal grid on outlet side and steel rod grid on inlet side, hinged, with pull and retaining handles sealed or bonded to the media.

E. Mounting Frames: Welded galvanized steel, with gaskets and fasteners; suitable for bolting together into built-up filter banks.

F. Characteristics:

1. Face Dimensions: 24 x 24 inches or 12 x 24 inches.
2. Thickness or Depth: 2 inches (50 mm).
3. Maximum or Rated Face Velocity: 500 fpm.
4. Composite Average Efficiency, %: 35≤E3≤50.
5. Average Arrestance, %: N/A
6. Initial Resistance: 0.30-inch wg (74 Pa) at 500 fpm (2.5 m/s).
7. Recommended Final Resistance: 1 inches wg.
8. MERV Rating: 6 when tested according to ASHRAE 52.2.

2.2 FRONT- AND REAR-ACCESS FILTER FRAMES

A. Framing System: Galvanized-steel framing members with access for either upstream (front) or downstream (rear) filter servicing, cut to size and prepunched for assembly into modules. Vertically support filters to prevent deflection of horizontal members without interfering with either filter installation or operation.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. AAF International.
b. Airguard.
c. Camfil Farr.
d. Flanders-Precisionaire.
e. Koch Filter Corporation.

B. Prefilters: Incorporate a separate track with spring clips, removable from front.

C. Sealing: Factory-installed, positive-sealing device for each row of filters, to ensure seal between gasketed filter elements and to prevent bypass of unfiltered air.

2.3 SIDE-SERVICE HOUSINGS

A. Description: Factory-assembled, side-service housings, constructed of galvanized steel with flanges to connect to duct or casing system.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. AAF International.
b. Airguard.
c. Camfil Farr.

d. Flanders-Precisionaire.
e. Koch Filter Corporation.

B. Prefilters: Integral tracks to accommodate 2-inch- (50-mm-) deep, disposablefilters.

C. Access Doors: Hinged, with continuous gaskets on perimeter and positive-locking devices, and arranged so filter cartridges can be loaded from either access door.

D. Sealing: Incorporate positive-sealing gasket material on channels to seal top and bottom of filter cartridge frames and to prevent bypass of unfiltered air.

2.4 FILTER GAGES

A. Diaphragm-type gage with dial and pointer in metal case, vent valves, black figures on white background, and front recalibration adjustment.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Dwyer Instruments, Inc.
b. Magnehelic.

2. Diameter: 4-1/2 inches (115 mm).
3. Scale Range for Filter Media Having a Recommended Final Resistance of 1.0- to 2.0-Inch wg (250 to 500 Pa) or Less: 0- to 2.0-inch wg (0 to 500 Pa).

B. Accessories: Static-pressure tips, tubing, gage connections, and mounting bracket.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Position each filter unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.

B. Install filters in position to prevent passage of unfiltered air.

C. Install filter gage for each filter bank. The gauge shall be mounted on the air handler, near the filter bank, in a convenient location for reading from the floor.

D. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing with new, clean filters.

E. Install filter-gage, static-pressure taps upstream and downstream from filters. Install filter gages on filter banks with separate static-pressure taps upstream and downstream from filters. Mount filter gages on outside of filter housing or filter plenum in an accessible position. Adjust and level inclined gages.

F. Coordinate filter installations with duct and air-handling-unit installations.

G. Provide brass tag, mounted near filter gauge, indicating size, flow rate, initial and final pressure drops, efficiency and fire classification for each type of filter.

3.2 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Test for leakage of unfiltered air while system is operating.

C. Air filter will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.3 CLEANING

A. After completing system installation and testing, adjusting, and balancing of air-handling and air-distribution systems, clean filter housings and install new filter media.

END OF SECTION 234100

SECTION 236200 - PACKAGED COMPRESSOR AND CONDENSER UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes:

1. Air-cooled condensing units.

1.3 SUBMITTALS

A. Product Data: For each condensing unit, include rated capacities, operating characteristics, furnished specialties, and accessories. Include equipment dimensions, weights and structural loads, required clearances, method of field assembly, components, and location and size of each field connection.

B. Field quality-control test reports.

C. Operation and Maintenance Data: For condensing units to include in emergency, operation, and maintenance manuals.

D. Warranties: Submit written special warranty as specified in this Section. Include contact information, description of coverage, and start date for each special warranty.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of condensing units and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Fabricate and label refrigeration system according to ASHRAE 15, "Safety Code for Mechanical Refrigeration."

1.5 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

C. Coordinate location of piping and electrical rough-ins.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of condensing units that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Compressor failure.

2. Warranty Period (Compressor Only): Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 AIR-COOLED CONDENSING UNITS, 1 TO 5 TONS (3.5 TO 17.6 kW)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AAON

B. Description: Factory assembled and tested, consisting of compressor, condenser coil, fan, motors, refrigerant reservoir, and operating controls.

C. Compressor: Scroll, hermetically sealed, with rubber vibration isolators.

1. Motor: Single speed, and includes thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
2. Accumulator: Suction tube.
3. Refrigerant: R-407C or R-410A.

D. Condenser Coil: Seamless copper-tube, aluminum-fin coil; circuited for integral liquid subcooler, with removable drain pan and brass service valves with service ports.

1. Spine-fin coils with continuously wrapped aluminum will not be accepted.

E. Condenser Fan: Direct-drive, aluminum propeller fan; with permanently lubricated, totally enclosed fan motor with thermal-overload protection and ball bearings.

F. Accessories:

1. Coastal Filter: Mesh screen to protect condenser coil from salt damage.
2. Crankcase heater.
3. Cycle Protector: Automatic-reset timer to prevent rapid compressor cycling.
4. Solid state electronic control including non-fused disconnect and motor starting contactors.
5. Evaporator Freeze Thermostat: Temperature-actuated switch that stops unit when evaporator reaches freezing temperature.
6. Filter-dryer.
7. High-Pressure Switch: Automatic-reset switch cycles compressor off on high refrigerant pressure.
8. Liquid-line solenoid.
9. Low Ambient Controller: Cycles condenser fan to permit operation down to 0 deg F (minus 18 deg C).
10. Low Ambient Lockout: Locate electric ambient lockout control under a shield on the north side of the building or of the unit.
11. Low-Pressure Switch: Automatic-reset switch cycles compressor off on low refrigerant pressure.
12. PE mounting base to provide a permanent foundation.
13. Precharged and insulated suction and liquid tubing.
14. Sound Hood: Wraps around sound attenuation cover for compressor.
15. Thermostatic expansion valve.
16. Time-Delay Relay: Continues operation of evaporator fan after compressor shuts off.

G. Unit Casing: Galvanized steel, finished with baked enamel; with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Mount service valves, fittings, and gage ports on exterior of casing.

2.2 MOTORS

A. General requirements for motors are specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.

2.3 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate condensing units according to ARI 210/240, ARI 340/360, or ARI 365.

B. Test and inspect shell and tube condensers according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

C. Testing Requirements: Factory test sound-power-level ratings according to ARI 270.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of condensing units.

B. Examine roughing-in for refrigerant piping systems to verify actual locations of piping connections before equipment installation.

C. Examine walls, floors, and roofs for suitable conditions where condensing units will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install units level and plumb, firmly anchored in locations indicated; maintain manufacturer's recommended clearances.

B. Install condensing units on concrete base. Concrete base is specified in Division 23 Section "Common Work Results for HVAC," and concrete materials and installation requirements are specified in Division 03.

C. Vibration Isolation: Mount condensing units on rubber pads with a minimum deflection of 1/4 inch (6.35 mm). Vibration isolation devices and installation requirements are specified in Division 23 Section "Vibration Controls for HVAC Piping and Equipment."

D. Maintain manufacturer's recommended clearances for service and maintenance.

E. Loose Components: Install electrical components, devices, and accessories that are not factory mounted.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Connect precharged refrigerant tubing to unit's quick-connect fittings. Install tubing so it does not interfere with access to unit. Install furnished accessories.

D. Connect refrigerant piping to air-cooled condensing units; maintain required access to unit. Install furnished field-mounted accessories. Refrigerant piping and specialties are specified in Division 23 Section "Refrigerant Piping."

E. Provide servicing apertures or similar devices to facilitate the recapture of refrigerants during service and repair. Provide adequate shutoff valves at locations such as condenser, coils, filter-driers, etc. for service with a minimum change of refrigerant loss.

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Perform electrical test and visual and mechanical inspection.
2. Leak Test: After installation, charge systems with refrigerant and oil and test for leaks. Repair leaks, replace lost refrigerant and oil, and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation, product capability, and compliance with requirements.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
5. Verify proper airflow over coils.

B. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

C. Remove and replace malfunctioning condensing units and retest as specified above.

3.5 STARTUP SERVICE

A. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

1. Inspect for physical damage to unit casing.
2. Verify that access doors move freely and are weathertight.
3. Clean units and inspect for construction debris.
4. Verify that all bolts and screws are tight.
5. Adjust vibration isolation and flexible connections.
6. Verify that controls are connected and operational.

B. Lubricate bearings on fans.

C. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.

D. Adjust fan belts to proper alignment and tension.

E. Start unit according to manufacturer's written instructions and complete manufacturer's startup checklist.

F. Measure and record airflow over coils.

G. Verify proper operation of condenser capacity control device.

H. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

I. After startup and performance test, lubricate bearings and adjust belt tension.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain condensing units.

END OF SECTION 236200

SECTION 238216 - AIR COILS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following types of air coils:

1. Hot-water.
2. Refrigerant.

B. Related Sections:

1. Division 23 Section “Air Terminal Units” for hydronic coil requirements for these devices.

1.3 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 air coil. Include rated capacity and pressure drop for each air coil.

B. Field quality-control test reports.

C. Operation and Maintenance Data: For air coils to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

A. ASHRAE Compliance:

1. Comply with ASHRAE 15 for refrigeration system safety.
2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
3. Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

PART 2 - PRODUCTS

2.1 WATER COILS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Aerofin Corporation.
2. Carrier Corporation.
3. Heatcraft Refrigeration Products LLC; Heat Transfer Division.
4. Trane.
5. Daikin – McQuay
6. Marlo
7. York

B. Performance Ratings: Tested and rated according to ARI 410 and ASHRAE 33.

C. Minimum Working-Pressure/Temperature Ratings: 200 psig (1380 kPa), 325 deg F (163 deg C).

D. Source Quality Control: Factory tested to 300 psig (2070 kPa).

E. Tubes: ASTM B 743 copper, minimum 0.035 inch (0.889 mm) thick.

F. Fins: Aluminum, minimum 0.010 inch (0.254 mm) thick.

G. Headers: Removable, cast iron, and drain and air vent tappings.

H. Frames: Galvanized-steel channel frame, minimum 0.064 inch (1.6 mm) thick for flanged mounting.

I. Hot-Water Characteristics:

1. Minimum Fin Spacing: 0.125 inch (3.18 mm).
2. Tube Diameter: 0.625 inch (15.9 mm).
3. Mounting: Flanged.
4. Coating: Include corrosion resistant coatings where applicable.

2.2 REFRIGERANT COILS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AAON
2. As approved by ACCU manufacturer.

B. Description: Direct expansion of refrigerant inside the tubes with multi-outlet venturi type distributors.

C. Performance Ratings: Tested and rated according to ARI 410 and ASHRAE 33.

D. Minimum Working-Pressure Rating: 300 psig (2070 kPa).

E. Source Quality Control: Factory tested to 450 psig (3105 kPa).

F. Tubes: ASTM B 743 copper, minimum 0.035 inch (0.889 mm) thick.

G. Fins: Aluminum, minimum 0.010 inch (0.254 mm) thick.

H. Suction and Distributor Piping: ASTM B 88, Type L (ASTM B 88M, Type B) copper tube with brazed joints.

I. Frames: Galvanized-steel channel frame, minimum 0.064 inch (1.6 mm) thick for flanged mounting.

J. Characteristics:

1. Minimum Fin Spacing: 0.125 inch (3.18 mm).
2. Tube Diameter: 0.625 inch (15.9 mm).
3. Mounting: Flanged.
4. Coating: Include corrosion resistant coatings where applicable.
5. Finned Area Face Velocity: Max. 500 fpm.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine ducts, plenums, and casings to receive air coils for compliance with requirements for installation tolerances and other conditions affecting coil performance.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before coil installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install as recommended by the manufacturer to permit complete drainage.

B. Install coils in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."

C. Straighten bent fins on air coils.

D. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to coils to allow service and maintenance.

C. Connect water piping with unions and shutoff valves to allow coils to be disconnected without draining piping. Control valves are specified in Division 23 Section "Instrumentation and Control for HVAC," and other piping specialties are specified in Division 23 Section "Hydronic Piping."

D. Connect refrigerant piping according to Division 23 Section "Refrigerant Piping."

E. Refrigeration system shall be equipped with a servicing aperture or similar device to facilitate the recapture of refrigerants during service and repair. Provide adequate shutoff valves for service with a minimum change of refrigerant loss.

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Test and adjust controls for the VIFB coils. Replace damaged and malfunctioning controls and equipment.
2. Upon completion of installation, operate system for not less than 8 hours under full load, and then conduct performance tests in presence of the Architect/Engineer or Construction Representative. Correct equipment defects or performance deficiencies, and repeat performance tests.

END OF SECTION 238216

SECTION 260500 – COMMON WORK RESULTS FOR ELECTRICAL

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. This section shall apply to all Division 26 sections.

1.2 SUMMARY

A. Work Included

1. The work shall be executed in conformity with the drawings, the approved shop drawings, and these specifications.

2. In general, this work shall consist of, but not necessarily be limited to the following:
   a. Demolition
   b. New Work

B. Work Not Included

C. The Contractor shall refer to Alternates listed in Division 01 and Proposals and shall submit price quotations for the alternates that apply to the electrical work.

1.3 SUBMITTALS

A. Shop Drawings and Samples

1. The Contractor shall submit shop drawings for all major equipment including, but not limited to the following items and/or the items listed in Division 26 sections.

2. Quantity of shop drawings and information to be included shall be as specified in Division 01 - General Requirements.

B. As-Built Drawings

1. Quantity of shop drawings and information to be included shall be as specified in Division 01 - General Requirements.

2. The Contractor shall submit as-built drawings indicating the location of all outlets, junction boxes, and conduit runs; including conduit size, circuit numbers, and number of wires in each run.

C. Certificate of Electrical Inspection: Provide certificate as described in this section.

1.4 QUALITY ASSURANCE

A. Codes and Regulations

1. See Division 01 General Requirements for Codes and Regulations that apply.

2. The latest National Electrical Code shall be observed and shall govern the character of work, style, quantity and the size of all material used.

3. All materials shall conform with the standards set forth by the State of Michigan in every case where such standards have been established for the particular type of material in question.

4. All material and equipment shall be listed by a "State of Michigan" approved testing agency or lab such as U.L. or ETL. and bear the appropriate label where such listing and labeling exists. Contractors shall refer to the State of Michigan LARA website for a full listing of all state approved testing labs or agencies.

5. The complete electrical installation shall comply with all the requirements of the MI.O.S.H.A.

6. Codes shall be used as minimum requirements, and where the Specifications or Plans call for an installation that exceeds and does not violate the Code requirements, the Specifications and Plans shall be followed.

B. Character of Work

1. The installation shall be executed in a workmanlike manner and shall present a neat mechanical appearance when completed.

2. Contractors working in the T.B. Simon Power Plant shall have a minimum of five years of experience working on like systems in power plants that involved in this project.

3. Where work is performed in existing spaces or buildings and abandoned wiring or conductors are encountered, they shall be removed in accordance with the requirements of the National Electric Code.

C. Permits and Inspections

1. The Electrical Contractor shall obtain and pay for all permits required by the State of Michigan Labor Department, Electrical Division.

2. The Electrical Contractor shall submit, to precede request for final payment, a copy of the Certificate of Electrical Inspection as required by the State of Michigan.

1.5 GUARANTEE

A. Refer to Division 01 - General Requirements.

B. Refer to individual Division 26 sections for any additional guarantee requirements.

PART 2 - PRODUCTS

2.1 GENERAL

A. Refer to individual Division 26 sections for product specifications.

B. Material to be Returned to the Owner

1. Refer to Division 01 - General Requirements.

PART 3 - EXECUTION

3.1 GENERAL

A. Refer to Division 01 - General Requirements for items such as examination of premises, coordination with other trades, cutting and patching, connection to present equipment, etc.

B. Laying Out Work

1. All exterior light locations shall be staked out by the Contractor and approved by the Engineer prior to installation.

2. A/E or consulting firm shall generate “Point-by-Point” photometric calculations for submission and approval prior to finalizing pole & luminaire layouts; “pole height-to-spacing” ratio for all installations shall not be greater than 4:1

C. Equipment Supports

1. Enclosures for panelboards, motor starters, motor control centers, and other similar equipment shall be mounted on ½" spacers when mounted in a room on a below grade exterior wall.

D. Feeders and/or branch circuit wiring shall not pass through electrical equipment such as switchboards, panelboards, disconnect switches, and motor starter enclosures where the power source for that wiring originates in another location.

END OF SECTION 260500

SECTION 260519 – LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

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. This Section specifies the conductors and cabling for buildings and structures electrical systems under 600 volts. Wiring for fire alarm and communication systems is specified in their respective sections.

2. Provide all labor, materials, and equipment as necessary to complete all work as indicated on the drawings, and as specified herein.

B. Related Sections include the following:

1. Applicable sections of Division 26 - Electrical

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70, “National Electrical Code”

C. Furnish wire and cable that has been manufactured and factory tested in accordance with ASTM, ANSI, IPCEA, and NEMA.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. All wiring, branch circuits and feeders, 600 volts and below, shall be stranded copper, type THW, THWN, or THHN sized as indicated on the drawing. Aluminum conductors are no longer approved for use as feeders.

B. Feeder phase identification from left to right or front to back facing front of equipment shall be one of the following:

Phase A	Phase B	Phase C	Neutral	System
X	Y	Z	N	Any voltage
BLACK	RED	BLUE	WHITE	120/208 volt feeders
BROWN	ORANGE	YELLOW	GRAY	277/480 volt feeders

C. In general, all branch circuit wiring shall be 600 volt type THHN or THWN, minimum wire size number 12 AWG, except where noted otherwise. Branch circuits 100 feet or longer shall be minimum size number 10 wire AWG.

D. 120 volt control circuits may be number 14 AWG wire.

E. Neutral conductor insulation color for emergency and “X” panel circuits shall be as noted above with a red tracer.

F. Cable types MC, MI, NM, NMC, or NMS shall not be used unless specifically noted on the drawings or in the specifications.

2.2 WIRING CONNECTIONS

A. Conductors #8 AWG and larger were tapped or spliced including motor terminations inside motor terminal housings shall be terminated with approved solderless, pressure-type bolted connectors or an approved mechanical connector such as Polaris or Unitap. splices in conductors no. 8 AWG and smaller may be made with approved pressure connectors such as pre-insulated Scotchlock or Ideal Wing-Nut spring tension connectors.

B. Termination of motor leads to branch circuit conductors shall be made with Burndy Clear UNITAP inspectable insulated multiple tap connectors sized for the conductors being terminated.

PART 3 - EXECUTION

3.1 CONDUCTORS

A. All wiring shall be installed in rigid galvanized conduit, intermediate metal conduit (I.M.C.), flexible conduit, electrical metallic tubing (E.M.T.), PVC (underground or in-slab) or other approved raceway. Wiring in Mechanical and Electrical spaces shall be run in metal conduit or other approved means.

B. Pulling compounds shall be compatible with the cable being installed in accordance cable manufacturers recommendations.

C. A shared neutral between branch circuits shall not be used for single phase, phase-to-neutral loads at either 120 volts or 277 volts.

D. Neutral conductors in junction boxes, pull boxes, outlet boxes, etc. shall be identified with the associated phase conductor circuit number.

END OF SECTION 260519

SECTION 260526 – GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

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. This Section specifies the grounding and bonding of electrical systems for buildings and structures.

2. Provide all labor, materials, and equipment as necessary to complete all work as indicated on the drawings, and as specified herein.

B. Related Sections include the following:

1. Applicable sections of Division 26 - Electrical

1.3 SUBMITTALS

A. Grounding test reports.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70, “National Electrical Code”

C. Comply with applicable requirements of U.L. Standards 467 pertaining to electrical grounding and bonding. Provide grounding products that are U.L. listed and labeled.

PART 2 - PRODUCTS

2.1 GROUND RODS

A. Ground bus shall be solid 98% conductivity, electrical grade copper.

2.2 CONDUCTORS USED FOR GROUNDING

A. Conductors used for grounding shall be stranded copper, THWN/THHN, the same as the feeder conductors and/or branch circuit conductors. Conductors buried in concrete shall have RHW or THW insulation.

B. Grounding conductors shall have green insulation the entire length. Isolated grounding conductors shall have green insulation with a yellow tracer the entire length.

PART 3 - EXECUTION

3.1 MAIN ELECTRICAL ROOMS

A. Ground Rods

1. At each location the rods shall be tied together by means of no. 4/0 AWG THW, stranded copper cables welded to each rod. Welded connections shall be Cadweld or Burndy Hyground.

2. The tops of the ground rods shall be below the finished floor slab with the 4/0 AWG THW ground wire brought up close to the wall.

B. Ground Bus

1. A 1/4 inch x 2 inch ground bus shall be installed approximately 12 inches above the floor. All joints shall be thoroughly cleaned and trimmed on both sides and edges, wiped smooth and bright, and bolted in approved manner.

C. Ground Connections

1. From the ground bus in the electrical room, run two ground cables to the ground rods located on the drawing and one ground cable to cold water main. Provide jumpers at all water meters. All ground cable shall be 4/0 AWG THW, stranded copper.

2. All conduit, pipe racks, switches, supports, wiring troughs, cable sheaths, cabinets, transformers, special equipment, and non-current carrying parts shall be permanently and effectively grounded to one of these ground systems.

3. Make ground connections at equipment with grounding devices manufactured for this purpose equal to Burndy Engineering Co. fittings. No soldered ground connections shall be used on grounding circuits at any point, except where ground conductor is attached to the lead sheathed cables. Primary grounds and secondary neutral shall be connected to ground bus with approved mechanical connectors.

4. Primary and secondary neutrals of transformers shall be connected to the ground bus with approved mechanical connectors.

5. An equipment grounding conductor shall be installed with feeders and branch circuits and connected to all devices and equipment.

6. Conductors used for grounding that are installed separately in electrical rooms or other locations shall be installed in conduit in areas where they are subject to physical damage. The conduit shall be bonded to the conductor.

3.2 Other Building Spaces

A. Install a 1/4 x 2 inch solid copper ground bus with predrilled holes where shown on the drawing. Length shall be 12” or longer as noted on the drawings. Connect each ground bus with a No. 4 AWG THWN/THHN grounding conductor in conduit to the ground grid in the main electrical room.

3.3 Grounding Conductors in Conduit

A. A grounding conductor shall be installed in all conduits and raceways containing lighting and/or power circuits. Size the grounding conductor per the NEC for the associated circuit unless noted otherwise on the drawings.

END OF SECTION 260526

SECTION 260533 – RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

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. This Section specifies the raceway, conduit, boxes, fittings, multioutlet assemblies, etc. for buildings and structures electrical systems.

2. Provide all labor, materials, and equipment as necessary to complete all work as indicated on the drawings, and as specified herein.

B. Related Sections include the following:

1. Applicable sections of Division 26 - Electrical

1.3 SUBMITTALS

A. Shop Drawings

1. Surface raceway.

2. Multioutlet assemblies.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70, “National Electrical Code”

PART 2 - PRODUCTS

2.1 GENERAL INFORMATION

A. All boxes, brackets, bolts, clamps, etc., shall be galvanized, electro-galvanized, metalized, or sherardized.

B. All hardware used outdoors shall be hot dipped galvanized.

C. Pull boxes, junctions boxes, and outlet boxes installed outdoors shall be heavy duty die cast aluminum construction powder coat finished with gasketed cover plate.

2.2 CONDUIT

A. PVC or Rigid galvanized conduit shall be installed in poured concrete slabs, walls and partitions, or underground. Rigid or I.M.C. shall be installed in damp locations and inaccessible places. Underground or in-slab PVC conduit runs over 50’-0” shall employ Rigid 90° conduit bends or elbows. Where PVC conduits is used in either below grade on in-slab applications, rigid conduit bends shall be used for turning the conduit up and out of the slab or concrete.

B. All rigid conduit, I.M.C. and E.M.T. shall be hot dipped galvanized, sherardized, metalized or electro-galvanized.

C. In locations where rigid or IMC conduit cannot be turned and a fitting is required, three piece malleable iron/steel rain-tight fittings shall be used.

D. E.M.T. may only be installed exposed, above suspended ceilings, in block walls, or in partitions. Fittings and connectors for EMT conduit shall be compression type.

E. Flexible metal conduit may be used for short runs, up to a length of six feet, to individual pieces of equipment.

F. Flexible metal conduit and flexible metallic tubing may be used for light fixture whips up to a length of six feet.

G. Liquidtight flexible metal conduit shall be used for short runs, up to a length of six feet, to individual pieces of equipment in mechanical rooms, penthouses, on roofs, water softener areas and other similar locations. Liquidtight conduit shall also be used for terminations to dry-type transformers.

H. MC (metal clad) 2 conductor with ground cable can be used for lighting fixture whips.

I. MC (metal clad) whips with 2#12 conductors & #12 ground conductor and 2#16 conductors can be used for lighting fixture whips for LED lighting fixtures with low voltage dimming. Lighting fixture whips shall be AFC LW4H3S62E46-00 or approved equal.

J. Conduit 2-1/2 inches and larger can be EMT, rigid or I.M.C., material type suitable for the environment. Where EMT conduit is utilized, all connectors or fittings shall be compression type.

K. No E.M.T. or aluminum conduit shall be used in concrete or direct burial, nor in water softener areas or similar corrosive locations.

L. Aluminum conduit may only be used in sizes 1" inch and larger. No aluminum conduit will be permitted in concrete. When aluminum conduit is used, all bends shall be "factory elbows".

M. Size and type of conduit shall comply with the National Electric Code. Where conduits are indicated on the drawing to be larger than required by Code, the larger conduit shall be used.

N. All conduit used for fire alarm system wiring shall have a red topcoat to identify it as fire alarm system.

O. All conduit used for life safety systems such as emergency lighting, shall have a green topcoat to identify as life safety.

P. Minimum conduit size shall be 3/4 inch for all feeder and branch circuit conduits to all panels, junction boxes, pull boxes, and outlets.

Q. Short runs of exposed conduit to individual pieces of equipment may be one-half inch.

R. Minimum conduit size shall be one-half inch for low-voltage control wiring.

S. PVC or Rigid conduit may be buried underground outside the building walls, to signs, exterior lights, etc. however it shall be not less than 1 inch in diameter regardless of conductor size.

2.3 PULL AND JUNCTION BOXES

A. All pull boxes shall be galvanized sheet steel, sized as required, with thickness not less than no. 14 gauge.

B. All pull and junction boxes used for fire alarm system wiring shall have a red cover plate.

C. Where box extensions are needed in addition to a recessed box, no more than one (1) additional box will be allowed.

2.4 OUTLET BOXES

A. All outlets, except as otherwise specified, shall consist of approved galvanized steel boxes of pattern adapted to the special requirements of each outlet, securely fastened in place in an approved manner.

2.5 SURFACE RACEWAY

A. Where necessary to run exposed on existing walls and/or ceilings in finished areas, use surface raceway series type, as required for each individual circuit, or as shown on drawing. Paint the new surface raceway to match the existing surface.

B. Surface raceway shall be Wiremold, Mono-Systems, or Hubbell.

2.6 MULTI-OUTLET ASSEMBLIES

A. Multi-outlet assemblies shall be Wiremold Plugmold series 2100 with receptacles, couplings, entrance and end fittings necessary for a complete installation, as shown on the drawing.

B. Receptacles for plugmold shall be 15 ampere, 125 volt, 3 wire grounding type, Wiremold catalog no. 2127GA.

C. 15 ampere, 250 volt, 3 wire grounding type receptacle shall be Wiremold catalog no. 2127GB.

D. The length of plugmold, number of outlets, spacing of outlets on centers, and mounting height shall be as shown on the drawing.

E. Mono-Systems and Hubbell are an approved equal to Wiremold.

PART 3 - EXECUTION

3.1 CONDUIT

A. Conduit shall be concealed in all new walls and run above suspended ceilings.

B. Channel existing plaster walls and/or ceilings to conceal conduit in finished areas.

C. In lieu of channeling existing plaster walls and where lay-in ceilings are used, flexible metal conduit of minimum size 3/4" may be installed from a switch or receptacle outlet up to a junction box located above the lay-in ceiling. In this instance, the conduit length may exceed six feet.

D. Use Wiremold where necessary to run exposed on existing walls and/or ceilings in finished areas as shown on the drawings.

E. Use Wiremold where necessary to run exposed on existing walls and/or ceilings in finished areas.

F. Provide (1) spare 1” inch conduit, and (1) spare ¾” conduit up and one down, to ceiling space, from each new flush panel.

G. All conduits shall be fastened or suspended from structural members, slabs, or walls only. It shall not be run on or fastened to tee bars of suspended lay-in ceilings.

H. All conduits shall be supported by approved hangers.

I. Conduit shall be terminated with locknuts and bushings in all outlet boxes and panels. Insulated bushings shall be used on all rigid conduits 1-1/4 inch and larger. Use insulated bushings and connectors on all E.M.T. All conduit connectors and couplings shall be galvanized steel; cast connectors and couplings are not acceptable.

J. Threaded couplings, connectors, and conduit bodies shall be used on rigid galvanized conduit and intermediate metal conduit; set screw or threadless types are not acceptable. Where a conversion is made between conduit to flexible metal conduit or seal-tight/liquid-tight conduit, the connectors used shall be “listed” and approved for the application.

K. All conduits run exposed shall be run parallel to the structural members of the building in a neat manner, securely fastened in place. Approved condulet type fittings or outlet boxes shall be used at all bends in a vertical plane or where breaking around beams or columns. Bends on ceilings in a horizontal plane shall be made with long sweep elbows. Paint all exposed conduit in finished areas to match existing or new finishes.

L. All conduits penetrating underground walls into basements, crawlspaces, vaults, etc. shall be sealed between the conduits and walls with Link-Seal Model “C” modular sealing system.

M. When metal conduit extends below the bottom of a slab on the ground, the slab shall be thickened in the area of the conduit so as to encase the conduit in concrete by at least 2 inches on all sides. The responsibility for and expense of this work shall be borne by the Contractor.

N. Where high voltage conduit or fiber duct is laid beneath the floor slab of a building, there shall be a minimum of 6 inches of sand fill between the outside of the concrete envelope around the conduit and the underside of the floor slab.

O. Provide (2) spare 4” conduit sleeves in-between the main electrical and telecom rooms.

3.2 PULL AND JUNCTION BOXES

A. Pull boxes shall not be installed in inaccessible locations.

B. In general, pull or junction boxes shall be used in conduit runs when the number of bends in the conduit run exceeds 360 degrees. When conduits are installed in a bank, conduit bodies may be utilized due to space limitations.

3.3 SURFACE RACEWAY AND MULTIOUTLET ASSEMBLIES

A. All joints and corners shall be tight with no gaps or spaces.

B. Raceway and assemblies shall be securely fastened to surface such that it cannot be moved.

3.4 MOUNTING UNDER ROOF DECKS

A. Conduit and raceways systems shall not be mounted directly to the underside of roof decks or installed through the webbing, flutes, or ribs of the roof deck support system.

B. Conduit and raceway systems shall be attached to the bottom of the structural elements supporting the roof deck.

END OF SECTION 260533

SECTION 260553 – IDENTIFICATION FOR ELECTRICAL SYSTEMS

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. This Section specifies the identification for electrical equipment in buildings and structures.

2. Provide all labor, materials, and equipment as necessary to complete all work as indicated on the drawings, and as specified herein.

B. Related Sections include the following:

1. Applicable sections of Division 26 - Electrical

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

3.1 NAMEPLATES

A. Nameplates shall be provided on all major equipment, including the following:

Primary Switches	Contactors
Substations	Remote Controlled Switches
Drawout Circuit Breakers	Dimmers
Disconnect Switches	Control Devices
Switchboards	Transformers
Panelboards, electrical cabinets, enclosures	Adjustable Frequency Drives
Motor Starters	Power Generating Units
Motor Control Centers	Fire Alarm Control Panel
Push Button Stations	Etc.

B. Nameplates shall be plastic laminate, white face with black engraved letters, numbers, etc.

C. All junction box and pull box covers shall be labeled with the circuit numbers of the circuits contained in the boxes using laminated labeling such as TZ Tape.

END OF SECTION 260553

SECTION 260573 – OVERCURRENT PROTECTVE DEVICE COORDINATION AND ARC FLASH HAZARD STUDY

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. This section shall apply to all Division 26 sections.

1.2 SUMMARY

A. This Section includes computer-based, fault-current and overcurrent protective device coordination studies, arc flash hazard studies.

B. Protective devices shall be set based on results of the protective device coordination study.

C. Electrical equipment shall be labeled with the arc flash hazard information based on the results of the arc flash hazard study.

D. As much as possible, the overcurrent protective device settings shall be to keep the arc flash hazard at any point in the system no greater than level 2. Where necessary, an appropriate compromise shall be made between system protection and service continuity with system protection and service continuity considered to be of equal importance.

1.3 SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Product Certificates:

1. For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.

2. For arc flash hazard calculations computer software program certifying compliance with IEEE 1584.

C. Qualification Data: For coordination-study and arc flash hazard specialist.

D. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed. Submittals shall be hardcopy and in digital form.

1. Coordination-study input data, including completed computer program input data sheets.
2. Study and Equipment Evaluation Reports.
3. Coordination-Study Report.
4. Arc flash hazard level report labels as defined in NFPA 70 and NFPA 70E.

1.4 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

B. Coordination-Study and Arc Flash Hazard Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study and all calculations. All elements of the study shall be performed under the direct supervision and control of engineer.

C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

D. Comply with IEEE 399 for general study procedures.

E. Comply with IEEE 1584 for arc flash hazard calculations.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE PROGRAMS

A. Computer software programs: Subject to compliance with requirements. Provide products by one of the following:

1. EDSA Micro Corporation
2. SKM Systems Analysis, Inc.
3. ESA Inc.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with IEEE 399.

B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots. The program shall generate signage indicating arc flash data that shall be installed on the equipment.

1. Optional Features:

a. Arcing faults.
b. Simultaneous faults.
c. Explicit negative sequence.
d. Mutual coupling in zero sequence.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.

1. Proceed with coordination and arc flash hazard studies only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 POWER SYSTEM DATA

A. Gather and tabulate the following input data to support coordination and arc flash hazard studies:

1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination and arc flash hazard studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.

2. Impedance of utility service entrance.

3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:

a. Circuit-breaker and fuse-current ratings and types.
b. Relays and associated power and current transformer ratings and ratios.
c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
d. Generator kilovolt amperes, size, voltage, and source impedance.

e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
f. Busway ampacity and impedance.
g. Motor horsepower and code letter designation according to NEMA MG 1.

4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:

a. Special load considerations, including starting inrush currents and frequent starting and stopping.
b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
d. Generator thermal-damage curve.
e. Ratings, types, and settings of utility company's overcurrent protective devices.
f. Special overcurrent protective device settings or types stipulated by utility company.
g. Time-current-characteristic curves of devices indicated to be coordinated.
h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.

j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

3.3 FAULT-CURRENT STUDY

A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker and fuse positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:

1. Switchgear and switchboards.
2. Motor-control centers.
3. Distribution panelboards.
4. Branch circuit panelboards.

B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.

C. Calculate momentary and interrupting duties on the basis of maximum available fault current.

D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply IEEE 241 and IEEE 242.

1. Transformers:

a. ANSI C57.12.10
b. ANSI C57.12.22
c. IEEE C57.12.00
d. IEEE C57.96

2. Medium-Voltage Circuit Breakers: IEEE C37.010
3. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1
4. Low-Voltage Fuses: IEEE C37.46

E. Study Report:

1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.

2. Show interrupting (5-cycle) and time-delayed currents (6 cycles and above) on medium-voltage breakers as needed to set relays and assess the sensitivity of overcurrent relays.

F. Equipment Evaluation Report:

1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.

3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

3.4 COORDINATION STUDY

A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.

1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.

2. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short-circuit currents.

3. Calculate the maximum and minimum ground-fault currents.

B. Comply with IEEE 241 (Gray Book) and IEEE 242 (Buff Book) recommendations for fault currents and time intervals.

C. Transformer Primary Overcurrent Protective Devices:

1. Device shall not operate in response to the following:

a. Inrush current when first energized.
b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.

2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

D. Motors served by voltages more than 600 V shall be protected according to IEEE 620.

E. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

F. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:

1. Tabular Format of Settings Selected for Overcurrent Protective Devices:

a. Device tag.
b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
d. Fuse-current rating and type.
e. Ground-fault relay-pickup and time-delay settings.

2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:

a. Device tag.
b. Voltage and current ratio for curves.
c. Three-phase and single-phase damage points for each transformer.
d. No damage, melting, and clearing curves for fuses.
e. Cable damage curves.

f. Transformer inrush points.
g. Maximum fault-current cutoff point.

G. Completed data sheets for setting of overcurrent protective devices.

3.5 ARC FLASH HAZARD CALCULATIONS

A. Perform calculations using an approved computer software program. Prepare signage and install on all equipment as defined by NFPA 70E.

1. Calculate maximum energy available at each location.

2. Indicate required PPE equipment level.

B. Comply with IEEE and NFPA 70E.

C. Provide tabular report indicating the following information at each piece of equipment.

1. Flash Protection Boundary (in inches).
2. System voltage.
3. Hazard Risk Category.
4. Available Fault Current (in kA).
5. Incident Energy level at 18 inches in CAL/CM^2.
6. Required PPE level and brief description of PPE.
7. Shock Hazard Approach Boundaries in inches for Limited, Restricted, and Prohibited.
8. Equipment ID.
9. Date.

END OF SECTION 260573

SECTION 260800 - COMMISSIONING OF ELECTRICAL SYSTEMS

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 commissioning process requirements for electrical systems, assemblies, and equipment.

B. Related Sections:

1. Division 01 Section "General Commissioning Requirements" for general commissioning process requirements.

C. Start up of equipment and systems such as medium voltage switches, transformers, unit substations, emergency power and lighting systems, etc. shall be done by or with a trained manufacturer's representative who can check and report on all items such as installation, operation, and see that the equipment or system starts and operates properly.

D. Testing shall be performed at the convenience of the Owner and with the Owner’s representatives present and the manufacturer’s representative of the equipment and/or system present.

1.3 DEFINITIONS

A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.

B. CxA: Commissioning Authority.

C. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.4 ALLOWANCES

A. Labor, instrumentation, tools, and equipment costs for technicians for the performance of commissioning testing are covered by the "Schedule of Allowances" Article in Division 01 Section "Allowances."

1.5 UNIT PRICES

A. Commissioning testing allowance may be adjusted up or down by the "List of Unit Prices" Article in Division 01 Section "Unit Prices" when actual man-hours are computed at the end of commissioning testing.

1.6 CONTRACTOR'S RESPONSIBILITIES

A. Perform commissioning tests at the direction of the CxA.

B. Attend construction phase controls coordination meeting.

C. Attend testing, adjusting, and balancing review and coordination meeting.

D. Participate in electrical systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.

E. Provide information requested by the CxA for final commissioning documentation.

F. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

1.7 CxA'S RESPONSIBILITIES

A. Provide Project-specific construction checklists and commissioning process test procedures for actual electrical systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.

B. Direct commissioning testing.

C. Verify testing and adjusting of Work are complete.

D. Provide test data, inspection reports, and certificates in Systems Manual.

1.8 COMMISSIONING DOCUMENTATION

A. Provide the following information to the CxA for inclusion in the commissioning plan:

1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for electrical systems, assemblies, equipment, and components to be verified and tested.

4. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
5. Certificate of readiness certifying that electrical systems, subsystems, equipment, and associated controls are ready for testing.
6. Test and inspection reports and certificates.
7. Corrective action documents.
8. Verification of testing and adjusting reports.

1.9 SUBMITTALS

A. Certificates of readiness.

B. Certificates of completion of installation, prestart, and startup activities.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TESTING PREPARATION

A. Certify that electrical systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.

B. Certify that electrical instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.

C. Certify that testing and adjusting procedures have been completed and that testing and adjusting reports have been submitted, discrepancies corrected, and corrective work approved.

D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

E. Inspect and verify the position of each device and interlock identified on checklists.

F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.

G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.2 TESTING VERIFICATION

A. Prior to performance of testing Work, provide copies of reports, sample forms, checklists, and certificates to the CxA.

B. Notify the CxA at least 10 days in advance of testing Work, and provide access for the CxA to witness testing Work.

C. Provide technicians, instrumentation, and tools to verify testing of electrical systems at the direction of the CxA.

1. The CxA will notify testing Contractor 10 days in advance of the date of field verification. Notice will not include data points to be verified.
2. The testing Contractor shall use the same instruments (by model and serial number) that were used when original data were collected.
3. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing and adjusting report.
4. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

3.3 GENERAL TESTING REQUIREMENTS

A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.

B. Scope of electrical testing shall include all components, equipment, and systems as outlined in outlined later in this section.

C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response to input signals.

D. The CxA along with the Electrical Subcontractor shall prepare detailed testing plans, procedures, and checklists for HVAC&R systems, subsystems, and equipment.

E. Tests will be performed using design conditions whenever possible.

F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

G. The CxA may direct that set points be altered when simulating conditions is not practical.

H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.

I. If tests cannot be completed because of a deficiency outside the scope of the electrical system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

3.4 EMERGENCY POWER SYSTEMS

A. Emergency power systems shall be tested under load by deenergizing the normal power feeders to verify proper transfer. All of the alarm systems will be tested to verify proper operation. The starting battery will be tested to ensure compliance with the manufacturer's specifications.

3.5 VARIABLE FREQUENCY DRIVES

A. All variable frequency drives shall be tested, connected in its final location to the building power system, under 100% motor load for compliance with the frequency and notch requirements specified under the Variable Frequency Drive section of the specification. The Contractor shall add any necessary filtering to the drive(s) to meet the specification.

3.6 LIGHTING DIMMING AND CONTROL SYSTEMS

A. All dimming systems shall be operated throughout its entire range with all functions operated to verify proper operation.

B. All occupancy sensors shall be tested for proper operation over the entire intended zone of coverage.

END OF SECTION 260800

SECTION 260923 – LIGHTING CONTROL DEVICES

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. This Section specifies the dimming control and occupancy sensors for lighting systems as shown and the drawing and specified herein for buildings and structures.

2. Provide all labor, materials, and equipment as necessary to complete all work as indicated on the drawings, and as specified herein.

3. The Contractor shall furnish and install a complete dimming control system and occupancy sensor system, as shown on the drawing and specified herein.

B. Related Sections include the following:

1. Applicable sections of Division 26 – Electrical

1.3 SUBMITTALS

A. Shop Drawings:

1. Occupancy sensors

B. Operation and Maintenance Data:

1. Occupancy sensors

1.4 QUALITY ASSURANCE

A. Wall box dimmers, occupancy sensors, and dimming systems shall comply with all applicable Underwriters Laboratory and ANSI/IEEE Standards.

PART 2 - PRODUCTS

2.1 OCCUPANCY SENSORS

A. Wall box occupancy sensor/dimmer for small offices and personal care restrooms shall be:

1. Lutron MS-Z-101W.

2. Legrand DW-311-W.

PART 3 - EXECUTION

3.1 OCCUPANCY SENSORS, DIMMERS AND ROOM CONTROLLERS

A. When occupancy sensor power packs are used they shall be mounted above the ceiling adjacent to one of the sensors and wired to the sensors with minimum 18 AWG multi-conductor low-voltage cable. In hard ceilings install an access panel having the same rating as the ceiling to access the power pack. Install low-voltage cable per NEC.

B. All control circuits – individual conductors or cables – shall be installed in conduit, basket or ladder style cable tray, or J-hooks. J-hooks to be spaced at 36” maximum intervals with a cable sag of less than 6”. Closer spacing may be necessary when cables are routed around corners or in close proximity to other mechanical and electrical systems. J-hooks to be 2” Doc Industries JH32 or equal.

C. Contractor shall furnish and install all equipment, labor, system setup, and other services necessary for the proper installation of the devices as indicated on the drawings and specified herein. System setup shall include defining each dimmers load type, assigning each load to a module, and setting the functions of the controls.

D. The following table describes the intended occupancy control for the various areas on campus.

SPACE TYPE	9.4.1.1.|b| RESTRICTED TO MANUAL ON	9.4.1.1.|b| EXCEPTION OF 50% AUTO ON	100% AUTO ON	100% AUTO ON PDC SAFETY AND SECURITY EXCEPTION	9.4.1.1.|d| BI-LEVEL CONTROL
1. AUDIENCE SEATING AREA - ALL TYPES, NOTE 1	NO	YES			YES
2. CLASSROOM/LECTURE HALL/TRAINING ROOM, NOTE 2	NO	YES			YES
3. CONFERENCE/MEETING/MULTPURPOSE ROOM, NOTE 2	NO	YES			YES
4. COPY/PRINT ROOM	YES				YES
5. CORRIDOR, NOTE 3	NOT REQD		YES		NOT REQD
6. COMPUTER ROOM	AUTO ON SAFETY		YES	YES	YES
7. RESEARCH OR CLASSROOM LAB, NOTE 4	NOT REQD		YES	YES	YES
8. LOBBY, NOTE 2	NO	YES			YES
9. LOCKER ROOM	AUTO ON SAFETY		YES	YES	YES
10. OPEN OFFICE, NOTE 2	NO	YES			YES
11. ENCLOSED OFFICES	YES				YES
12. RESTROOMS	NOT REQD		YES		NOT REQD
13. STAIRWELLS, NOTE 3	NOT REQD		YES		YES
14. STORAGE ROOMS	YES				NOT REQD
15. OTHER AREAS ON CAMPUS NOT LISTED, NOTE 7					

9.4.1.1.|a| LOCAL CONTROL	See Design GL
9.4.1.1.|c| RESTRICTED TO PARTIAL ON	Not used
9.4.1.1.|g| AUTO PARTIAL OFF	NOTE 5
9.4.1.1.|h| AUTO FULL OFF	NOTE 5
9.4.1.1.|I| SCHEDULED SHUT OFF	NOTE 6

NOTES:
1. LARGE AUDITORIUMS WILL HAVE A LIGHTING CONTROL SYSTEM OR BAS.
2. ROOM CONTROLLERS TO PROVIDE 50% AUTO ON LOGIC.
3. NL LIGHTS TO PROVIDE 1FC MIN IN UN-OCCUPIED STATE. SEE MBC 2015
4. INSTALL OCCUP SENSORS IN LABS.
5. AUTO FULL OFF IS USED IN PLACE OF PARTIAL OFF.
6. OCCUP SENSOR SIGNAL IS USED IN PLACE OF TIME OF DAY SHUTOFF.
7. VERIFY LIGHTING OPERATION WITH ATHLETICS, RHS OR OTHER AREAS.

E. The following index is the listing of the interior lighting details to be used at MSU.

DETAIL NO	MSU ROOM	APPLICATIONS	EQMT	DIM	EMG	CONTROL ACTION
1	3	COPY/SUPPLY ROOM	WALLBOX OS			MANUAL ON/AUTO OFF
2A	6B,12A	I.T. CLOSET/SMALL RESTROOM	WALLBOX OS		X	AUTO ON/AUTO OFF
2B	13	PERSONAL CARE RESTROOM	WALLBOX OS	X	X	AUTO ON/AUTO OFF
3A	11A	SMALL OFFICE	WALLBOX OS	X		MANUAL ON/AUTO OFF
3B	11A	SMALL OFFICE WITH TLED	WALLBOX OS - 2 ZONE			MANUAL ON/AUTO OFF
4	9,12B	LOCKER ROOM/LARGE RESTROOM	CEILING OS - 1 ZONE		X	AUTO ON/AUTO OFF
5	6A,7A	I.T. ROOM & LAB WITH HAZARDOUS MATERIALS	CEILING OS - 3+ ZONES		X	AUTO ON/AUTO OFF
6	4	CORRIDOR/STAIRWELL	CEILING OS - 1 ZONE		X	AUTO ON/AUTO OFF
7	5	PASSAGEWAYS	CEILING OS - 1 ZONE		X	AUTO ON/AUTO OFF
8	11B,14	LARGE OFFICE /MEETING ROOM	CEILING OS - 1 ZONE	X		MANUAL ON/AUTO OFF
8A	11B,14	DETAIL 8 WITH EMG BATTERY	CEILING OS - 1 ZONE	X	X	
8B	11B,14	DETAIL 8 WITH EMG GENERATOR	CEILING OS - 1 ZONE	X	X	
9	1,2A,7B	CONF/MULTI/CLASSROOM/LAB W/OUT HAZARD. MTL.	CEILING OS - 2 ZONES	X		MAN. ON/AUTO OFF WITH
9A	1,2A,7B	DETAIL 9 WITH EMG BATTERY	CEILING OS - 2 ZONES	X	X	50% AUTO ON EXCEPTION
9B	1,2A,7B	DETAIL 9 WITH EMG GENERATOR	CEILING OS - 2 ZONES	X	X	
10A	1,8,10	CONF/MULTI/LOBBY/OPEN OFFICE - EMG BATTERY	RM CNTL - 3+ ZONES	X	X	MAN. ON/AUTO OFF WITH
10B	1,8,10	CONF/MULTI/LOBBY/OPEN OFFICE - EMG GENERATOR	RM CNTL - 3+ ZONES	X	X	50% AUTO ON EXCEPTION
11A	2B	CLASSROOM/LECTURE HALL - EMG BATTERY	RM CNTL - 3+ ZONES	X	X	MAN. ON/AUTO OFF WITH
11B	2B	CLASSROOM/LECTURE HALL - EMG GENERATOR	RM CNTL - 3+ ZONES	X	X	50% AUTO ON EXCEPTION

MSU ROOM TYPES	
1. CONFERENCE/MULTIPURPOSE	8. LOBBY
2A. CLASSROOM - 2 ZONE	9. LOCKER ROOM
2B. CLASSROOM/LECTURE HALL - 3 ZONE	10. OPEN OFFICE
3. COPY/SUPPLY	11A. SMALL OFFICE <=120 SF
4. CORRIDOR/STAIRWELL	11B. LARGE OFFICE > 120 SF
5. PASSAGEWAY IN OPEN OFFICE/SUITE	12A. SMALL RESTROOM - SINGLE
6A. I.T. ROOM	12B. LARGE RESTROOM
6B. I.T. CLOSET	13. PERSONAL CARE ROOM
7A. LABS - WITH HAZARDOUS MATERIALS	14. MEETING ROOM
7B. LABS - WITHOUT HAZARDOUS MATERIALS	

END OF SECTION 260923

SECTION 262726 – WIRING DEVICES

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. This Section specifies the wiring devices for buildings and structures.

2. Provide all labor, materials, and equipment as necessary to complete all work as indicated on the drawings, and as specified herein.

B. Related Sections include the following:

1. Applicable sections of Division 26 - Electrical

1.3 SUBMITTALS

A. Shop Drawings:

1. Switches
2. Receptacles
3. Receptacle and switch cover plates
4. Floor boxes and all associated fittings and components
5. Relays
6. Time switches

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70, “National Electrical Code”

PART 2 - PRODUCTS

2.1 SWITCHES

A. Switches, single, 2 pole, 3 way, 4 way and key type, shall be lifetime quite type, Cooper 2200 series, Hubbell HBL1200 series, Leviton 1200 series, or equal P. and S., color brown.

B. Switch and pilot light combination shall consist of switch, Cooper 2200 series, and a flush neon pilot light, 125 volt with red plastic jewel, Cooper 277 or Leviton catalog no. 5336.

C. Switch and pilot light combination shall be Leviton catalog no. 5226, 15A., 120 VAC single pole switch and 1/25W, 125V. neon pilot light, red jewel face.

D. Presswitch single, 2 pole, 3 and 4 way, shall be Hubbell 1200 series, color brown.

E. Three position, two circuit, momentary contact switches shall be such as Hubbell catalog no. 1556, 15A., 120-277V. color brown or equal Cooper, Leviton, or P. and S.

2.2 RECEPTACLES

A. In general, duplex receptacles shall be 20 ampere, 125 volt, 3 wire, grounding type, heavy duty, specification grade, color brown. Receptacles shall be:

1.	Cooper	5362
2.	Hubbell	HBL5362
3.	Leviton	5362
4.	Pass and Seymour	5362A

B. 15 ampere, 125 volt, 3 wire grounding type duplex receptacles shall be heavy duty, specification grade, color brown. Receptacles shall be:

1.	Cooper	5262
2.	Hubbell	HBL5262
3.	Leviton	5262
4.	Pass and Seymour	5262A

C. Ground fault circuit interrupter receptacles shall be self-testing, industrial specification grade, extra-heavy duty, 20 ampere, 125 volt, with feed through, pilot light, color brown. GFCI receptacles shall be:

1.	Leviton	GFPL2-PL

D. 15 ampere, 125 volt, 3 wire duplex receptacles with isolated ground, shall be Hubbell catalog no. IG-5262, Leviton catalog no. 5262-IG, Cooper catalog no. IF5262, or equal P. & S.

E. 15 ampere, 125 volt, 3 wire, grounding type with transient voltage surge suppressor for computer outlets, shall be Leviton catalog no. 5280.

F. 20 ampere, 250 volt, 3 wire twist-lock receptacle, shall be Hubbell catalog no. 2320, Leviton catalog no. 2320, or equal Cooper or P. & S.

G. 30 ampere, 125 volt, 2 pole, 3 wire receptacle shall be such as Hubbell catalog no. HBL9308, Leviton catalog no. 5371, or equal Cooper or P. & S.

H. 30 ampere, 125 volt, 2 pole, 3 wire twist-lock receptacle with isolated ground, shall be Hubbell catalog no. IG-2610, Leviton catalog no. 2610-IG, or equal Cooper or P. & S.

I. 30 ampere, 250 volt, 2 pole, 3 wire receptacle shall be such as Hubbell catalog no. HBL9330, Leviton catalog no. 5372, or equal Cooper or P. & S.

J. 30 ampere, 250 volt, 2 pole, 3 wire twist-lock receptacle, shall be Hubbell catalog no. 2620, Leviton catalog no. 2620, or equal Cooper or P. & S.

K. 15 ampere, 250 volt, 3 wire grounding type, single receptacle for window a.c. unit shall be Hubbell catalog no. 5652 or Leviton catalog no. 5661.

L. 20 ampere, 250 volt, 3 wire, single receptacle for window a.c. unit shall be Hubbell catalog no. 5461 or Leviton catalog no. 5461.

M. 20 ampere, 250 volt, 2 pole, 3 wire, single phase, duplex receptacle shall be Hubbell catalog no. 5462 or Leviton catalog no. 5462.

N. 20 ampere, 125/250 volt, 3 pole, 4 wire grounding, single phase receptacle shall be Hubbell catalog no. HBL8410.

O. 20 ampere, 250 volt, 3 pole, 4 wire grounding, 3 phase single receptacle shall be Hubbell catalog no. HBL8420.

P. Floor receptacles shall be Walker 500 AL series, G.E. Co. SP-400RG, or National no. 7903-LGC.

Q. Clock outlets shall be Leviton catalog no. 5261-CH. Clock outlets to be mounted 6 inches to center below suspended ceiling or 7 feet above the floor in rooms without suspended ceiling.

2.3 COVER PLATES

A. Switch and receptacle plates shall be stainless steel, non-magnetic type 302, such as Hubbell 97000 series, except where specified otherwise.

B. Weatherproof receptacle rain tight while in use covers shall be Hubbell WP826 series, Leviton 5970 or 5990 series, or equal Cooper or P. & S.

2.4 SPECIAL CONTROLS

A. As specified, special controls shall be furnished by the contractor furnishing the associated equipment. These controls shall be connected by the electrical contractor.

B. Refer to Mechanical Specifications.

2.5 EMERGENCY-OFF STATION

A. Emergency-off station to control contactor panel shall be such as Square D, Class 9001, Type K-15 break-glass operator with KA-2 N/O contact block, K-25 stainless steel plate, flush mounting, and KN-299 EMERGENCY-OFF legend plate.

PART 3 - EXECUTION

3.1 SWITCHES

A. Switches, unless otherwise noted, shall be mounted 48 inches to center above finished floor.

3.2 RECEPTACLES

A. Receptacle outlets, unless otherwise noted, shall be mounted 18 inches to center above finished floor.

END OF SECTION 262726

SECTION 262813 – FUSES

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. This Section specifies the fuses for buildings and structures.

2. Provide all labor, materials, and equipment as necessary to complete all work as indicated on the drawings, and as specified herein for a complete operating system.

B. Related Sections:

1. Applicable sections of Division 26 - Electrical

1.3 SUBMITTALS

A. Shop Drawings

1. Low-voltage fuses.

PART 2 - PRODUCTS

2.1 FUSES

A. Fuses where required and/or specified for electrical equipment shall be Bussmann Fusetrons or equal by Littelfuse.

B. Where fused disconnect switches are used protect for wire protection fuses shall be sized to protect the wire and be furnished for the disconnect switches.

C. Fuses sized for motor protection shall be furnished for all combination starters. (Not greater than 125% of motor nameplate rating.)

D. Fuses sized as shown on drawings shall be installed in all non-motor starter switches of motor control centers.

PART 3 - EXECUTION

Not used.

END OF SECTION 262813

SECTION 262816 – ENCLOSED SWITCHES AND CIRCUIT BREAKERS

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. This Section specifies the enclosed switches and circuit breakers for buildings and structures.

2. Provide all labor, materials, and equipment as necessary to complete all work as indicated on the drawings, and as specified herein for a complete operating system.

B. Related Sections:

1. Applicable sections of Division 26 - Electrical

1.3 SUBMITTALS

A. Shop Drawings

1. Disconnect switches
2. Enclosed circuit breakers

PART 2 - PRODUCTS

2.1 DISCONNECT SWITCHES

A. Disconnect switches shall be furnished and installed where indicated on the drawing, size as noted.

B. Disconnect switches for motors on cooling tower fans and similar applications shall be furnished with watertight, stainless steel enclosures.

C. Disconnect switches mounted exterior of the building shall be NEMA type 4X stainless steel.

D. Disconnect switches for two speed motors shall be six pole, single throw.

E. All disconnect switches shall have interlock defeaters for maintenance purposes.

F. Disconnect switches shall be Square D heavy duty type or approved equal by General Electric, Cutler-Hammer, or Siemens.

G. All disconnect switches shall be provided with an engraved laminated plastic name plate indicating equipment controlled by that particular switch.

H. Disconnect switches located on the load side of a VFD (between VFD and Motor) shall be non-fused.

I. Disconnect switches for indoor HVAC equipment shall be NEMA 1, aluminum cover and base, 30A, 2-pole. Hubbell HBL1372D, 30A, 3-pole. Hubbell HBL1379D.

2.2 ENCLOSED CIRCUIT BREAKERS

A. Molded case circuit breakers shall be size and type as noted on drawing and as manufactured by Square D, General Electric, Cutler-Hammer, or Siemens.

PART 3 - EXECUTION

3.1 EQUIPMENT SUPPORTS

A. Electrical equipment shall be mounted on ½" spacers when mounted in a room on a below grade exterior wall.

B. Disconnects shall be mounted on separate structures. They shall not be mounted on HVAC housings, duct work, pump frames, etc.

END OF SECTION 262816

SECTION 263213 – ENGINE GENERATORS

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. This Section specifies emergency generator equipment for buildings and structures emergency electrical systems.

2. Provide all labor, materials, and equipment as necessary to complete all work as indicated on the drawings, and as specified herein for a complete operating system.

B. Related Sections:

1. Applicable sections of Division 26 - Electrical

1.3 REFERENCES

A. Emergency generators shall be in accordance with the latest applicable standards as recommended by, SAE, IEEE, and ANSI/NEMA MG-1 Motors and Generators.

1.4 SUBMITTALS

A. Shop Drawings

1. Standby generator system including:

a. Engine-generator set and foundation requirements.
b. Auxiliary and remote equipment.
c. Make of engine, number of cylinders, compression ratio, bore and stroke, cylinder displacement, and speed.
d. Make of generator, electrical rating, number and type of bearings, and exciter type.

2. Plan and elevation views with overall and interconnection point dimensions, fuel consumption rate curves at various loads, ventilation and combustion air requirements, and electrical diagrams including schematic and interconnection diagrams.

3. Product data showing dimensions, weights, ratings, interconnection points, and internal wiring diagrams for engine, generator, control panel, battery, battery rack, battery charger, exhaust silencer and vibration isolators.

4. Installation instructions.

5. Name, location and phone number of nearest authorized distributor/service facility.

6. Sequence of Operation - Manufacturer shall prepare a detailed, typewritten sequence of operation and submit as part of the approval documents. Final approved sequence of operation shall be permanently encapsulated in plastic laminate and permanently attached to the equipment. Format shall be 8½" x 11" or 11" x 17" as appropriate. Include schematic one-line diagram with appropriate symbols and nomenclature properly referenced to text.

7. Thermal damage curves for generator and Time-current characteristic curves for generator protective devices.

B. Manuals and Test Data

1. Operation and Maintenance Manuals for all major components including instructions for normal operation, routine maintenance requirements, service manuals for generator, engine, oil sampling and analysis for engine wear, and emergency maintenance procedures.

2. Test data required in 1.5 Quality Assurance.

C. Certified Performance Test: Provide data as described in this section.

D. Warranties: Submit written special warranty as specified in this Section. Include contact information, description of coverage, and start date for each special warranty.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70, “National Electrical Code”

C. Submit certified performance test data for this or an exact duplicate prototype unit. Test shall include a full load test conducted at the specified ambient temperature for at least four (4) hours. The test shall be conducted with all components intended for this project including engine, generator fan and radiator. Single pass cooling systems shall NOT be used to replace the radiator for testing. Test shall include actual surge and steady state performance data for "0-to-50%", "0"-to-100%" and "50-to-100%" instantaneous load applications. Steady state performance shall be recorded at no greater than 15 minute intervals, application as well as 100% steady state performance. Test results shall include oil pressure, oil temperature, coolant temperature, fuel pressure, ambient temperature, load in kW, kVA, amperes and output voltage. Load characteristic shall be sinusoidal, 80% power factor and steady state performance testing shall also include at least four (4) hours at 100% rating, with load characteristic of 80% power factor and total harmonic distortion of 50%.

D. Warranty

1. Furnish full parts and labor warranty to cover the entire engine generator package including all accessories for two years from date of installation.

1.6 MATERIALS TURNED OVER TO OWNER

A. Provide two spare sets of each oil, and air filter element required for each engine generator system.

PART 2 - PRODUCTS

2.1 GENERAL INFORMATION

A. Furnish a new natural gas engine driven electric generating unit, factory assembled single unit generator set, with continuous output ratings as shown on the drawings at 0.8 power factor, 60 hertz, grounded neutral service, fully rated for operation at 1000 feet above sea level in an ambient temperature range of 120 deg.F. maximum to -20 deg.F. minimum, consisting of a natural gas engine, electric jacket heater, direct-connected generator, exciter, radiator and fan cooling system, exhaust system with muffler and weather cap, automatic battery starting equipment, battery rack with heater, batteries and charger, instrument panel, control panel, instruments and controls, all mounted on a common steel base suitable for mounting on a concrete foundation pad, remote mounted derangement panel, weather-proof remote mounted emergency E-Stop button, and all accessories as specified and required for normal operation in standby service.

B. Generator set shall be manufactured by Cummins, Caterpillar, or Kohler.

C. Manual and Automatic Start - Unattended Operation

1. Manual start shall be done by operating the “start” button on the generator or selecting “manual” on the manual-off-automatic selector switch on the automatic transfer switch.

2. Automatic start shall be done by the automatic transfer switch when the manual-off-automatic selector switch on the automatic transfer switch is in the “automatic” position.

D. Voltage and frequency regulation

1. Engine/generator shall deliver rated output (kVA) at rated frequency and power factor, at not more than 2% above or below rated voltage.

2. Voltage regulation shall be plus or minus 2% for any constant load between no load and rated load. Random voltage variation shall not exceed .5% for any constant load. Voltage recovery to 100% normal output shall take no longer than two seconds after single step application of 100% rated load.

3. Frequency regulation shall be isochronous from steady state no load to steady state rated load. Random frequency variation with any steady load from no load to full load shall not exceed plus or minus 0.25%.

4. The engine-generator set shall be capable of single step load pick up of 100% nameplate kW and power factor, less applicable derating factors, with the engine-generator set at operating temperature.

E. The alternator shall produce a clean AC voltage waveform, with not more than 5% total harmonic distortion at full linear load, when measured from line to neutral, and with not more than 3% in any single harmonic. Telephone influence factor shall be less than 40.

F. Furnish all necessary electrical connections internal to the generator set enclosure, transfer switch, control panel, relays, etc., for installation of new generator set.

G. Generator and engine shall be mounted on vibration isolating supports capable of 95% isolation to minimize vibration of the remainder of the skid-mounted equipment and transmission of vibration to the supporting pad.

H. Generator shall be fully enclosed or suitably guarded to prevent exposure to all parts which operate at extremely high temperatures, electrically energized, or rotating. All noncurrent carrying parts shall be grounded.

I. Thoroughly clean all equipment, and prime and finish paint with manufacturer's standard paint finish; enclosure color shall be manufacturers variation of Tan, Almond, or Cashmere. Submit standard color chart with bid proposal; final color selection to be made during shop drawing review. Painted metal samples shall be provided with shop drawings.

J. The engine/generator set shall be suitable for outdoor installation and be totally enclosed and rated for outdoor use.

K. Outdoor Weather-Protective Housing: Factory-assembled to generator set base and radiator cowling. Housing shall provide ample airflow for generator set operation and exclude entry of moisture into interior components. The housing shall have hinged side-access doors and rear control door. All doors shall be lockable. Housing shall be aluminum. All sheet metal shall be primed for corrosion protection and finish painted with the manufacturer’s standard color.

2.2 ENGINE

A. Engine shall be standby power rated, multi-cylinder, spark ignited four stroke cycle, liquid cooled, internal combustion engine for use with natural gas fuel, industrial type, designed for full rated power output at 1800 rpm, 60 hertz. Aspiration may include turbocharger with after-cooler system. Block and head shall be cast-iron with replaceable cylinder liners.

B. Governor shall be electronic isochronous type no load to full load, with recovery to steady state within 2 seconds following sudden load changes. Random frequency variation shall not exceed ±0.25% of its mean value for constant loads from no load to full load. Governor shall be provided with means for manual operation and adjustment.

C. Lubrication system.

1. Full pressure type with engine driven positive displacement sump pump.
2. Full flow strainer.
3. Full flow filter.
4. Pressure relief and automatic bypass valves.
5. Crankcase ventilator with filter and connection for outside venting.
6. Bayonet type oil level indicating pressure gauges on the upstream and downstream side of the strainer and filter.
7. Drain connection.
8. Oil cooler.
9. Low oil pressure safety shutoff device.
10. Provide water shutoff valves and drain on the oil cooler to facilitate draining water without draining the complete engine cooling system.
11. Provide a radiator coolant level sight glass.

D. Cooling System

1. Pressure type, with radiator, blower type fan.
2. Engine driven circulating pump.
3. Radiator cap incorporating a pressure-vacuum valve.
4. Thermostat in conjunction with a radiator bypass.
5. Drain connection.
6. High coolant temperature safety device.
7. Fan shall be sized to maintain safe engine temperature in ambient temperature of 120 degrees F.
8. Provide gaskets and packing in the cooling system which are unaffected by ethylene glycol base coolant.
9. Provide a 50% ethylene glycol antifreeze solution for the coolant.
10. Radiators shall be provided with a duct adapter flange permitting the attachment of air discharge duct for directing discharge air through the wall.
11. Radiator and Air Intake/Discharge System Flow Restriction requirement shall be no less than 0.5 inches of water.

E. Provide thermal circulation type engine jacket water heater with integral thermostatic control, sized to maintain engine jacket water at 90 degrees F and suitable for operation at 480 or 240 Volts AC. Provide plug-in type connection.

F. Air intake system shall be complete with a dry type filter, and high frequency filter-type silencer for reducing the sound level at the intake to a point acceptable for residential use.

G. Air shutoff for emergency shutdown.

H. Engine exhaust system shall be complete with residential type silencer capable of reducing ambient exhaust noise level to 75 dBA or lower when measured 23 feet from the engine under full engine load and clear weather. Silencer shall be supported independently of the engine. Flexible exhaust connection shall be provided from the engine exhaust manifold to the silencer. An exhaust condensation trap with manual drain valve shall be provided to prevent condensation from entering the engine. Furnish and install a rain cap at the exhaust stack outlet.

I. Standard SAE nuts, bolts, and studs.

J. Standard NPT or SAE tubing and fittings.

2.3 GENERATOR

A. Generator shall be alternating current, three phase, four pole, re-connectible brushless revolving field synchronous type with brushless exciter directly connected to the generator field windings without slip rings or commutators.

B. Generator shall have a single pre-lubricated sealed bearing, direct connected to the engine, and air cooled by a direct drive centrifugal blower fan.

C. Insulation shall be Class H in a self-ventilated enclosure. Temperature rise shall be 125 deg C. max over ANSI 40 deg C. ambient for standby service; starting KVA SHALL BE 272 sKVA or better.

D. Bring out all leads from each winding to a generator main lead terminal box adequate in size for making up all connections and grounding the neutral to the generator set supporting frame.

E. Voltage regulation shall include 3 phase sensing, generator-mounted volts per Hertz exciter-regulator to match engine and generator characteristics. Include manual controls to adjust voltage output plus or minus 5% of nominal voltage level.

F. The generator shall have the necessary excitation control circuitry to prevent the loss of excitation on fault conditions allowing quick return to full voltage and power to normal and faulted circuits.

G. Furnish NEMA 1 output terminal and outgoing cable termination compartment integral with the engine-generator frame.

H. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components

2.4 VOLTAGE REGULATION

A. Static type, three phase, mounted either on the generator control panel or combined with the exciter. Voltage shall have "manual-automatic" switch and be adjustable +/- 10% under all operating conditions.

2.5 ELECTRIC START SYSTEM

A. Engine starting system shall be a 12 volt or 24 volt DC system depending on size of engine/generator, consisting of a heavy duty electric cranking motor(s) with drive mechanism, heavy duty batteries with metal frame or box, engine driven alternator, battery charger, and transistorized voltage regulator.

B. Cranking motor shall be capable of starting the engine five times in rapid succession without overheating the motor and at sufficient speed for starting in ambient temperatures as low as -10 deg.F.

C. Storage batteries shall be lead acid type of voltage and capacity as determined by the engine manufacturer, with sufficient capacity to start the generator set five times consecutively in rapid succession.

D. Battery charger shall be an automatic, self-protected, self-regulated, dual rate rectifier type of a capacity determined by the engine manufacturer and sufficient to automatically recharge the batteries quickly according to the requirements governed by battery discharge duty, and suitable for 120 volt, single phase, 60 hertz input service from a remote receptacle panel.

E. Engine governor shall be a hydraulic, adjustable, isochronous type designed to maintain a constant engine speed from no load to full load. The frequency at any constant load, including no load, shall remain within a steady state band width of plus or minus 0.25% of rated frequency. The governor shall not permit frequency modulation to exceed one cycle per second.

F. Fuel system shall be natural gas type designed for a fuel pressure at the inlet of the safety valve of 15”-20” inches water column. Unit shall be complete with all code required operating and safety controls and valves.

2.6 ACCESSORIES

A. Exhaust silencer: critical grade silencer, with muffler companion flanges and flexible stainless steel exhaust fitting, suitable for orientation, sized in accordance with engine manufacturer's instructions.

B. Batteries: Heavy duty, engine starting type lead-acid storage batteries (2 batteries at 225 ampere - hours each) minimum capacity, thermostatically controlled battery heater, powered by the battery charger. Match battery voltage to starting system. Include necessary cables and clamps.

C. Battery Tray: Plastic coated metal for electrolyte resistance, constructed to contain spillage of electrolyte.

D. Battery Charger: Current limiting type designed to float at 2.17 volts per cell and equalize at 2.33 volts per cell. Include overload protection, full wave rectifier, voltmeter and ammeter, and 120 volt AC fused input. Charger shall include NEMA 1 enclosure (may be NEMA 1 if the entire assembly is provided in an integral outdoor weatherproof enclosure). Package shall include provisions for single point connection of 120V power for charger, for engine jacket water heater, and any other devices requiring energization while in storage. External charger shall automatically disconnect from the engine battery charging system immediately on engine starting.

E. One 150 amp – 3 pole molded case, thermal magnetic 100% rated output circuit breakers with shunt trip and adjustable Long-Time, Short-Time and Instantaneous settings configured as the main circuit breaker. One 200 amp – 3 pole molded case, thermal magnetic 100% rated output circuit breakers with shunt trip and adjustable Long-Time, Short-Time and Instantaneous settings for connection of load-bank leads for monthly testing.

F. CT's with shorting blocks and potential connections with fuse blocks for metering.

G. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.

1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow. Louver assembly shall have bird screen and filter arranged to permit air circulation while excluding exterior dust, dirt, insects, birds and rodents.

2.7 ENGINE-GENERATOR CONTROL PANEL

A. Control panel shall be engine generator frame mounted in NEMA 1 enclosure, totally front accessible. Control panel shall be completely factory pre-wired. All external connections shall be wired out to terminal blocks for field wiring. Control panel shall be complete with all engine and generator controls and indicators. Include front hinged double doors with latches and provision for padlock.

B. Control panel shall provide a contact closure to initiate operation of the ventilation system. Wire out to terminal block. Contact shall be field wired by manufacturer as indicated on the Drawings.

C. Control panel shall include the following fully identified by means of permanent nameplates:

1. Control

a. Output voltage adjustment.
b. Cranking limiter relay.
c. Overspeed shutdown.
d. Low oil pressure shutdown.
e. High coolant temperature shutdown.
f. Remote Alarm Contacts: Pre-wired SPST contacts to terminal strip for remote indication of all alarm functions.
g. Battery operated service light to illuminate panel during power outage conditions.
h. Manual-off-auto engine start switch.

2. Visual monitoring (digitally adjustable via master control panel LCD screen), along with Shut Down and Warning lights:

    a. Frequency Meter: 45-65 Hz range
    b. AC Output Voltmeter: 2 percent accuracy, with phase selector switch (phase-to-phase and phase-to-ground).
    c. AC Output Ammeter: 2 percent accuracy, with phase selector switch and 3 current transformers.
    d. Engine performance:

        1) Engine run
        2) Low oil pressure
        3) High water temperature
        4) Overspeed and over-crank
        5) Overspeed shutdown
        6) Failure to crank
        7) Failure to establish voltage or frequency
        8) Failure to reach rated voltage at transfer switch in ten seconds

    e. Engine running time meter.
    f. Electrical oil pressure gauge.
    g. Electrical water temperature gauge.
    h. Mechanical fuel pressure gauge.
    i. Radiator sight glass.
    j. DC voltmeter and ammeter.

3. Audible monitoring

    a. Low oil pressure alarm condition.
    b. High coolant temperature alarm.
    c. Failure to crank.
    d. Failure to establish voltage or frequency.
    e. Failure to reach rated voltage at transfer switch in 10 seconds.

D. Battery charging system including alternator and solid state regulator.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. Furnish, as part of the base scope of work, a factory authorized field service engineer to inspect the equipment for proper installation and proper functioning, to direct (and/or perform) all electrical and mechanical adjustments which may be required, to supervise (and/or participate in) all testing and to certify that the installation and equipment is in accordance with Manufacturer's requirements, ready for energization and for being placed in operation.

B. The equipment shall be operated through all design functions. This shall include all remote control operation, actuation of all alarm and indication devices, mechanical and electrical operation from protective devices. In addition perform all specific inspections and tests as recommended by the manufacturer.

C. Wiring and Connections:

1. Provide conduit, wiring, and connections as required and recommended by equipment supplier.
2. Make all connections to generator set with flexible conduit.

D. The engineering field service shall include, but not be limited to, the following:

1. Examine for evidence of shipping, storage, and handling damage. Identify parts damaged and reorder as required. Expedite equipment as appropriate.

2. Determine that shipping devices and tags have been removed. Direct the removal of such straps, blocks, braces that remain.

3. Examine all interior wiring, breakers, fuses, etc., for any damage.

4. Examine insulation and assembly of phase bus, ground bus, control, sensors, relaying and metering connections. Identify and direct all necessary changes.

5. Check all accessible connections to manufacturer's tightening torque specifications.

6. Verify phasing.

7. Check internal circuitry for electrical continuity.

8. Test internal circuit integrity with a megohm meter (can be performed and documented at plant).

9. Check electrically operable devices by operating several times.

10. Check that primary and control connections are made. Determine that control voltages are consistent with equipment furnished.

11. Visually inspect main bus between the generator terminals and the outgoing feeder. Direct the disconnecting of the generator and check the bus with a megohm meter if conditions dictate. Values shall be in accordance with the manufacturer's recommendations.

12. Megger insulation resistance levels phase-to-phase and phase-to-ground. Values shall be in accordance with the manufacturer's recommendations but no less than 6 megohms on 2500V megohm-meter (can be performed and documented at plant).

13. Verify that the equipment is clean and free of debris.

14. Assure that the equipment is level, properly secured to the floor, physically connected to the grounding system, and that doors swing properly and can be readily secured closed. Direct any adjustments or additional work required.

15. Review the field assembly work and, to the extent possible, determine that the work was completed in accordance with the manufacturer's instructions and drawings.

16. Test temperature relays, gages, switches, alarms, safety shut-down systems, and local and remote control meters and indicating lights for proper installation and operation.

17. Check operation of auxiliaries, interlocks, etc. Check contact wipe, gaps and clearances as described in the Manufacturer's instruction book.

18. Verify proper operation of starting battery and charger system.

19. Set governor, voltage regulator, etc. and verify proper operation under all load conditions.

20. Assist in energization.

E. Load Bank Test

1. Furnish a continuous on site four (4) hour full load "Load Bank" test. Test shall be conducted when ambient temperatures are at least 85^{o}F.

F. Adjusting and Cleaning

1. Adjust operating mechanisms for free mechanical movement.
2. Touch-up scratched or marred surfaces to match original finishes.
3. Remove debris, tools, and foreign material from enclosures.

G. Inspection

1. Manufacturer must examine areas and conditions under which the engine-generator and components are to be installed, and notify the Engineer and Owner's Representatives in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until satisfactory conditions have been corrected in a manner acceptable to the Engineer and Owner's Representative.

H. Generator Start-Up, Transfer, and Run

1. Verify the proper functioning of all indicating devices.
2. Verify the proper functioning of all indicating devices.
3. Verify proper phasing, proper frequency and isochronous operation no-load to full-load.

I. A checklist with this information shall be prepared by the manufacturer and three copies signed and dated by the manufacturer's engineer verifying proper installation, energization, and operation of the equipment shall be submitted to the Owner’s Representative.

END OF SECTION 263213

SECTION 265100 – INTERIOR LIGHTING

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. This Section specifies the interior light fixtures for buildings and structures.

2. Provide all labor, materials, and equipment as necessary to complete all work as indicated on the drawings, and as specified herein.

3. The Contractor shall furnish and install all light fixtures, as shown on the drawing. Light fixtures shall conform to the types and manufacturers as hereinafter specified.

4. The Contractor shall furnish all lamps and necessary hangers, supports, wiring, etc., for installation of light fixtures.

B. Related Sections include the following:

1. Applicable sections of Division 26 – Electrical

1.3 SUBMITTALS

A. Shop Drawings:

1. Light fixtures

1.4 QUALITY ASSURANCE

A. Light fixtures: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70, “National Electrical Code”

1.5 DESIGN REQUIREMENTS

A. Light fixtures and lenses must comply with School Fire Safety Regulations adopted January 3, 1973. Certification shall accompany shop drawing submittal.

PART 2 - PRODUCTS

2.1 LENSES

A. Lenses shall be flat, 0.125 inch thick, 100% virgin acrylic plastic, clear, with a prismatic pattern, and mounted in hinged metal frames.

B. The following manufactures shall be considered as approved equal for the following luminaire types: Lithonia, Metalux, Hubbell Columbia.

C. Refer to Section 265113 Lighting Accessories for lamp and ballast specifications.

2.2 LIGHT FIXTURE SCHEDULE

A. LED Light Fixtures

1. See luminaire schedule on drawings.

PART 3 - EXECUTION

3.1 Framing members of suspended ceiling systems used to support light fixtures shall be securely fastened to each other and shall be securely attached to the building structure at appropriate intervals.

3.2 Light fixtures so supported shall be securely fastened to the ceiling framing member by clips identified for use with the type of ceiling framing member and fixture. Bolts, screws, or rivets are not acceptable.

3.3 Light fixtures shall be served from a junction box, they shall not be daisy chained together. Light fixtures that share the same ballast may be tandem wired.

END OF SECTION 265100

SECTION 265200 - EMERGENCY LIGHTING

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. This Section specifies the emergency lighting fixtures for buildings and structures.

2. Provide all labor, materials, and equipment as necessary to complete all work as indicated on the drawings, and as specified herein.

3. The Contractor shall furnish and install all fixtures, as shown on the drawing. Fixtures shall conform to the types and manufacturers as hereinafter specified.

4. The Contractor shall furnish all lamps and necessary hangers, supports, wiring, etc., for installation of fixtures.

B. Related Sections include the following:

1. Division 26 Section "Interior Lighting" for luminaires that have an emergency lighting function that are not specified in this section.

2. Applicable sections of Division 26 - Electrical

1.3 DEFINITIONS

A. CRI: Color-rendering index.

B. HID: High-intensity discharge.

C. LED: Light emitting diode

D. Luminaire: Complete lighting fixture, including ballast housing if provided.

E. Pole: Luminaire support structure, including tower used for large area illumination.

F. Standard: Same definition as "Pole" above.

1.4 SUBMITTALS

A. Shop Drawings: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, for the following:

1. EXIT lights

B. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70, “National Electrical Code”

PART 2 - PRODUCTS

2.1 EXIT LIGHTS

A. Exit lights shall be type of mounting as indicated on drawing and shall be cast aluminum, black housing, with brushed aluminum face with 6 inch letters, green LED panel for multi-voltage. They shall be the Sure-Lites CX6G series, Lithonia LESG “Tru-Green” series, or Lightolier LDS-N-G-ASD.

PART 3 - EXECUTION

3.1 NOT USED.

END OF SECTION 265200

SECTION 265600 - EXTERIOR LIGHTING

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. This Section specifies the exterior lighting fixtures for buildings, structures, and exterior areas.

2. Provide all labor, materials, and equipment as necessary to complete all work as indicated on the drawings, and as specified herein.

3. The Contractor shall furnish and install all fixtures, as shown on the drawing. Fixtures shall conform to the types and manufacturers as hereinafter specified.

4. The Contractor shall furnish all lamps and necessary hangers, supports, wiring, etc., for installation of fixtures.

B. Related Sections include the following:

1. Division 26 Section "Interior Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings that are not specified in this section.

2. Applicable sections of Division 26 - Electrical

1.3 DEFINITIONS

A. CRI: Color-rendering index.

B. HID: High-intensity discharge.

C. LED: Light Emitting Diode.

D. Luminaire: Complete lighting fixture, including ballast housing if provided.

E. Pole: Luminaire support structure, including tower used for large area illumination.

F. Standard: Same definition as "Pole" above.

1.4 SUBMITTALS

A. Shop Drawings: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, for the following:

1. Lighting fixtures
2. Poles
3. Street light conductors
4. Pull boxes/handholes

B. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70, “National Electrical Code”

1.6 DELIVERY, STORAGE, AND HANDLING

A. Package aluminum poles for shipping according to ASTM B 660.

B. Store aluminum and concrete poles on decay-resistant-treated skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

C. Retain factory-applied pole wrappings on poles until right before pole installation. Handle poles with web fabric straps.

PART 2 - PRODUCTS

2.1 STREET LIGHTS

A. 25 Foot Street Light / roadway pole mounted Luminaires – LED

1. Luminaires shall be the following:
2. Autobahn ATB2-P601-MVOLT-R2-NR-AO with 4000K color temperature, provided with the “Field Adjustable Output” (FAO) module. FAO module to be set at position #4 (16,048 LU/96 watts, +/-)

B. 25 Foot Street Light Standards

1. Standards shall be aluminum poles, type as manufactured by one of the following:

2. Hapco catalog no. RTA25D7B4M16-01, 25 foot single arm aluminum pole 7 inch by 4-1/2 inch shaft diameter with plain base and 4 inch by 6 inch hand hole, 6 foot upsweep pipe arm and 2 inch slip fitter.

3. Hapco catalog no. RTA25D7B4M26-01, 25 foot double arm aluminum pole, 7 inch by 4-1/2 inch shaft diameter with plain base and 4 inch by 6 inch hand hole, 6 foot upsweep pipe arms and 2 inch slip fitter.

4. Street light standard anchor bolts shall be galvanized steel, size as noted on the drawing.

2.2 EXTERIOR BUILDING LIGHT FIXTURES

Refer to drawings.

2.3 STREET LIGHT CONDUCTORS

A. Street light cable shall be three 600 volt insulated conductors with an overall jacket for direct burial installation. Cable shall be suitable for use in wet or dry locations; indoors or outdoors; in free air, cable trays, ducts, conduits, or direct burial in earth. This streetlighting cable shall be used for all street lighting and concourse lighting on campus, and there shall be no single conductors used in any lighting projects in green spaces or hard spaces.

B. Conductors shall be #4 AWG Class B concentric strand (7 strand) copper conductor.

C. Conductors shall be insulated with a minimum of 45 mils of ethylene-propylene rubber (FR-EPR) Type III insulation.

D. The cable shall consist of three conductors. One insulated 600 volt conductor shall be color black (phase), one 600 volt conductor shall be color white (neutral), and one 600 volt conductor shall be color green (ground) consistent with ICEA Method 3.

E. The cable shall be assembled with the three conductors using flame retardant non-hygroscopic fillers in the cable interstices to preserve the round cable geometry and to limit water ingress and transmission.

F. The cable jacket shall be lead-free flame retardant; water, sunlight, and oil resistant; thermoplastic Chlorinated Polyethylene (CPE). The cable jacket shall pass the -40 degree C. cold bend test. The jacket shall be a minimum thickness of 80 mils.

G. The cable jacket shall be surface printed with the manufacturer’s name, year of manufacture, gauge size, number of conductors, voltage rating, and pertinent U.L. information at 24 inch intervals.

H. Conductors shall be manufactured and tested in accordance with this specification and the latest version of U.L. Standard 44 UL1277 Type TC-ER; ICEA S-95-658/NEMA WC70; and IEEE 1202, ICEA T-29-520, U.L. 1685, U.L VW-1.

I. Conductor ends shall be sealed to prevent the ingress of water.

J. Conductors shall be as manufactured by Draka, Catalog No. 400699.

2.4 STREET LIGHT PULL BOXES

A. Street light pull boxes shall be 11" x 18" x 18" deep, Hubbell CDR catalog no. B12111818A box and C12111802A041 cover with penta-socket bolts and "STREET LIGHTING" logo.

2.5 STREET LIGHT FUSING

A. Fuses for street lights and area lights shall be Bussmann Tron in-line fuse holder and fuse, Type HEB-AA, 30A, 600V with KTK-5 fuse. Install one fuse in each phase conductor. Fuses shall be sized for the fixtures being protected. Fuses shall be installed in the handhole.

2.6 STREET LIGHT VOLTAGE

A. The operating voltage for street lights and area lights shall be 277 V.

PART 3 - EXECUTION

3.1 LAYING OUT WORK

A. All exterior light locations shall be staked out by the Contractor and approved by the Engineer prior to installation.

B. A/E or consulting firm shall generate "Point-by-Point" photometric calculations for submission and approval prior to finalizing pole & luminaire layouts; "pole height-to-spacing" ratio for all installations shall not be greater than 4:1.

3.2 STREET LIGHTS

A. 25 Foot Street Light Bases

1. Bases for 25 foot street light poles and parking area lights shall be constructed as shown on the drawing. Bases shall be 18" diameter with integrated rebar.

2. Bases shall be made of 3,000 psi strength, 6-AA limestone concrete mixture.

3. Install LFNC-B marked for concrete embedment and direct burial conduits to be left in base. Size and quantity as shown on drawings. LFNC-B shall be manufactured by Southwire Ultratight Type NM, Thomas and Betts XTRA Flex, or equal.

4. Chamfer top edge of the base with a one inch chamfer.

5. After the base has cured the form shall be removed.

B. Install the street light standard with on nut above and one nut below the standard base. The nut below shall be used as a leveling nut.

C. After the standard is plumb, grout the opening between the concrete base and standard base full from the conduit to the edge of the standard base.

3.3 GROUNDING

A. Each street and walk light shall be grounded with a 5/8 inch x 8 foot copperweld ground rod driven adjacent to the base, covered by a minimum of 6 inches of earth and connected to the standard or post with a no. 6 bare copper wire.

B. Provide Burndy GRC58 or equal ground rod connector.

C. Install a No. 10 USE ground wire from the luminaire grounding lug to the hand hole and connect to the grounding rod conductor.

3.4 TRENCHING

A. The Contractor shall use a trenching machine or back hoe in digging trench for conductors. Trench shall have a minimum width of 6 inches and a maximum width of 12 inches. Depth of trench shall be a minimum of 30 inches.

B. Trench shall be free of stones or debris before conductors are installed.

C. When backfilling, fill first 6 inches of trench with sand. Earth removed may only be used in this first 6 inches of fill if it is hand shoveled and kept free of stone, cinders, and other debris.

D. All backfill placed under roadways, sidewalks, parking areas, or other surfaced areas shall be compacted to 95 maximum density. All backfill placed in lawn or field areas shall be compacted to 90 maximum density. Density tests shall conform to A.A.S.H. Test T-180 and field test T-147.

E. Failures of any surface areas caused by settlement shall be repaired at the contractors expense for a period of 3 years after completion of contract.

3.5 STREET LIGHT PULL BOXES

A. Pull Box Location

1. At all locations where a three-way splice is made within the street light circuit cable, an underground street light pull box shall be located next to a light pole for a tap to the pole, or for a splice.

2. The street light cable shall be daisy chained by looping into and out of the light pole and the tap for the fixture will be made in the handhole.

3. All street light underground pull boxes and sleeves, shall be GPS located for street light mapping purposes. All electronic as-built utility information in the as-built survey must reference the Michigan State Plane Coordinate System, South Zone, **NAD83(86)** horizontal and **NVGD29** vertical utilizing **GEOID 12B** grid #3; the units must be in **US Survey Feet** and tied to the benchmark control network that can be found at https://apps.gis.msu.edu/facilities-information-tool/maps/benchmarks/.

B. Pull Box Installation

1. Install pull box approximately 1 to 2 feet from the light standard as shown on the details.

2. Install street light conduits to enter the bottom of the street light pull box.

3. Install 6 inches of peastone around the conduits to form a level base for the pull box to set on. Install the pull box on the peastone so that the top of the box even with grade.

4. Install crushed peastone inside the pull box to a depth of 2 inches around the conduits. Leave conduits extended a minimum of 3 inches above the peastone which will allow approximately 8” of room for cable splices.

5. Provide conduit end bells on all conduits that enter the street light pull box.

6. Provide a locator sound ball in each box for ease of locating in the future.

7. Pull Box shall be Hubbell CDR Cat No. B1211818A box and C12111802A cover, with penta-socket bolts and “Street light” Logo.

3.6 CONDUIT

A. Install minimum 3 inch Sch 40 PVC conduit under all walks, roadways, parking lots, and all other hard surfaces.

B. Install a locator ball at one of the sleeve for sleeves eight feet or less, and at both ends of the sleeve for sleeves over eight feet.

C. Locator balls shall be 3M Dynatel EMS 4” extended range, color red, transmitting at a frequency of 169.8 kHz.

3.7 CONDUCTOR INSTALLATION

A. Care shall be taken not to cross conductors in the trench.

B. All street light underground cabling and conductors installed, shall be GPS located for street light mapping purposes and annotated on 'As-Built' drawings. All electronic as-built utility information in the as-built survey must reference the Michigan State Plane Coordinate System, South Zone, NAD83(86) horizontal and NVGD29 vertical utilizing GEOID 12B grid #3; the units must be in US Survey Feet and tied to the benchmark control network that can be found at https://apps.gis.msu.edu/facilities-information-tool/maps/benchmarks/.

C. Connections Made In Street Light Standard.

1. Extend the street light conductors up into pole so that 10 inches of each conductor is accessible out through hand hole.

2. Install 3#10 AWG USE stranded copper conductors from luminaire to hand hole.

3. Street light conductors shall be connected to luminaire conductors in hand holes using Polaris Electrical Connectors catalog number IT-1/0.

D. Connections Made In Street Light Pull Box

1. Extend the street light conductors up into pull box so that 24 inches of each conductor is accessible from the end of the conduit.

2. Install MSU street light cable from pull box to hand hole.

3. Street light conductors shall be connected to luminaire conductors in hand holes using Homac catalog no. RAB 1/0-3 (UPC 35042) for three conductor connections and Homac catalog no. RAB 1/0-4 (UPC 35043) for four conductor connections.

3.8 CONDUCTOR SPLICING

A. Street light conductors shall be installed in continuous lengths from light to light with connections in the base of lights or street light pull boxes. Where a pipe in an existing base is filled, drill an additional hole in base to insert new conductors.

B. A buried splice may only be made if conductors are to be cut and rerouted, extended where a light is removed, or if broken by another trade during construction. Buried splices shall be made in the following manner:

1. Form conductors and cut to length so that ends of the three conductors to be spliced meet with no tension.

2. Remove 3-1/2" jacket from the ends of each cable.

3. Cut back each conductor's insulation just far enough so that the conductors will meet in the center of a sleeve and have from 1/8 to 1/4 inch of bare conductor showing on each end of the sleeve.

4. Thoroughly clean the insulation of each conductor and the cable jacket of each cable end prior to applying heat shrink tubing to provide good adhesion.

5. Apply the compression connectors.

6. Apply 3-1/2 inch Raychem WCSM-20/6-1200-S heavy wall heat shrink tubing (or approved equal) over each conductor splice.

7. Apply 12 inch Raychem WCSM-33/8-1200-SS heavy wall heat shrink tubing (or approved equal) over the three spliced conductors and the cable jacket overlapping the cable jacket a minimum of 2 inches beyond the edge of the each cable jacket.

3.9 STREET LIGHT FUSES

A. Install Bussmann Tron type ‘in-line’ fuse holders and fuses in the handhole.

3.10 EXTERIOR LIGHTING CONTROL

A. Exterior building lights and site lights shall be controlled by the MSU Central Control system.

B. The exterior building lights shall be served from one lighting panel thru a multi-pole lighting contactor with an integrated Hand-Off-Auto switch. A signal from MSU Central Control via the building ‘BMS’ panel shall be connected at the “Auto” position of the lighting contactor.

C. The site lighting shall be served from one lighting panel thru a multi-pole lighting contactor with a Hand-Off-Auto switch. A signal from MSU Central Control via the building ‘BMS’ panel shall be connected at the “Auto” position of the lighting contactor.

D. The contactor control power shall originate from the same panel serving the lighting load.

E. The lighting panels and contactors shall be located in the building electrical substation room.

3.11 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.

C. Illumination Tests:

1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IESNA testing guide(s):

   a. IESNA LM-5, "Photometric Measurements of Area and Sports Lighting."
   b. IESNA LM-50, "Photometric Measurements of Roadway Lighting Installations."
   c. IESNA LM-52, "Photometric Measurements of Roadway Sign Installations."

d. IESNA LM-64, "Photometric Measurements of Parking Areas."
e. IESNA LM-72, "Directional Positioning of Photometric Data."

D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION 265600

SECTION 270500 – COMMON WORK RESULTS FOR COMMUNICATIONS

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. This section shall apply to all Division 27 sections.

1.2 SUMMARY

A. Work Included

1. The work shall be executed in conformity with the drawings, the approved shop drawings, and these specifications.

2. In general, this work shall consist of, but not necessarily be limited to the following:

3. Demolition

4. New Work

B. Work Not Included

C. The Contractor shall refer to Alternates listed in Division 01 and Proposals and shall submit price quotations for the alternates that apply to the electrical work.

1.3 SUBMITTALS

A. Shop Drawings and Samples

1. The Contractor shall submit shop drawings for all major equipment including, but not limited to the following items and/or the items listed in Division 27 sections.

2. Quantity of shop drawings and information to be included shall be as specified in Division 01 - General Requirements.

B. As-Built Drawings

1. Quantity of shop drawings and information to be included shall be as specified in Division 01 - General Requirements.

2. The Contractor shall submit as-built drawings indicating the location of all outlets, junction boxes, and conduit runs; including conduit size, circuit numbers, and number of wires in each run.

C. Certificate of Electrical Inspection: Provide certificate as described in this section.

1.4 QUALITY ASSURANCE

A. Codes and Regulations

1. See Division 01 General Requirements for Codes and Regulations that apply.

2. The latest National Electrical Code shall be observed and shall govern the character of work, style, quantity and the size of all material used.

3. All materials shall conform with the standards of the Underwriter's Laboratories in every case where such standards have been established for the particular type of material in question.

4. All material and equipment shall be UL listed and bear the UL label where such listing and labeling exists.

5. The complete electrical installation shall comply with all the requirements of the MI.O.S.H.A.

6. Codes shall be used as minimum requirements, and where the Specifications or Plans call for an installation that exceeds and does not violate the Code requirements, the Specifications and Plans shall be followed.

B. Character of Work

1. The installation shall be executed in a workmanlike manner and shall present a neat mechanical appearance when completed.

C. Permits and Inspections

1. The Electrical Contractor shall obtain and pay for all permits required by the State of Michigan Labor Department, Electrical Division.

2. The Electrical Contractor shall submit, to precede request for final payment, a copy of the Certificate of Electrical Inspection as required by the State of Michigan.

PART 2 - PRODUCTS

2.1 GENERAL

A. Refer to individual Division 26 sections for product specifications.

B. Material to be Returned to the Owner

1. Refer to Division 01 - General Requirements.

PART 3 - EXECUTION

3.1 GENERAL

A. Refer to Division 01 - General Requirements for items such as examination of premises, coordination with other trades, cutting and patching, connection to present equipment, etc.

B. Equipment Supports

1. Enclosures for communications equipment, and other similar equipment shall be mounted on 1/2" spacers when mounted in a room on a below grade exterior wall.

END OF SECTION 270500

SECTION 271700 – INTERIOR FIBER OPTIC CABLE SYSTEM

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. This Section specifies the fiber optic cabling system for buildings and structures.

2. Provide all labor, materials, and equipment as necessary to complete all work as indicated on the drawings, and as specified herein.

3. The Contractor shall furnish and install a complete fiber optic cabling system with all necessary components for a complete system as described in the specification and shown on the drawings.

B. Related Sections include the following:

1. Applicable sections of Division 26 - Electrical

1.3 SYSTEM DESCRIPTION

A. Installation of new fiber optic communication cable including all terminations and outlets for a complete system.

1.4 SUBMITTALS

A. Shop Drawings:

1. Fiber optic cables
2. Equipment racks, enclosures, patch panels, and all related components
3. Outlets

B. Test Data: Provide data as described in this section.

C. On-reel Tests: Provide traces as described in this section.

D. Proof-of Performance Tests: Provide tests as described in this section.

1.5 QUALITY ASSURANCE

A. The fiber optic cables shall be installed under the supervision of an installer having a minimum of five years experience in fiber optic cable installation under this type of application.

B. All fiber optic connections and terminations shall be made by a fiber optic technician with a minimum of two years experience in similar installations.

C. The contractor assumes responsibility for ensuring the electrical and mechanical integrity of the combination of components used in the system. Any components which are not engineered suitably for the devices to which they are attached shall be subject to exchange before or after installation at the Contractor's expense. All components shall be operated within the manufacturer's specifications without modification.

D. The Contractor shall test each fiber to be used in the system using an OTDR. The test shall be performed at the installation site with cables on reels. An authorized Owner representative shall be present during the entire testing phase. The test data shall be submitted to the Project Representative prior to cable installation.

E. On-reel tests shall consist of OTDR traces for each multi-mode fiber at 850 and 1300 nm. Photographic or hardcopy traces shall be submitted to the Owner for approval.

F. After installation, Proof-of-Performance tests shall be performed and documented as described in Section 260800.

G. In some cases the new cable will be installed in the vicinity of the existing broadband cable. The broadband cable system is fully functional with no abnormalities. At the conclusion of the project, the Owner will test the broadband system and if any problems are identified the Owner will repair the system at the Contractors expense

PART 2 - PRODUCTS

2.1 FIBER OPTIC CABLES

A. All fiber optic cables not installed in conduit shall have as a minimum the rating required by the NEC for the space in which they are to be installed.

B. The new fiber optic cable shall be Belden LANLite, six fiber, 62.5 micron fibers, 900 micron buffers, non-breakout, with a Kevlar central strength member and Kevlar strength member over the fibers, and overall PVC jacket, catalog number 550265.

C. All fibers in the cable must be usable fibers and meet or exceed the fiber specifications contained in the project document.

D. All optical fibers shall be sufficiently free of surface imperfections and inclusions to meet the optical, mechanical, and environmental requirements of this specification.

2.2 FIBER OPTIC PIGTAILS AND CONNECTORS

A. Pigtails shall be defined as a length of fiber with a connector on only one end. Pigtails shall be:

1. Siecor Fiber Optic Cable Assembly, part number 5000-01K3141-003M (multi- mode)

B. All new pigtails and jumpers shall have a length of at least 3 meters or be sufficient to reach the entire length of the fiber optic rack or cabinet, whichever is greater.

C. All pigtails shall be labeled with a durable label in accordance with the labeling scheme described in Execution and as shown on the drawings.

D. Pigtails shall be factory assembled production units.

E. The maximum loss of any pigtail's connector shall be 0.30 dB.

F. The optical return loss for each pigtail's connector shall be greater than 30 dB.

G. Pigtails shall be fusion spliced to the fiber optic cable.

H. The maximum loss of any splice shall be 0.20 dB.

I. Splice procedure shall be suitable for the cable used and as recommended by the cable manufacturer.

J. All splices shall be contained in splice trays.

K. Provide dust caps for all connectors and adapters. Leave dust caps on site after connections are made.

2.3 EQUIPMENT

A. All hardware installed in plenums shall be approved by the Underwriters' Laboratory (UL) for safe use in environmental air spaces without conduit.

B. Fiber optic connector/splice panels shall be mounted in existing racks or new racks as provided for Category 5 cables.

2.4 CONNECTOR PANELS AND SPLICE TRAYS

A. Connectors shall terminate in a combination splice/connector panel. Connector panels shall be Siemon FCP-DWR-1 with one fusion splice tray and all necessary manufacturer recommended components for a complete and secure installation.

B. Provide one splice/connector panel for each patch panel rack and main telephone rooms.

C. Connector panels shall accommodate up to 16 ST adapters. Adapters shall be labeled and documented accordingly.

PART 3 - EXECUTION

3.1 GENERAL

A. All equipment shall be installed and firmly secured in place per manufacturers recommendations.

B. Consideration shall be given for operational efficiency and aesthetic factors in the installation of equipment and cables.

C. The minimum bend radius of the fiber optic cable shall be 10 times the cable O.D. or as rated by the manufacturer; which ever is greater. Minimum bend radius shall be observed at all times.

D. Cable manufacturer's recommendations shall be followed during installation of cable. Pull force shall be monitored and shall not exceed manufacturer's ratings.

E. Precautions shall be taken to avoid imparting twist or torque to the cable during installation. Implement the use of pulling swivels and figure-eighting the cable as required.

F. Cable endcaps shall be used at all times possible to prevent moisture from entering cable.

G. Following cable pull-in, the cable end to which the cable puller is fastened shall be removed and discarded. A minimum of two meters of cable shall be removed.

H. Cable pulling compounds shall be compatible with the fiber optic cable in accordance with cable manufacturers recommendation.

3.2 CABLE

A. Cables located inside buildings shall be installed in conduit to the designated communication rooms.

B. A new cable tray shall be installed in each communication room to train the cables over to the communication racks. Ends of trays shall be supported from the wall. Trays longer than 10' shall also be supported at tray midspan from the deck above. The fiber optic cable shall be installed in the tray separate from the twisted pair cable to avoid having the twisted pair cable bear any weight on the fiber optic cable.

C. A 30' service loop of cable shall be provided in the cable tray above each fiber optic cabinet.

D. The cable shall be properly secured at the Fiber Splice Center using manufacturers recommended means for attachment.

E. All fiber must be looped in the splice trays between the point of fiber entry and the splice. Sufficient spare fiber must be provided to permit replacement of the splice at a future date.

F. Arrangement of the components in the fiber rack and cabinets shall be approved by the Owner prior to installation.

G. Install one new connector/splice panel in each communication room in the communication rack.

H. Each new fiber end shall be fusion spliced to a pigtail. Pigtails shall be used for linking to the connector panel.

I. In each connector/splice panel, each pigtail shall be labeled with the color codes of the fiber to which it is spliced. (Example: ORG/GRN for orange tube/green fiber.) The labels shall be near the connector.

J. In each connector/splice panel, each cable shall be labeled with the room name from which the cable came.

END OF SECTION 271700

SECTION 280500 – COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY

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. This section shall apply to all Division 28 sections.

C. Refer to Section 087100 for hardware on doors with card access controls.

1.2 SUMMARY

A. Work Included

1. The work shall be executed in conformity with the drawings, the approved shop drawings, and these specifications.

2. In general, this work shall consist of, but not necessarily be limited to the following:

3. Demolition

4. New Work

B. Work Not Included

C. The Contractor shall refer to Alternates listed in Division 01 and Proposals and shall submit price quotations for the alternates that apply to the electrical work.

1.3 SUBMITTALS

A. Shop Drawings and Samples

1. The Contractor shall submit shop drawings for all major equipment including, but not limited to the following items and/or the items listed in Division 28 sections.

2. Quantity of shop drawings and information to be included shall be as specified in Division 01 - General Requirements.

B. As-Built Drawings

1. Quantity of shop drawings and information to be included shall be as specified in Division 01 - General Requirements.

2. The Contractor shall submit as-built drawings indicating the location of all outlets, junction boxes, and conduit runs; including conduit size, circuit numbers, and number of wires in each run.

C. Certificate of Electrical Inspection: Provide certificate as described in this section.

D. Warranties: Submit written special warranty as specified in this Section. Include contact information, description of coverage, and start date for each special warranty.

1.4 QUALITY ASSURANCE

A. Codes and Regulations

1. See Division 01 General Requirements for Codes and Regulations that apply.

2. The latest National Electrical Code shall be observed and shall govern the character of work, style, quantity and the size of all material used.

3. All materials shall conform with the standards of the Underwriter's Laboratories in every case where such standards have been established for the particular type of material in question.

4. All material and equipment shall be UL listed and bear the UL label where such listing and labeling exists.

5. The complete electrical installation shall comply with all the requirements of the MI.O.S.H.A.

6. Codes shall be used as minimum requirements, and where the Specifications or Plans call for an installation that exceeds and does not violate the Code requirements, the Specifications and Plans shall be followed.

B. Character of Work

1. The installation shall be executed in a workmanlike manner and shall present a neat mechanical appearance when completed.

C. Permits and Inspections

1. The Electrical Contractor shall obtain and pay for all permits required by the State of Michigan Labor Department, Electrical Division.

2. The Electrical Contractor shall submit, to precede request for final payment, a copy of the Certificate of Electrical Inspection as required by the State of Michigan.

1.5 WARRANTY

A. Refer to Division 01 - General Requirements.

B. Refer to individual Division 26 sections for any additional warranty requirements.

PART 2 - PRODUCTS

2.1 GENERAL

A. Refer to individual Division 26 sections for product specifications.

B. Material to be Returned to the Owner

1. Refer to Division 01 - General Requirements.

PART 3 - EXECUTION

3.1 GENERAL

A. Refer to Division 01 - General Requirements for items such as examination of premises, coordination with other trades, cutting and patching, connection to present equipment, etc.

B. Equipment Supports

1. Enclosures for communications equipment, and other similar equipment shall be mounted on ½" spacers when mounted in a room on a below grade exterior wall.

END OF SECTION 280500

SECTION 280800 – COMMISSIONING OF FIRE ALARM SYSTEMS

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 commissioning process for the fire alarm systems for buildings and structures.

B. Related Sections:

1. Division 01 Section "General Commissioning Requirements" for general commissioning process requirements.

C. Start-up of equipment and systems for the fire alarm systems, shall be done by or with a trained manufacturer's representative who can check and report on all items such as installation, operation, and see that the equipment or system starts and operates properly.

D. Testing shall be performed at the convenience of the Owner and with the Owner’s representatives present and the manufacturer’s representative of the equipment and/or system present.

1.3 DEFINITIONS

A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.

B. CxA: Commissioning Authority.

C. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.4 ALLOWANCES

A. Labor, instrumentation, tools, and equipment costs for technicians for the performance of commissioning testing are covered by the "Schedule of Allowances" Article in Division 01 Section "Allowances.”

1.5 UNIT PRICES

A. Commissioning testing allowance may be adjusted up or down by the "List of Unit Prices" Article in Division 01 Section "Unit Prices" when actual man-hours are computed at the end of commissioning testing.

1.6 CONTRACTOR'S RESPONSIBILITIES

A. Perform commissioning tests at the direction of the CxA.

B. Attend construction phase controls coordination meeting.

C. Attend testing, adjusting, and balancing review and coordination meeting.

D. Participate in fire alarm systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.

E. Provide information requested by the CxA for final commissioning documentation.

F. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

1.7 CxA'S RESPONSIBILITIES

A. Provide Project-specific construction checklists and commissioning process test procedures for actual fire alarm systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.

B. Direct commissioning testing.

C. Verify testing and adjusting of Work are complete.

D. Provide test data, inspection reports, and certificates in Systems Manual

1.8 COMMISSIONING DOCUMENTATION

A. Provide the following information to the CxA for inclusion in the commissioning plan:

1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for fire alarm systems, assemblies, equipment, and components to be verified and tested.

4. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
5. Certificate of readiness certifying that fire alarm systems, subsystems, equipment, and associated controls are ready for testing.
6. Test and inspection reports and certificates.
7. Corrective action documents.
8. Verification of testing and adjusting reports.

1.9 SUBMITTALS

A. Certificates of readiness.

B. Certificates of completion of installation, prestart, and startup activities.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TESTING PREPARATION

A. Certify that fire alarm systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.

B. Certify that fire alarm instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.

C. Certify that testing and adjusting procedures have been completed and that testing and adjusting reports have been submitted, discrepancies corrected, and corrective work approved.

D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

E. Inspect and verify the position of each device and interlock identified on checklists.

F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.

G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA

3.2 TESTING VERIFICATION

A. Prior to performance of testing Work, provide copies of reports, sample forms, checklists, and certificates to the CxA.

B. Notify the CxA at least 10 days in advance of testing Work, and provide access for the CxA to witness testing Work.

C. Provide technicians, instrumentation, and tools to verify testing of fire alarm systems at the direction of the CxA.

1. The CxA will notify testing Contractor 10 days in advance of the date of field verification. Notice will not include data points to be verified.
2. The testing Contractor shall use the same instruments (by model and serial number) that were used when original data were collected.
3. Failure of an item includes, a deviation of more than 10 percent from an item's sensing set-point or output level, or an item's failure to function properly. Failure of an item shall result in rejection of final testing and adjusting report.
4. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

3.3 GENERAL TESTING REQUIREMENTS

A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.

B. Scope of fire alarm testing shall include all components, equipment, and systems as outlined in outlined later in this section.

C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response to input signals.

D. The CxA along with the Electrical Subcontractor shall prepare detailed testing plans, procedures, and checklists for HVAC&R systems, subsystems, and equipment.

E. Tests will be performed using design conditions whenever possible.

F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

G. The CxA may direct that set points be altered when simulating conditions is not practical.

H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.

I. If tests cannot be completed because of a deficiency outside the scope of the fire alarm system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests

3.4 FIRE ALARM SYSTEM

A. Fire alarm and smoke detector systems shall be tested by operating each pull station and activating all system sensors to verify proper operation.

B. Fire alarm notification devices, visual, audio, and transmitted signals, shall each be tested to verify proper operation.

C. Any fire voice communications systems shall be tested to verify correct operation of all voice inputs and all speakers.

END OF SECTION 280800

SECTION 283100 - DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

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. Fire alarm system is existing National Time and Signal.

2. Provide all labor, materials, and equipment as necessary to complete all work as indicated on the drawings, and as specified herein for a complete operating system.

3. Provide 8 hours of factory service engineer training on the operation of the manufacturer's fire-alarm system in general and on the system installed on this project.

1.3 DEFINITIONS

A. FACP: Fire Alarm Control Panel
B. FARCP: Fire Alarm Remote Control Panel
C. NACP: Fire Alarm Notification Appliance Control Panel
D. FAA: Fire Alarm Annunciator Panel
E. FAIGA: Fire Alarm Interactive Graphic Annunciator
F. FFCP: Fire Fighter Control Panel
G. LED: Light-emitting diode
H. NICET: National Institute for Certification in Engineering Technologies
I. Definitions in NFPA 72 apply to fire-alarm terms used in this Section

1.4 SYSTEM DESCRIPTION AND PERFORMANCE REQUIREMENTS

A. Fire alarm system is existing National Time and Signal. Provide new fire alarm AV units as indicated on drawings.

1.5 SUBMITTALS

A. General Submittal Requirements:

1. Refer to Division 01 – Specification Sections.

2. Shop Drawings shall be prepared by persons with the following qualifications:

    a. Trained and certified by manufacturer in fire-alarm system design.
    b. NICET-certified fire-alarm technician, Level III minimum.
    c. Licensed or certified by authorities having jurisdiction.

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

C. Shop Drawings: For fire-alarm system. Include plans, elevations, sections, details, and attachments to other work.

1. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire-alarm Systems" Chapter in NFPA 72.

2. Shop drawings shall include:
    a. Fire-alarm signal devices
    b. Fire-alarm wiring details

3. Device Address List: Coordinate with final system programming. Allow for two corrections of device/system descriptions.

4. Include voltage drop calculations for notification appliance circuits.

5. Wiring diagram:

    a. Power, signal, and control wiring. Include diagrams for equipment and for system with all terminals and interconnections identified. Show the wiring color code.

    b. On all addressable systems, all devices on a loop shall be documented in a sequential order that the trunk enters and leaves them.

    c. On all non-addressed device loops, all devices shall have numbers assigned to each device which is directly related to their wiring sequence.

    d. Show all break-out boxes.

6. Batteries: Size calculations. Battery size shall be a minimum of 125% of the calculated requirement.

D. Qualification Data: For qualified Installer.

E. As-Built Drawings

1. Contractor shall submit as-built drawings as specified in Division 1 - General Requirements.

2. The Contractor shall submit as-built drawings indicating the location of all devices, addresses, junction boxes, and conduit runs; including conduit size, circuiting and circuit numbers, and number of wires in each run; and the number and sequential wiring of speakers and strobes.. The drawings shall be separate from the electrical drawings. Provide "as-built" drawings in electronic media, CD, minimum AutoCAD 2004 format and Adobe Acrobat pdf format.

1.6 QUALITY ASSURANCE

A. Codes and Standards

1. Americans with Disabilities Act
2. National Electrical Code
3. National Fire Protection Agency
4. Underwriter's Laboratory

B. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

C. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level II technician.

D. Source Limitations for Fire-Alarm System and Components: Obtain fire-alarm system from single source from single manufacturer. Components shall be compatible with, and operate as, an extension of existing system.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.

G. Guarantee

1. The Contractor shall provide a written guarantee stating that all work performed and material furnished is free from all defects in workmanship, and material for a period of two years after the equipment has been accepted by the Owner. Final payment or Certificate of Substantial Completion, whichever is issued first, shall constitute Owner acceptance.

2. A 24 hour telephone number or numbers shall be provided for quick service engineering assistance concerning hardware and software problems. There shall be provisions made for getting an expert on the scene quickly should the need arise, minimum 8 hour on site response time.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:

1. Notify Owner no fewer than two weeks in advance of proposed interruption of fire-alarm service.
2. Do not proceed with interruption of fire-alarm service without the Owner's written permission.

1.8 SEQUENCING AND SCHEDULING

A. Existing Fire-Alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service and label existing fire-alarm equipment "NOT IN SERVICE" until removed from the building.

B. If any interruption of the existing or new fire alarm system is required the Contractor must provide a "fire watch" for that area of the building.

C. Equipment Removal: After acceptance of new fire-alarm system, remove existing disconnected fire-alarm equipment and wiring.

PART 2 - PRODUCTS

2.1 FIRE ALARM CONTROL PANEL (FACP)

A. General Description:

1. Existing National Time and Signal Panel to remain.

2.2 NOTIFICATION APPLIANCES

A. Manufacturers:

1. National Time and Signal Corporation, SG-CX Series Speaker Strobes and SG Series Strobes.

2. Siemens Building Technologies, Inc
   a. Speaker Strobe wall mount red, SL2SPSWR-AL.
   b. Speaker Strobe ceiling mount white, SL2SPSCW-AL.
   c. Strobe wall mount red, SL2SWR-AL.
   d. Strobe ceiling mount white, SL2SCW-AL.

B. Description: Equipped for mounting as indicated and with screw terminals for system connections.

1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly.

2. Color: Provide red or white for all wall mounted devices and white for all ceiling mounted devises.

C. Visible Alarm Devices: LED strobe lights listed under UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "ALERT" is engraved in minimum 1-inch- (25-mm-) high letters on the lens.

1. Rated Light Output: 15, 30, 75, 110 candela on the MC Series or 135/185 on the HMC Series as required to meet NFPA 72 requirements.

2. Strobe Leads: Factory connected to screw terminals.

3. Strobe Lights shall be synchronized so that all strobes flash simultaneously.

D. Voice/Tone Speakers:

1. UL 1480 listed.

2. Speakers shall be connected for 70 volt amplifier output.

3. Low-Range Units: Rated 1 to 2 W.

a. Tap all speakers at 1 watt and 2 watts in mechanical rooms, unless otherwise indicated.

4. Mounting: Flush, semi-recessed, or surface mounted; bidirectional as indicated.

5. Matching Transformers: Tap range matched to the acoustical environment of the speaker location.

2.3 WIRE AND CABLE

A. Wire and cable for fire alarm systems shall be UL listed and labeled as complying with NFPA 70, Article 760.

1. All fire alarm cabling regardless of use must be stranded and installed in conduit.

2. Shielded cable is only permitted for use from main FACP to remote FARCP and FAA. The shield on shielded cable shall be continuous throughout the circuit and insulated from ground and any other shielded cable except for the connection point at the panel.

3. Shield cable shall also be used for the microphone circuit.

4. Field devices shall be wired with non-shielded cable.

B. Initiating Device or Signaling Line Circuits and Annunciator Communication Circuit

1. Point addressable wiring shall be one pair of minimum #16 AWG THHN twisted pair stranded copper cable. Size of conductors shall be as recommended by manufacturer unless indicated otherwise on the drawings. If there is a conflict in conductor size, the larger conductor shall be installed if called for on the drawings or required by the manufacturer.

2. Each initiating device circuit shall have a separate circuit number and labeled at every point the circuit is accessible.

C. Notification Appliance Circuit

1. Notification appliance circuits shall be one pair of minimum #14 AWG THHN twisted pair stranded copper cable. Size of conductors shall be as recommended by manufacturer unless indicated otherwise on the drawings. If there is a conflict in conductor size, the larger conductor shall be installed if called for on the drawings or required by the manufacturer.

2. Notification appliance circuits shall be wired with different color, colors not already used in the fire alarm system, or circuits shall be numbered with wire markers on each end of each wire at every termination and joint. Wire markers shall be related to the fire alarm circuit or module connector numbers in the fire alarm control panel.

3. Annunciator communication wiring shall be one pair of minimum size #18 AWG shielded twisted pair cable.

D. Provide two minimum #14 AWG THHN stranded copper wire to devices requiring power such as door magnets and annunciator panel power. Circuits shall be numbered with wire markers on each end of each wire at every termination and joint. Wire markers shall be related to the fire alarm circuit or module connector numbers in the fire alarm control panel. Larger conductors sizes shall be used if required to serve the load.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Audible Alarm-Indicating Devices: Install per NFPA 72 and manufacturers recommendations.

B. Visible Alarm-Indicating Devices: Install per NFPA 72 and manufacturers recommendations.

C. Any fire alarm device utilizing LED's for visual identification must be mounted so they can be viewed and read from the floor. If mounting cannot be viewed from the floor provide a remote indication device.

3.2 WIRING INSTALLATION

A. Install wiring according to the following:

1. NECA 1.
2. TIA/EIA 568-A.

B. Wiring Method: Install wiring in metal raceway according to Division 16 Section "Raceways and Boxes".

1. Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a dedicated raceway system. This system shall not be used for any other wire or cable.

2. Install red fire alarm conduit in all concealed locations including above accessible ceilings, and exposed areas such as mechanical rooms, electrical, and loading docks.

3. Install all fire alarm wiring/circuits entering or exiting junction/pull boxes with a minimum of six inches of slack at each end.

C. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, tie wrap, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

D. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

E. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and a different color-code for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.

3.3 IDENTIFICATION

A. All wiring shall be labeled where accessible in panels, at devices, junction boxes, pull boxes, etc. All smoke and heat detectors shall be permanently labeled with their respective address typewritten on the outside of the unit base. Marking shall be done with gummed paper tags installed on the surfaces that have been steel wool cleaned and typewritten addresses.

1. Label all notification devices and visible alarm indicating devices with P-touch labeler. Identify circuit number, device number, and end of line.

2. Provide a minimum of ¼ inch high text for all labeling requirements, unless otherwise indicated.

B. Install instructions frame in a location visible from the FACP.

C. Paint all fire alarm junction box covers red.

3.4 GROUNDING

A. Ground the FACP and associated circuits; comply with IEEE 1100. Install a minimum No. 10 AWG insulated ground wire from main service ground to all FACP.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

1. Before requesting final approval of the installation, submit a written statement using the form for Record of Completion shown in NFPA 72.

2. Perform each electrical test and visual and mechanical inspection listed in NFPA 72. Certify compliance with test parameters. All tests shall be conducted under the direct supervision of a NICET technician certified under the Fire Alarm Systems program at Level III.

a. Include the existing system in tests and inspections.

3. Visual Inspection: Conduct a visual inspection before any testing. Use as-built drawings and system documentation for the inspection. Identify improperly located, damaged, or nonfunctional equipment, and correct before beginning tests.

4. Testing: Follow procedure and record results complying with requirements in NFPA 72.

5. Test and Inspection Records: Prepare according to NFPA 72, including demonstration of sequences of operation by using the matrix-style form in Appendix A in NFPA 70.

3.6 SYSTEM COMPLIANCE

A. Manufacturer to provide two years of *On-Point*™ System Compliance connection to include:

1. Reporting of fire alarm events via text and/or email messaging.

2. Remote event viewing of active and historical events via secure browser interface.

3. Remote factory diagnostic support.

3.7 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project outside normal occupancy hours for this purpose.

3.8 DEMONSTRATION

A. Training

1. Provide a minimum of 2 hours of factory service engineer training on the operation of the manufacturer’s fire alarm system in general and on the system installed.

END OF SECTION 283100

SECTION 283600 – GAS DETECTION AND ALARM

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 monitors and notification appliances.

1.3 SYSTEM DESCRIPTION

A. Provide a complete design and installation of gas detection and alarm systems where indicated or shown on drawings. System shall include, but not be limited to, building areas as indicated herein and on plans, and as required by code. Applicable system types to be applied are as follows:

1. Oxygen Detection System

B. Drawings indicate material and equipment locations, and general design of gas detection systems. Refer to Oxygen Detection Panel diagram on Sheet M-004.

C. Provide all system control components required for gas detection, alarms, alarm annunciation, emergency shutdown, area exhaust continuous airflow monitoring, manual alarm notification, ventilation direct interlocks, and security panel interface as required per Code and the specifications. Oxygen detection system shall monitor areas where oxygen is depleted and displaced by other gases. Alarms and equipment interlocks shall be actuated at specified values as indicated. System shall be capable of indicating, alarming, emergency shutdown of equipment, ventilation control and interfacing to the security system to notify the MSU Police and Public Safety as specified below, on drawings, and in governing Building Code regulations.

D. System design and content shall meet or exceed current state and federal codes and standards; including but not limited to Michigan Building Code, Michigan Mechanical Code, International Fire Code, National Electrical Code 70, Life Safety Code 101, and as applicable: NFPA 45, NFPA 55, OSHA CFR 29 Part 1910. System intrinsic safety design shall conform to CSA C22.2, No. 157, NEC / ISA, ANSI/ISA-RP 12.6, and NFPA-70 Article 504 requirements where required.

E. All devices shall be UL listed.

1.4 SUBMITTALS

A. Product Data: Manufacturer's product technical data information for all system components.

B. Shop Drawings:

1. General system layout including all devices locations, device identification numbers along with sequence of operation, system interlock details for interface to building exhaust and ventilation system, building automation system, security system, etc.
2. Wiring Diagrams:
   a. Include diagrams for equipment and for system with all terminals and interconnections identified.
   b. Include all interconnections between components, control panels, and other system interfaces and devices. Include control panel wiring details.
3. Piping Diagrams: Include diagrams for equipment and for system with all interconnections identified.

C. Construction Documents: Include information specified in accordance with applicable codes and standards.

D. Code Compliance Documentation: Include code references and code trail, and hazard evaluation for each zone or area.

E. Product Certificates: UL listed.

F. Operation and Maintenance Data:

1. System operation description covering this specific Project.
2. Operating instructions for mounting at each control panel.
3. Operation and maintenance data for inclusion in Operating and Maintenance Manual.

G. Warranties: Submit written special warranty as specified in this Section. Include contact information, description of coverage, and start date for each special warranty.

1.5 WARRANTY

A. Gas Detection and Alarm System shall be provided with a two (2) year warranty and all applicable recommended spare and consumable parts for two years of operation.

PART 2 - PRODUCTS

2.1 SAFETY SYSTEM SUPPLIER

A. Subject to compliance with requirements, provide turnkey gas detection and alarm system including design responsibility, fabrication and installation.

B. Supplier shall be factory trained and authorized service center for gas detection products specified and factory authorized to provide code compliant turnkey system design, fabrication, installation, service and training of specified products.

2.2 MAIN CONTROL PANEL

A. Main control panel shall be wall mounted or free standing at location shown on plans, NEMA 12 enclosure painted safety blue, sized as required. See Oxygen Detection Panel diagram on Sheet M-004.

2.3 EMERGENCY POWER BATTERY BACKUP SYSTEM

A. Provide battery backup system to meet MBC / NFPA requirements for emergency alarm systems back up power supply system as required for full load duration mode; include sizing for load with duration of backup per code. Provide load calculation information in submittal data and for permanent site records. Interface power loss status contacts to security system as TROUBLE per building code requirements. Backup entire emergency alarm system hardware including all alarm and warning devices. Panel shall be wall mount; NEMA 12 enclosure painted safety blue and identified with proper tagging for function and use.

2.4 INTERFACE TO OTHER SYSTEMS

A. The emergency alarm system shall provide the central interface to other facility systems as noted in the Emergency Shutdown Interlocks Matrix. These systems include but are not limited to the following:

1. Building Management System
2. Building Fire Alarm System

2.5 FIELD DEVICES

A. Provide oxygen detection sensors. See Oxygen Detection Panel diagram on Sheet M-004.

B. Emergency Alarm Pushbutton / Pullstation (EAPB or ESP). Provide color coded, mushroom style, Emergency Pushbuttons / Pull Stations with Push – Pull action, SPDT switch rated per area requirements. Emergency pushbuttons shall be located at each point of use for flammable, toxic or highly toxic liquids or gas, within the path of egress from each control area and outside each control area, as required by code and at the control panel. Emergency stop pushbuttons (E-Stops) are also required for the engine test cells. Gas detection related devices shall be blue and provided with a plastic guard; E-Stops shall be Red or Yellow as identified on the drawings and in the alarm matrix.

C. Provide alarm horns and visual units. See Oxygen Detection Panel diagram on Sheet M-004.

D. Tagging / Warning Signs / Area Maps. Signs to be pre-approved prior to installation.

1. Hazardous Area Entrance / Exit Signs at Annunciation Devices
   a. Multi-Color Warning Signs. Provide multi-color lexan screen sign with black lettering at each remote visual and audible alarm warning device and where directed by plans and specifications. Sign size shall be minimum 8" wide and sized to match the height of the visual annunciation device and shall be horizontally aligned so that sign description is adjacent the appropriate beacon color. Tag background colors to match beacon color with black letter description internal to the background color. Tag lettering shall be aesthetically aligned and positioned next to each color alarm beacon so as to clearly identify the beacon function at a glance. Detailed gas type lettering contained within each section of the tag shall be no less than ½"; but 1" where capable.
   b. A separate tag sized 3.5" x 8" shall denote Zone # and Area in Alarm.
2. Area Map. Provide color map, approximately 11"x 17" behind lexan protective frame at each control panel. Map to denote Zone I.D. / Areas being monitored. Include location and identification of input field devices; including but not limited to airflow switches, pushbuttons, sensors, etc. Color code each zone.
3. All warning signs must be approved by Owner Safety Department.
4. Emergency Pushbutton shall denote shutdown or interlock information.
5. Field Devices: Tag all field devices. Anchor tag to wall adjacent to wall mounted devices, suspend with brass security chain adjacent to ceiling mounted devices.
6. Signs shall comply with building code standards.

2.6 CALIBRATION GAS AND HARDWARE

A. Provide all necessary calibration gas and hardware for system start up, Fire Marshal acceptance testing and owner training.

B. After system start up and acceptance testing provide two (2) years of calibration complete with calibration gas and hardware kit.

PART 3 - EXECUTION

3.1 INSTALLATION

A. System supplier shall have turnkey responsibility to provide mechanical and electrical installation, provide on-site installation supervision, and properly locate sampling points after review of room air flow and ventilation patterns.

B. Install control panels and electrical field devices in accordance with applicable codes and manufacturer's printed instructions. Install conduit and wire for all interlocks to each remote system. Make final electrical terminations. Installation personnel shall be trained in the proper installation and application of Gas Detection / Emergency Alarm Systems. Installer must be familiar with division 16 installation practices.

C. Install all wire, conduit and mounting hardware for interface to other building systems. Final termination into other system shall be by that other system contractor. For example: Security System contractor shall provide all necessary security system hardware, programming of his equipment, final termination, interface drawings, commissioning assistance as required to make a complete operating system. This also applies to Building Automation System Contractor, Fire Suppression, Test Cell Controls, Facility Monitor System, etc. Interlocks to other systems shall be direct connection and not through other systems.

D. Install all associated piping and tubing for airflow switches, dual condulet assembly calibration adaptor, emergency shutoff valves, etc. as required making a complete and operating approvable system.

3.2 FIELD QUALITY CONTROL

A. General:

1. Prior to project completion and when directed by Owner's Representative, thoroughly test and calibrate each field device and gas detection system for proper operation. Should corrections be required to any system, and after corrections have been completed, system shall be re-tested.
2. Assist MSU EHS and Physical Plant Maintenance Department in development of emergency procedures.
3. Tests shall be witnessed by Owner or his designated representative and a letter shall be submitted certifying system performance.

B. Safety Certification:

1. Furnish Owner with written report certifying that work has been accomplished with results. Provide Safety Certification documentation to the owner including the following: Air Flow Profile Report for each sample point location, Calibration Report with before and after results of each analyzer, Alarm / Interface Report stating all threshold levels, alarm and interface action at each level of alarm with field verification report, Safety Training Checklist, and List of all owner attendees.
2. Near end of warranty period of operation, provide similar service as described above complete with written report. Should a control or device be suspect in its operation or function, this deficiency shall be reported to operating personnel, documented in report, and replaced.

C. Post Construction On Site Service:

1. Each three months after final acceptance until warranty expires; systematically inspect, examine, clean, calibrate and adjust when necessary, gas detection system, back up power supply, transmitters, detector, panels, relays, replace defective sensors, and accessories pertaining to the system.

2. Prior to the end of the first year warranty period provide code required annual alarm operation and shutdown inspection audit with AHJ approved report and certification. Annual inspection report to include: quarterly sensor calibration and alarm setpoint reports for entire year, alarm signaling device and appliance operation matrix verification with prior year, indication of any system modifications since prior inspection, remote alarm initiating device operation, interlock operation, ventilation interlock and alarm operation, code back up power supply test sequence and report, operation of interlocks to 24 hour supervised station, etc. and as required per governing code and local AHJ. Include report for main control panels and all remote system panels. One (1) copy of annual inspection and certification information shall be turned over to the owner and one (1) copy shall be forwarded to the local municipal Fire Marshall / AHJ. Inspection certification to be posted at each system main control panel.
3. Prior to end of warranty period, provide similar service as described above complete with written report. Should a control or device be suspect in its operation or function, this deficiency shall be reported to operating personnel, documented in report, and if under warranty, replaced.

3.3 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain gas detection devices. Refer to requirements in Division 01 Section "Demonstration and Training."

END OF SECTION 283600

SECTION 311400 – 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. Provide all labor, materials and equipment as necessary to complete all work as indicated on the Drawings and specified herein.

B. This Section includes sod and topsoil stripping.

C. Related sections include the following:

1. Division 01 Section “General Requirements - Temporary Facilities and Controls.”
2. Division 02 Section “Site Demolition.”
3. Division 31 Section “Earthwork.”

1.3 DEFINITIONS

A. Topsoil: Friable clay loam surface soil containing 2.5% to 12% organic matter. Topsoil shall be free of subsoil, clay lumps, stones, rocks, weeds, roots, construction debris, and other unsuitable materials as determined and approved by the Project Representative.

1.4 PLANT PROTECTION

A. Refer to Division 01 Section “General Requirements - Temporary Facilities and Controls.”

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

3.1 SOD STRIPPING

A. Stripping and stockpiling sod shall be done under reasonably dry conditions. Secure approval of soil quality in advance from the Project Representative to begin sod stripping. Sod removal shall include the entire root system but not an excess amount of topsoil. Contractor shall haul the sod to a campus location, as directed.

3.2 TOPSOIL STRIPPING

A. Stripping and stockpiling topsoil shall be done under reasonably dry conditions. Stripping and stockpiling under wet conditions will not be allowed.

B. Contractor shall strip available topsoil to its full depth from within the Contract limits, excluding areas in close proximity to trees designated to remain, unless otherwise specified or directed by the Project Representative.

C. Contractor shall stockpile topsoil in a storage pile in an area shown on the Drawings or as directed by the Project Representative. Storage pile shall be shaped to freely drain surface water during and after stockpiling operations. Excess topsoil shall be hauled by the Contractor and stockpiled on the Owner's property as directed by the Project Representative. The stockpile shall be protected from soil and sediment erosion as required elsewhere in these Specifications.

END OF SECTION 311400

SECTION 312300 – EARTHWORK

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. Provide all labor, materials and equipment as necessary to complete all work as indicated on the Drawings and specified herein.

B. Related sections include the following:

1. Division 01 Section 15000-TEMPORARY FACILITIES AND CONTROLS
2. Division 02 Section 024116-SITE DEMOLITION
3. Division 31 Section 311400-SITE CLEARING
4. Division 32 Section 321216-BITUMINOUS PAVEMENT
5. Division 32 Section 321313-CONCRETE PAVEMENT
6. Division 32 Section 320514-TOPSOIL

C. Approved Topsoil Installation Contractors shall bid directly to and be contracted directly by the General Contractor or Construction Manager.

D. Approved Topsoil Installation Contractors:

1. Anderson Fischer Associates Inc., 225 E. Kipp Rd, Mason MI 48854-1946 (517) 676-5522

2. Carols Excavating Inc., 5103 Lansing Rd, Charlotte MI 48813 (517) 645-0670

3. Central Excavating LLC , 11303 W Price Rd, Westphalia MI 48894-8208 (517) 749-2566

4. E.T. MacKenzie, 4248 W. Saginaw Highway, Grand Ledge MI 48837 (517) 627-8408

5. Eagle Excavation Inc., 4295 Holiday Drive, Flint MI 48507 (810) 767-7878

6. Owner Pre-Approved Topsoil Installation Contractor

E. Testing and inspection agency will be under contract with the contractor and will perform QA activities of the material below all pavements and structures.

1.3 DEFINITIONS

A. Excavation: Removal of material encountered to indicated subgrade elevations and subsequent disposal of materials removed. Excavation material is unclassified.

B. Unauthorized Excavation: Removal of materials beyond indicated subgrade elevations or dimensions without specific direction by the Project Representative. Unauthorized excavation shall be at the Contractor's expense. Undermining of existing footings or disturbing the bearing soil shall not be permitted unless it is specifically indicated or specified in the Contract Documents.

C. Additional Excavation: When excavation has reached required subgrade elevations the Contractor shall notify the Project Representative who will inspect conditions. If the Contractor encounters unsuitable bearing materials at the required subgrade elevations Contractor shall carry excavations deeper and replace excavated material as directed by the Project Representative. Removal of unsuitable material and its replacement, as directed, is part of this Contract.

D. Backfilling: Placement of fill soil, either provided on site or Contractor-furnished, which shall be uniformly compacted to the required density.

E. Bedding: The material placed around a utility between 4 inches below to 12 inches above the utility the full width of the trench.

F. Building Compacted Areas: Areas under slabs on ground within the building line. Exterior concrete slabs attached to the building, such as entrances, shall be considered within the building line.

G. Contract Limits: Those areas of the project site on which, or upon which, work will be done in accordance with the Contract.

H. Fill: Imported material which is placed in structure undercut.

I. Imported Material: Soil material which is purchased by Contractor and hauled onto the site.

J. MDOT: Michigan Department of Transportation's Standard Specifications for Construction, 2012.

K. Proof-Rolling: The use of a loaded 10 CY capacity or larger truck driven over the subgrade and subbase to check for unstable areas that should be undercut. The method, pattern and frequency will be determined by the Pavement Consultant.

L. Quality Assurance (QA): All activities that have to do with the Owner ensuring the quality of the product as specified, including materials sampling and testing, construction inspection, and review of Contractor quality control documentation. This work will be performed by the Pavement Consultant.

M. Quality Control (QC): All activities that have to do with the Contractor producing the quality of the product as specified, including training, materials sampling and testing, project oversight and documentation.

N. Rock Excavation:

1. Excavation of igneous, metamorphic or sedimentary rock or hardpan which cannot be excavated without continuous drilling or continuous use of a ripper or other special equipment.

2. Excavation of boulders of 1/2-cubic yard or more in volume.

O. SESC: Soil Erosion and Sedimentation Control as required in Division 01 "General Requirements – Temporary Facilities and Controls" and elsewhere in these Specifications.

P. Site Compacted Areas: Areas outside of the building line within the Contract limits.

Q. Structure: A building, retaining wall, tank, footing, slab or other similar construction.

R. Structure Backfill: Soil or other material which is placed against walls or sides of structures.

S. Subbase: Compacted fine and course aggregate layers used in the pavement between the subgrade and the pavement.

T. Subgrade: Compacted soil, either existing or provided as part of the Work, upon which new construction is to be installed.

U. Undercut: Excavation of native material from below the bottom of footings, floors, structures and subbases.

1.4 SUBMITTALS

A. Warranties: Submit written special warranty as specified in this Section. Include contact information, description of coverage, and start date for each special warranty.

1.5 SOIL EROSION AND SEDIMENTATION CONTROL

A. Prior to and during earthwork operations refer to Division 01 Section "General Requirements - Temporary Facilities and Controls" to ensure that provisions of that section are fulfilled.

1.6 BACKFILL COMPACTION TESTING

A. Contractor shall retain a licensed soils testing engineer, approved by the Owner, paid for as an allowance item, and shall submit to the Project Representative 3 copies of a report containing testing procedure, test results, and a statement that soil has been compacted in accordance with the specifications. The Project Representative shall give final approval of the backfill before construction continues. The following submittals shall be submitted directly to the Project Representative from the soils testing engineer, with one copy to the Contractor:

1. Test reports of borrow material.
2. Verification of each footing subbase.
3. Field density test reports.
4. One optimum moisture-maximum density curve for each type of soil.

B. Where more than one lift of soil is being placed, the soils testing engineer shall be present during the entire filling operation to confirm that each lift is properly compacted with approved soil.

C. Perform a maximum density test conforming to ASTM D1557 (Modified Proctor) for each type of soil encountered.

D. Field density tests shall conform to ASTM D2922 - Nuclear Method.

E. The frequency of testing shall be as follows:

1. Footing Subgrade: As required by Project Representative.

2. Paved Areas and Building Slab Subbase: One test per 2000 square feet for Subbase and one test per 1500 square feet per lift.

3. Footing and Trench Backfill: One test per 50 lineal feet per lift.

4. Trench Backfill: One test per 50 lineal feet per lift.

5. Post Backfill: One test per 12-inch lift (provided equipment is available).

6. Tree Stump Backfill: One test per 12-inch backfill lift (same as above).

F. Quality Assurance for Bituminous Pavement: the Pavement Consultant will perform QA of existing and installed material below the bituminous pavement. In order to perform that function, Contractor shall contact the Pavement Consultant 2 days prior to seperatly proof rolling the subgrade and subbase material, as well as keep the Pavement Consultant informed of the schedule of the installation of aggregates prior to paving. the Pavement Consultant will inform the Owner of deficient areas that have not been identified by Contractor as part of the Contractor’s quality control procedure. This inspection by the Pavement Consultant does not relieve Contractor of Contractor's responsibility to provide adequate quality control.

1.7 DESIGN AND PERFORMANCE REQUIREMENTS

A. Trench Bottom Suitability:

1. Contractor shall be responsible for the suitability of the normal trench bottom in supporting utility, bedding and backfill.

2. Contractor shall notify the Project Representative and await the Project Representative's decision if a possible unsuitable condition exists.

3. NOTE: Poor dewatering techniques or lack of excess water control shall not be a reason for additional payment for remedial measures.

B. Trench Wall Stability:

1. Contractor shall be responsible for trench configuration, including sheeting, shoring and bracing necessary to support trench side walls from collapsing.

2. Contractor shall be responsible for structural design and stability of a pipe-laying box if utilized on the Project to prevent trench walls from collapsing.

C. Excavation Side Stability: Be responsible for structural design of sheet piling, underpinning, shoring and bracing to prevent sides of excavation from collapsing and causing damage to adjacent structures pavements and materials.

1.8 MATERIAL STORAGE

A. Stockpile satisfactory excavated materials in accordance with MDOT Standards where directed, until required for backfill or fill. Place grade, and shape stockpiles for proper drainage. Locate and retain soil materials away from edge of excavations. Do not store within drip line of trees indicated to remain. Place silt fence around stockpile, if left overnight.

1.9 WARRANTY

A. Failures of surface areas caused by settlement shall be repaired at Contractor's expense for a period of 3 years after completion of Contract.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Materials: For backfill and fill, soils complying with ASTM D2487 soil classification groups GW, GP, GM, SM, SW, and SP. (Contractor shall note exceptions under Article 3.11 – Backfill and Fill.)

B. Unsatisfactory Soil Materials: For backfill and fill, soils complying with ASTM D2487 soil classification groups GC, SC, ML, MH, CL, CH, OL, OH, and PT.

C. Granular Materials: In accordance with MDOT Sections 301, 302 and 902 for 22A aggregate, Class I, II and Class II Subbase materials, except no foundry sand is permitted. Granular material shall contain sufficient binder to provide fill capable of supporting construction equipment without displacement.

1. Sections 2.11 and 8.02 for Class II Subbase and shall meet or exceed a minimum permeability requirement (K) of 8 feet per day as determined by the Michigan Test Method (MTM) 122.

2. Quality control shall include a lab test prior to delivery and field testing each 1000 cubic yard delivered or fraction thereafter. Each test shall include taking 3 samples, testing them individually and averaging the results.

3. The Michigan Test Method (MTM) shall be used to determine acceptable material. Once tested and accepted, Contractor shall acquire the material from the identical location.

4. Contractor shall notify the Project Representative in advance of changing the source location.

5. Field permeability test samples shall only be taken after the material has been spread uniformly on the subgrade and before compaction takes place. Material shall be less than 90% saturated upon completion of the test.
6. Material that fails the test shall be replaced at no cost to the Owner, and the cost for failed tests shall be paid by Contractor.

D. Sand:

1. Fill Sand: MDOT Class II granular material that is free of clay.
2. Washed Sand: MDOT 2NS.

E. Lean Concrete: Mixture of Portland cement, aggregate and water having compressive strength of 2,000 psi at 28 days.

F. Granular Surface Materials: In accordance with MDOT specifications.

1. Gravel Drives: 22A aggregate modified to minimum 6% wash.

2. Limestone Drives: 21AA limestone aggregate.

3. Construction Tracking Mat: 6A crushed limestone.

4. Pavement Subbase: If not specified on Drawings, place thicknesses and materials as follows:

a. For concrete pavement, use 2-inch Class II sand compacted in place (CIP).

b. For bituminous pavement in parking lots, use 6-inch Owner provided 21AA recycled concrete aggregate (CIP) over 6-inch Class II Subbase (CIP). *(Option 1)*

1) Provided to Contractor from Owner stockpile. Loaded by Owner. Contractor is responsible for hauling, spreading and compacting.

c. For bituminous pavement in roadways and loading docks with parking spaces, use 8-inch - 21AA aggregate (CIP) over 12-inch Class II Subbase (CIP).

G. Topsoil

*Note: Select one of the following **three** options.*

1. Topsoil (Owner-Provided & Placed). *(Option 1)*
1. Topsoil (Owner-Provided & Contractor Placed): *(Option 2)*

a. Provided to Contractor from Owner stockpile or site stockpiled topsoil, or both, and approved by the Owner. Contractor is responsible for hauling and spreading the topsoil.

b. 6-inches total depth of screened topsoil with compaction of 80-85% maximum density to eliminate settling.

c. Owner shall direct Contractor as to which topsoil stockpile shall be used.

2. Topsoil (Contractor-Provided & Placed): *(Option 3)*

a. Provided by Contractor in accordance with Division 32 Section "Topsoil."

b. 6-inches total depth of screened topsoil with compaction of 80-85% maximum density to eliminate settling.

2.2 UTILITY SLEEVING

A. Schedule 80 PVC under roads.

B. Schedule 40 PVC under walks.

C. End caps as required.

2.3 SMART BALL

A. Product 1428-XR/1D purple; manufactured by 3M Dynatel. Michigan Representative: Gregware Equipment, Grand Rapids, Michigan; 1-800-248-5678.

1. Provided by Owner

B. Quantity:

1. One smart ball on pipe lengths 0 to 12 feet; with end cap at other end.
2. For pipe lengths over 12 feet, place one smart ball at each end of the sleeve.

PART 3 - EXECUTION

3.1 SOIL EROSION AND SEDIMENTATION CONTROL

A. Prior to and during earthwork operations, refer to Division 01 Section "General Requirements - Temporary Facilities and Controls" to ensure that provisions of that section are fulfilled.

3.2 PREPARATION

A. Plan the Work to minimize the time excavation remains open. If excavation remains open beyond the time approved in the Project schedule, additional requirements may be imposed at no additional cost to the Owner.

B. Adequately barricade the excavation at all times to protect workers and the public from the danger of the open excavation.

3.3 EXCAVATION FOR STRUCTURES

A. Excavations shall extend a sufficient distance from footings and foundations to permit placement and removal of concrete formwork, installation of services, other construction, and inspection. Care shall be taken not to disturb bottom of excavation. Trim bottoms to required lines and grades to leave solid base to receive concrete.

B. Bracing and Sheeting:

1. Do not install by jetting.

2. Furnish, put in place and maintain sheeting, bracing and shoring, as may be required to properly support the sides of excavations and to prevent movement of earth which could in any way injure the Work or adjacent property.

3. Exercise care in removal of sheeting, shoring, bracing and timbering to prevent collapse or caving of excavation faces being supported and damage to the Work and adjacent property.

4. Do not leave sheeting or bracing in the excavation after completion of the Work, unless approved by the Project Representative.

C. Undercut:

1. If suitable bearing for foundations is not encountered at elevations indicated on the Drawings, immediately notify the Project Representative.

2. If soft material, which in the opinion of the independent testing laboratory is not suitable, is encountered below a structure, the Project Representative may order removal of this soft material and its replacement with specified material in order to make a suitable foundation for construction of the structure.

3. Undercutting made at the order of the Project Representative will be paid for on the basis of the actual quantity of material excavated. Do not proceed further until instructions are received and necessary measurements made for purposes of establishing additional volume of excavation.

4. No extra payment will be made if removal is required as a result of poor dewatering techniques.

5. Undercutting, which is specifically indicated on the Drawings or herein specified, shall be included in the base bid.

6. Soil removed may be used as fill in areas not below driving surfaces, structures or utility structures.

7. Compact subgrade at bottom of undercut prior to placing fill.

8. Place and compact specified fill in undercut.

9. Lateral extent of undercut shall be a horizontal distance equal to the depth of undercut below structure.

D. Excavating:

1. Excavation shall be by open cut from the surface except as herein specified or as indicated on the Drawings.

2. Excavations for structures shall be made in such manner and to such depth and width as will give ample room for building the structures and for bracing, sheeting and supporting the side of the excavation, for pumping and draining groundwater and wastewater which may be encountered, and for removal of material excavated.

3. Excavate to required cross section and elevation indicated on the Drawings. Subgrade shall not vary more than 0.1 feet above or below the established elevations.

4. Depression caused by excess excavation, traffic or rolling shall be filled with MDOT 902 Granular Material Class II or approved fill and rerolled and compacted in place as specified herein.

5. If required because of excess water conditions, place stone stabilization course prior to proceeding with construction. Place filter fabric over stone stabilization course.

3.4 EXCAVATION FOR PAVEMENT

A. Cut surface under pavements to comply with cross-sections, elevations and grades as indicated on Drawings.

3.5 EXCAVATION FOR UTILITIES

A. Width of Trenches:

1. Steam Tunnels: Widths at bottom of trench shall be 3 feet wider than the overall width of tunnel or vault, and shall at all times be of sufficient width to permit tunnel and vaults to be built properly, waterproofed and backfilled.

2. Pipelines: Widths of trenches for pipe lines shall allow for proper compaction of the haunching. The trench width at the spring line of the pipe for pipes less than 48 inches shall be pipe width plus 18 inches. The trench width for pipes larger than 48 inches shall be the pipe diameter plus 30 inches.

3. Electric and Telephone Ducts: Trench shall be the proper width and depth for the duct bank, allowing a minimum of 3 inches of concrete on each side of the duct formation.

4. Street Light Cable: Minimum trench width shall be 6 inches, maximum width shall be 12 inches, and minimum depth shall be 30 inches.

B. Length of Trenches: Excavation shall be finished to the required grade for an adequate distance in advance of the completed installation. Unless otherwise permitted by the Project Representative, the amount of trench that shall be open in advance of the construction shall not exceed the following limits:

1. Steam Tunnels: Length between 2 vaults, minimum.
2. Buried Steam Systems: Length between 2 vaults, minimum.
3. Sewers: 50 lf.
4. Water Mains: 50 lf.
5. Electric and Telephone Ducts: The amount that can be encased in concrete in a day.
6. Street Light Cable: The amount of cable that can be laid in a day.

3.6 REMOVAL OF EXCESS SUBSOIL

A. Excess subsoil shall be removed from the Owner’s property and legally disposed.

3.7 UTILITIES TO BE ABANDONED

A. When pipes, conduits, sewers or utility structures are removed from the trench, leaving dead ends in the ground, fully plug such ends with brick and mortar.

B. Entirely remove abandoned utility structures unless otherwise specified or indicated on Drawings.

C. Remove materials which can be readily salvaged from the excavation and store on site as indicated on the Drawings.

D. Salvageable materials will remain the property of the Owner unless otherwise indicated on the Drawings.

3.8 UTILITY SLEEVING

A. Place sleeve as located on the Drawings. Maintain structural integrity of pipe.

B. Place Smart ball at end of pipe and fabric. Attach with duct tape to end of pipe. See PART 2 - PRODUCTS for quantities.

C. Place PVC cap on end of pipe when only one Smart ball is required.

3.9 BEDDING

A. Place bedding material up to 1/8 the height of the utility. Compact as herein specified.

B. Accurately shape bedding material to fit pipe shape. Recess bedding to relieve pressure on the bell or other projecting utility joint.

C. After laying out the utility, tamp additional bedding in place up to the midpoint of the utility. Use hand-operated compactors to achieve required compaction.

D. Place additional bedding up to 12 inches above top of utility. Use hand-operated compactors to achieve required compaction.

E. Place bedding in maximum lifts of 12 inches.

F. No payment shall be made for aggregate or stone bedding when used for Contractor convenience.

G. Provide concrete encasement at utilities as indicated on the Drawings.

3.10 SHEETING, SHORING AND BRACING EXCAVATIONS

A. General:

1. Furnish, put in place and maintain sheeting, bracing and shoring as may be required to properly support side of excavations and to prevent movement of earth, which could in any way injure the Work or adjacent property.

2. Exercise care in the removal of sheeting, shoring, bracing and timbering to prevent collapse or caving of excavation faces being supported and damage to the Work or adjacent property.

3. A pipe-laying box may be used in lieu of sheeting.

B. Sheeting:

1. Do not install by jetting.

2. Remove as backfilling proceeds, unless ordered left in place by the Project Representative. Use care to fill and compact voids created by removal, especially below mid-height of utility.

3. Sheeting Left In Place:

   a. Required written approval of the Project Representative.
   b. Cut off minimum of 4 feet below finished grade.

3.11 BACKFILL AND FILL

A. General:

1. Commencement of Backfill Operations: Backfill excavations as promptly as work permits, but not until completion of the following:

   a. Acceptance by Project Representative of construction below finish grade including where applicable, dampproofing, waterproofing and perimeter insulation.

   b. Removal of trash and debris.

   c. Permanent or temporary horizontal bracing is in place on horizontally supported wall.

   d. Removal of concrete formwork.

   e. Removal of shoring and bracing, and backfilling of voids with satisfactory materials. Cut off temporary sheet piling driven below bottom of structures and remove in manner to prevent settlement of the structure or utilities. Contractor shall leave shoring to be embedded in the backfill of the trench or other excavation, for the purpose of preventing injury to the completed structure or other adjacent structures or property. Ends of sheeting, bracing or timber left embedded in the backfill shall be cut off and removed at least 2 feet below the established grade.

2. Acceptable Backfill: Place specified soil material in layers to required subgrade elevations, up to, but not including subbase material, for each area classification listed below:

   a. In excavations, use approved excavated or borrow material, except as otherwise specified.

   b. Under grassed areas use satisfactory excavated materials, unsatisfactory excavated soil classification groups GC, SC, ML, and CL, or approved borrow material.

   c. Under pavement use satisfactory excavated Class II and Class II subbase granular material. Soil classification groups GC, SC, ML and CL may be used with the approval of the Project Representative.

   d. Under building slabs, use Class II granular material.

   e. In utility trenches, use Class II granular material.

3. Required Concrete Within Backfill:

   a. Backfill trenches with concrete where trench excavations pass within 18 inches of column or wall footings and are carried below bottom of such footings, or which pass under wall footings. Place concrete to level of bottom of adjacent footing.

   b. For piping or conduit less than 2′-6″ inches below surface of roadways, provide 4-inch thick concrete base slab support. After installation and testing of piping or conduit, provide minimum 4-inch thick encasement (sides and top of concrete) prior to backfilling or placement of roadway subbase.

B. Ground Surface Preparation:

1. Remove vegetation, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface prior to placement of fills. Plow strip, or break-up sloped surfaces steeper than 1-foot vertical to 4 feet horizontal so that fill material will bond with existing surface.

2. Subsoil Preparation Prior to Topsoiling: This procedure is required to prevent permanent establishment of a dense layer of soil caused by construction operations, that would make it difficult for vigorous plant growth and proper drainage. In areas of the Project site that are compacted during construction, as determined by Project Representative, and after completion of exterior building construction operations, where vehicles/equipment would be required to travel across the soil around the structure or the constructed site improvements, or both, the existing subsoil, as well as the top 12 inches of newly placed subsoil, shall be loosened using the following procedures:

   a. Prior to beginning this work, notify Project Representative at least 1 business day in advance. Also, re-stake existing and new utilities that may be disturbed by these earthwork operations.

   b. The moisture content of existing and new soil shall be optimum for this earthwork operation. Each step shall be approved by the Project Representative, prior to continuing to the next step, and prior to satisfactory completion of the final step.

c. For areas where the existing subsoil grade is to remain and for areas which will receive additional soil:

1) STEP 1 – Loosening Existing Subsoil and Debris Removal: Existing subsoil shall be brought to a friable condition 12-inches deep, prior to placing additional subsoil fill. Possible equipment to use to loosen the soil include, but are not limited to, chisel plow, backhoe bucket, disc or harrow; followed by discing, if a disc is not initially used, to reduce the soil clump to the desired size. Contractor will submit a proposed method of loosening the subsoil to the Project Representative for approval at least 14 days prior to commencement of the work. The submittal shall include the method of equipment to be used. The soil shall be broken up sufficiently so that the resulting soil fragments are small. Also it is equally important to legally dispose of construction debris and rocks larger than 27 cubic inches exposed during this process.

2) STEP 2 – Placing of Additional Subsoil Fill- Transitional Layer Blending: Where additional fill is required, place the initial "transitional" layer and blend with the existing subsoil utilizing methods mentioned in Step 1.

3) STEP 3 –Subsoil Fill - Top Layer Loosening: Loosen top layer to a friable condition, blending in the first 1"-2" of topsoil. If no additional subsoil is required, delete Step 2.

4) STEP 4 – Final Grading and Protection: Grade the disturbed area to the elevations as specified, in preparation for topsoil placement. Do not otherwise recompact the subsoil. Once the subgrade is approved, construction equipment and vehicles unrelated to topsoiling and planting operations shall be prohibited. (Contractor may be required to provide temporary construction fencing to prevent recompaction of the subsoils. Costs for temporary fencing is a Contractor expense.)

d. For areas where existing subgrade is to be lowered:

1) STEP 1 – Existing Subsoil Excavation and Debris Removal: Excavate the subsoil, removing all excess material from the site to the proposed subgrade. Remove and legally dispose of construction debris exposed during this process.

2) STEP 2 – Subsoil Loosening: Existing subsoil shall be brought to a friable condition 12-inches deep. Possible equipment to use to loosen the soil include, but are not limited to, chisel plow, backhoe bucket, disc or harrow; followed by discing, if a disc is not initially used, to reduce the soil clump to the desired size. The resulting soil shall be broken up sufficiently so that the resulting soil fragments are small.

3) STEP 3 – Final Grading and Protection: Grade the disturbed area, as specified, in preparation for topsoil placement. Do not otherwise recompact the subsoil. Once the subgrade is approved, construction equipment and vehicles, unrelated to topsoiling and planting operations, shall be prohibited. (Contractor may be required to provide temporary construction fencing to prevent recompaction of the subsoils. Costs for temporary fencing is a Contractor expense.)

3. Subsoil Preparation for Paved Areas:

a. If, after rough grade has been achieved in cut areas and prior to placement of fill material in fill areas, the exposed subgrade has a density less than that specified under Article 3.12 – Compaction for particular area classification, break-up ground surface, pulverize, moisture condition to optimum moisture content, and compact to required depth and percentage of maximum density. Entire area shall be proof rolled with a heavy rubber-tired vehicle, such as a loaded scraper or loaded dump truck, to locate areas of extreme pumping and yielding, which shall be repaired as follows:

1) Soft areas due to moisture laden soil shall be corrected by applying an appropriate soil stabilization procedure to be specified, or as directed by Project Representative.

2) If required density cannot be obtained, the objectionable material shall be removed and replaced as ordered by the Project Representative.

3) The cost of corrective measures incurred as a result of stabilizing poor subgrade conditions shall be paid on basis of contract conditions relative to changes in work.

C. Placement and Compaction:

1. No backfill shall be placed without it being compacted in place. Backfill material shall be compacted in layers not exceeding 6 inches in compacted thickness.

a. Granular, non-cohesive soils shall be compacted with mechanical tamping or vibration-type compactors. Sand may be compacted by flooding the trench when water is available.

b. When clays are encountered, a mechanical tamper or sheeps-foot roller shall be used to compact the soil. Manual mechanical tamping equipment shall have a rammer which weighs not less than 20 pounds and has surface area of not more than 36 square inches. Hand compaction is not acceptable.

2. Before compaction, moisten or aerate each layer as necessary to provide the optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification. Do not place backfill or fill material on surfaces that are muddy, frozen or contain frost or ice.

3. Place backfill and fill materials evenly adjacent to structures, to required elevations. Take care to prevent wedging action of backfill against structures by carrying the material uniformly around structure to approximately same elevation in each lift.

4. Existing Utilities: Where existing utilities are required to be tunneled under, the area under the utility shall be filled with compacted sand, and have the pipe embedment reconstructed as for new piping.

5. Pipe Embedment: New piping shall be laid on a sand leveling bed compacted to maximum thickness of 6 inches. Dig holes in bedding for bells and fittings so pipe bears uniformly along its length. Hand compact the haunching under the spring line of the pipe. Take extra care to control the density of the haunching on plastic pipe in accordance with the manufacturer's instructions.

3.12 COMPACTION

A. General: Control soil compaction during construction providing minimum percentage of density specified for each area classification. Perform all required tests.

B. Moisture Control:

1. Where soil material must be moisture conditioned before compaction, uniformly apply water to surface of subbase, or layer of soil material, to prevent free water appearing on surface during or subsequent to compaction operations.

2. Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density.

3. Soil material that has been removed because it is too wet to permit compaction may be stockpiled or spread and allowed to dry. Assist drying by discing, harrowing or pulverizing until moisture content is reduced to a satisfactory value.

C. Required Densities:

1. Structures, Building Slabs and Steps: Compact top 18 inches of subgrade and each layer of backfill or fill material to 95% of maximum density or greater.

2. Pavements: Compact disturbed soil to remain and subbase material to 95% maximum density or greater.

3. Lawn or Unpaved Areas: 80-85% maximum density, Refer to Article 3.11.B.

4. Trench Backfill: Compact layers 6 inches or less to 95% maximum density or greater.

5. Walkways: Compact top 6 inches of subgrade and each layer of backfill or fill material to 95% maximum density or greater.

6. Fill Under Existing Utilities: Compact top 6 inches of subgrade and each layer of backfill to 95% maximum density or greater.

7. Sand Pipe Bedding: Compact top 6 inches of subgrade and 6-inch layer of sand to 95% maximum density or greater.

3.13 FINISH GRADING

A. Finish surfaces free from irregular surface changes, and as follows:

1. Lawn or Unpaved Areas: Finish topsoil to within not more than 0.10 feet above or below specified finish grade as measured after settlement and/or specified compaction is attained

2. Pavements: Shape surface of areas under pavement to line, grade and cross section, with finish surface not more than ¾ of an inch above or below required subgrade elevation.

3. Grading Surface of Fill Under Building Slabs: Grade smooth and even, free of voids, compacted as specified, and to required elevation. Provide final grades within tolerance of 2 inches when tested with a 10 foot straightedge.

B. After grading, compact subgrade surfaces to the depth and indicated percentage of maximum or relative density for each area classification.

C. Proof Roll: Contractor shall arrange with the Pavement Consultant to approve subgrade as indicated in Articles 3.11 and 3.12.

3.14 PAVEMENT SUBBASE COURSE

A. Grade Control: During construction, maintain lines and grades including crown/cross-slope of subbase course.

B. Placing: Place subbase course material on prepared subgrade in layers of uniform thickness of 6 inches or less, conforming to indicated cross section and thickness. Maintain optimum moisture content for compacting subbase material during placement operations.

C. Class II subbase shall be spread and compacted identical to regular Class II material.

D. Proof-roll before placing the bituminous pavement.

3.15 GRANULAR SURFACE COURSE

A. Grade Control: During construction, maintain lines and grades including cross-slope of subbase course.

B. Placing: Place granular course material (22A gravel for parking areas and 21AA for roadways and loading docks) on prepared subbase in a layer of uniform thickness, as indicated on the Drawings for cross section and thickness.

3.16 BUILDING SLAB SUBBASE

A. Place subbase material on prepared subgrade in layers of uniform thickness, conforming to indicated cross-section and thickness. Maintain optimum moisture content for compacting material during placement operations.

B. Compact subbase in maximum 6-inch lifts.

3.17 TOPSOIL OPERATIONS (SUBSOIL SURFACE PREPARATION, HAULING, SPREADING, ROUGH GRADING AND CLEAN-UP)

A. Project Representative shall approve rough grade elevations of existing subsoil prior to commencement of subsoil loosening operations.

B. Once loosening of subsoil has been completed, the Project Representative shall approve prior to topsoiling.

C. Topsoiling operation shall be complete before October 31, unless approved by the Project Representative.

D. Topsoil shall be placed by an approved topsoil installation contractor.

E. Contractor shall submit a proposed method for placement of topsoil to the Project Representative for approval at least 14 days prior to commencement of the Work. The submittal shall include equipment to be used.

Owner will identify topsoil stockpile for use. The contractor will be responsible for hauling and spreading the topsoil. Stockpile storage site is open from 6 a.m. to 4:30 p.m., unless other times are arranged with Project Representative and MSU Landscape Services Department. *(Option 1)*

F. Topsoil shall be placed in quantities appropriate to result in 6 inches of depth when compacted to 80-85% maximum density, spread to minimize uneven compaction, and placed as follows:

1. Place 6 inches of screened topsoil over loosened subgrade blending first 1”-2” into the subgrade. Obtain approval of subgrade from Project Representative prior to placement of topsoil (review Article 3.11 B Ground Surface Preparation for requirements and procedures).

G. Place silt fence at locations designated on the Contract Documents and locations specified by the Project Representative prior to topsoil placement. Silt fence shall become property of Owner and removed by Owner.

H. Notify the Project Representative when topsoiling is complete for final inspection, approval and Owner seeding of site.

3.18 INSPECTION

A. Contractor shall notify the Project Representative when the excavation is complete. A visual subgrade inspection shall be performed prior to placing reinforcing steel, concrete, pipe beddings, etc. If satisfactory soil conditions are not found at the depths indicated, immediately notify the Project Representative in writing before proceeding further. Should Contractor fail to notify the Project Representative, all settlement and damage caused by new work resting on soft or unsound earth shall be made good at the sole expense of the Contractor.

3.19 PROTECTION

A. Protect newly graded areas from traffic and erosion. Keep free of trash, debris and plant material, including weeds and grass.

B. Repair and re-establish grades in settled, eroded, and rutted areas to specified tolerances. Where settling is measurable or observable at excavated areas during Project warranty period, remove pavement, lawn or other finish, add backfill material, compact, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

C. Where completed compacted areas are disturbed beyond specified tolerances by subsequent construction operations or adverse weather, scarify, reshape, and restore surface to match surface of originally installed work. Eliminate evidence of the repair to the greatest extent possible.

D. Continue to properly maintain soil erosion and sedimentation control measures. Perform and document required site inspections until the Owner has officially accepted the Project site.

3.20 CLEAN-UP

A. Refer to Division 01 Section “General Requirements - Temporary Facilities and Controls.”

B. The Contractor shall perform daily maintenance and cleanup of construction materials and debris tracked on and off site. Materials and debris that accumulate and are not removed or maintained after a 24-hour notification of a violation by the Owner, will be separately contracted by the Owner and all associated costs will be charged to the Contractor.

END OF SECTION 312300

SECTION 312323 - FLOWABLE FILL

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 furnishing and installation of flowable fill in abandoned piping.

B. Related Sections include the following:

1. Division 2 Section “Site Demolition”.
2. Division 2 Section “Site Clearing”.
3. Division 2 Section “Earthwork”.

1.3 REFERENCES

A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:

1. ASTM Standards, Specifications, Methods, Test Methods and Classifications:
   a. C33 - Specification for Concrete Aggregates.
   b. C39 - Test Method for Compressive Strength of Cylindrical Concrete Specimens.
   c. C94 - Specification for Ready-Mixed Concrete.
   d. C136 - Sieve Analysis of Fine and Coarse Aggregates.
   e. C150 - Specification for Portland Cement.
   f. C260 - Specification for Air-Entraining Admixtures for Concrete.
   g. C618 - Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.
2. ACI - American Concrete Institute:
   a. 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete.
   b. 304R - Guide for Measuring, Mixing, Transporting and Placing Concrete.
   c. 304.2R - Placing Concrete by Pumping Methods.
   d. 305R - Hot Weather Concreting.
   e. 306R - Cold Weather Concreting.
3. MDOT:
   a. 2012 Standard Specifications for Construction.
   b. Standard Plans.

1.4 DESIGN AND PERFORMANCE REQUIREMENTS

A. Formwork: The design and construction of all formwork shall be the responsibility of Contractor.

B. Mix Proportions: Select flowable fill proportions according to the procedures specified herein to achieve the specified performance requirements.

1.5 SUBMITTALS

A. Design Data:

1. Submit flowable fill mix design.
2. Required Information:
   a. Dry weights of cement.
   b. Saturated surface-dried weights of fine aggregate.
   c. Quantities, type and name of all mix design contents.
   d. Weight of water.

1.6 QUALITY ASSURANCE

A. Installation Personnel Qualifications:

1. Trained and experienced in the installation of the materials.
2. Knowledgeable of the design and the reviewed mix designs.

B. Flowable Fill Supplier Qualifications:

1. Ready-mix concrete producer.
2. Experienced in design and control of flowable fill.

C. Testing of Flowable Fill: Not required.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cement:

1. Portland cement, ASTM C150, Type I.
2. Do not use different types or manufacturers of cement interchangeably without Engineer's approval.

B. Fly Ash: ASTM C618, Type C or F.

C. Aggregates:

1. Grade aggregates according to procedures of ASTM C136.
2. Fine aggregate: ASTM C33 or MDOT 902 Fine Aggregate 2NS.

D. Water: Clean, fresh, and potable.

E. Admixtures:

1. Chlorides:
   a. No admixture shall contain more than 0.1% water soluble chloride ions by mass of cementitious material.
   b. No admixture shall contain calcium chloride.
2. Air-Entraining: Daravair series or Darex series, by W.R. Grace & Company; Micro Air, by Master Builders; or equal.
3. Stable Air Generator: Darafill, by W.R. Grace & Company; Flow-Air, by Axim Concrete Technologies; or equal.

2.2 MIXES

A. Mix Design Performance Requirements:

1. Flowable fill which may be hand excavated in the future.
2. Compressive Strength Range f'c: 40 to 75 psi at 28 days.
3. Slump: 8 to 10 inches, minimum.
4. Air Content: 15% to 35% utilizing stable air generator.

2.3 SOURCE QUALITY CONTROL

A. Production and Delivery:

1. Batch, mix and transport flowable fill in accordance with ASTM C94.
2. Furnish a delivery ticket with each batch of flowable fill before unloading at the Site, on which is printed, stamped or written the following information:
   a. Name of ready-mix batch plant.
   b. Serial number of ticket.
   c. Date and truck number.
   d. Name of Contractor.
   e. Job name and location.
   f. Specific class or designation of flowable fill.
   g. Amount of flowable fill (cubic yards).
   h. Time loaded or of first mixing of cement and aggregates.
   i. Type, name and amount of admixture.
   j. Type, brand and amount of cement and fly ash.
   k. Total water content by producer (or water-cementitious ratio).
   l. Maximum size of aggregate.
   m. Weight of fine aggregate.
3. Flowable fill delivered in an outdoor temperature lower than 40 degrees F shall arrive at the Site of the Work having a temperature of not less than 50 degrees F and not greater than 90 degrees F unless otherwise specified or permitted by Engineer's representative.
4. Complete the discharge of the flowable fill within 2-1/2 hours after introduction of mixing water to the cement or 2 hours after arriving at the Site, whichever is sooner.

PART 3 - EXECUTION

3.1 PREPARATION

A. Preplacement Inspection:

1. Before placing flowable fill, inspect and complete the formwork installation.
2. Notify other trades to permit the installation of their work; cooperate with other trades in setting such work, as required.

B. Components:

1. Seal pipes, manholes and similar components not intended to be filled.
2. Restrain from floatation.

3.2 PLACEMENT

A. General:

1. Ensure flowable fill fills all cavities required to be filled.
2. Avoid dislocation of components.
3. Place in lifts if required to prevent floatation or to limit fluid pressures on formwork, walls, flexible wall pipe, or similar conditions.
4. Wait 24 hours, minimum, between the start of subsequent placement lifts.

B. Handling:

1. Handle flowable fill from mixer to place of final deposit in chutes, carts, buggies, conveyors, pumps or crane buckets.
2. Do not deliver flowable fill by a method with a free fall of more than 3 feet.
3. Take every possible precaution to prevent separation or loss of ingredients while transporting flowable fill.

C. Rate: Carry on placement at such a rate that flowable fill surfaces not yet to grade or lift shall not have reached their initial set before additional flowable fill is placed.

D. Retempering: Do not add water to the flowable fill once it has left the ready-mix plant.

E. Cold-Weather Operations:

1. Comply with the recommendations of ACI 306R.
2. Recommended Protective Measures:
   a. Heating materials.
   b. Providing insulating blankets and windbreaks.
   c. Use heated enclosures.
3. Do not use frozen materials or materials containing ice or snow.
4. Do not place on frozen subgrade.

F. Hot-Weather Operations:

1. Comply with the recommendations of ACI 305R.
2. Recommended Protective Measures:
   a. Cooling materials.
   b. Placement during cooler hours of the day.
   c. Providing shading and windbreaks.

3.3 PROTECTION

A. Cold Weather:

1. Keep all freshly placed flowable fill from damage due to low temperatures when the mean daily temperature is below 40 degrees F (4.5 degrees C) in accordance with ACI 306R.
2. Protect flowable fill from freezing until hardened, 36 hours minimum.

B. Loading: Protect flowable fill from construction, traffic or other loads until sufficient strength has been reached.

END OF SECTION 312323

SECTION 312500 – EROSION AND SEDIMENTATION CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. Soil Erosion and Sedimentation Control Rules and Regulations of the Gun Lake Tribe.

B. This Section includes the furnishing, installation and maintenance of soil erosion and sedimentation control (SESC) measures.
   1. Minimum SESC measures/Best Management Practices (BMP) are indicated on the Drawings. These measures are to be installed correctly before any grading or excavating begins on the Site. Contractor may add additional BMP's as required by their operations, such as temporary stock piles, equipment storage etc.
   2. Stage Construction and stabilization activities to minimize the amount of disturbed area at any one time.
   3. Remove sediment caused by erosion from storm water before it leaves the Site or enters waters of the state.
   4. Place soil piles away from drainage courses. Soil piles must be protected from precipitation and wind with non-erosive covers or other BMP's.
   5. Provide anti-tracking areas for haul roads and equipment. Sweep streets, parking areas regularly as needed.
   6. Dust control must be implemented on all sites exposed to wind erosion.
   7. Keep copies of permits and inspections on Site at all times.

C. This section also includes requirements for Contractor supplied Certified Storm Water Operator.

1.2 REFERENCES

A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
   1. ASTM Standards:
      a. A974 - Standard Specification for Welded Wire Fabric Gabions and Gabion Mattresses (Metallic-Coated or Polyvinyl Chloride (PVC) Coated).
      b. C33/C33M - Standard Specification for Concrete Aggregates.
      c. D4491 - Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
      d. D4751 -Standard Test Method for Determining Apparent Opening Size of a Geotextile.
      e. D4992 - Standard Practice for Evaluation of Rock to be Used for Erosion Control.
      f. D5313 - Standard Test Method for the Evaluation of Durability of Rock for Erosion Control Under Wetting and Drying Conditions.
      g. D6092 - Standard Practice for Specifying Standard Sizes of Stone For Erosion Control.
      h. D6459 – Standard Test Method for Determination of Erosion Control Blanket (ECB) Performance in Protecting Hillslopes from Rainfall-Induced Erosion.
      i. D6461, D6462 - Standard Practice for Silt Fence Materials and Installation.
      j. D6599 - Practice for Construction of Live Fascines on Slopes.
      k. D6711 - Practice for Specifying Rock to Fill gabions, Revet Mattresses, and gabion Mattresses.

1.3 SUBMITTAL

A. Action Submittals (Manufacturers information):
   1. Mulch blankets.
   2. Geotextile fabric.
   3. Silt Fence.
   4. Inlet Protection.
   5. Seed mixtures.
   6. Tacking Agents.
   7. Fertilizer.

1.5 QUALITY ASSURANCE

A. Performance Standard:
   1. Compliance with the Soil Erosion Control Permit already in place and issued and held by the Gun Lake Tribe. The SESC measures indicated on the Drawings and specified here in are a minimum requirement. If more SESC measures are required to comply with the permit, notify the Engineer responsible for preparation of the SESC plan for plan amendment. Additional SESC measures required due to the Contractor's operations will not be considered for additional payment.

B. SESC Preconstruction Meeting:
   1. Conduct a field evaluation of the Site with the Engineer, Certified Storm Water Operator, the Local Enforcing Agent, Construction Manager, and the Earthwork Contractor's Superintendent after all initial SESC measures are installed and prior to any excavation work.
   2. This meeting shall be scheduled and organized by the Construction Manager.
   3. Review the installed SESC measures by walking the Site and confirm compliance to the Permit and the approved SESC Plan.
   4. Review the location for display of the permit.
   5. Review location for SESC inspection log.

C. Stop Work Order:
   1. Owner reserves the right to issue a Stop Work Order if soil erosion and sedimentation controls are not properly installed or maintained.
   2. Work performed under a Stop Work Order will not be considered for payment.
   3. Costs resulting from delay due to issuance of a Stop Work Order shall be the responsibility of Contractor.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in original, unbroken, brand marked containers or wrapping as applicable.

B. Handle and store materials in a manner which will prevent deterioration, damage, contamination with foreign matter, damage by weather or elements, and in accordance with manufacturer's directions.

C. Reject damaged, deteriorated, or contaminated material and immediately remove from the Site. Replace rejected materials with new materials at no additional cost to Owner.

PART 2 - PRODUCTS

2.1 SOIL EROSION AND SEDIMENTATION CONTROL MATERIALS

A. Stabilized Construction Entrance:
1. Stabilize a pad of clean crushed stone located at points where traffic will be accessing a construction site. Minimize construction access points to locations as indicated on the Drawings.
2. Stone Size - Use ASTM C33, size No. 2 (2-1/2-inch to 1-1/2-inch) or 3 (2 inch to 1 inch). Use clean crushed angular stone. Crushed concrete of similar size may be substituted, but will require more frequent upgrading and maintenance.
3. Place on woven geotextile fabric if underlying soils are soft. TerraTex GS, or equal.
4. Thickness: Not less than 6 inches.
5. Width: Not less than full width of points of ingress or egress or a minimum of 20 feet.
6. Length: 50 feet minimum where the soils are course grained (sands or gravels) or 100 feet minimum where soils are fine grained (clays or silts), except where the traveled length is less than 50-feet or 100 feet respectively. These lengths may be increased where field conditions dictate. Stormwater from up-slope areas shall be diverted away from the stabilized pad where the slope of the access road exceeds 5%, a stabilized base of Hot Mix Asphalt Base Course.

B. Temporary Vegetation:

Seed Type	Lower Peninsula (south of US10)*	Lower Peninsula (north of US10)*	Upper Peninsula*	Seeding Rate
Oats, Barley	4/1 to 9/15	4/15 to 8/1	5/1 to 8/1	2 lbs/1,000 sft
Annual Rye	8/1 to 10/15	8/1 to 10/10	8/1 to 11/1	3 lbs/1,000 sft
Wheat	9/20 to 10/15	9/10 to 10/10	9/10 to 10/1	3 lbs/1,000 sft
Buckwheat	6/1 to 7/15	6/1 to 7/15	6/15 to 7/15	2 lbs/1,000 sft
Perennial Ryegrass	8/1 to 10/15	8/1 to 10/1	8/1 to 10/1	1 lbs/1,000 sft
*Seasonal Limitation Dates				

C. Mulch Blanket:
1. 4H:1V: Straw; North American Green S-75; LANDLOK S1; or equal
2. 3H:1V: Straw; North American Green S-150; LANDLOK S2; or equal.
3. 2H;1V: Straw and Coconut: North American Green SC-150; North American Green P-300, LANDLOK SC2; or equal.
4. 1.5H:1V: Coconut: North American Green C-125; LANDLOK C2; or equal.
5. Anchoring Staples or Pins:
6. Hardwood stakes at least 6 inches long; or
7. North American Green Bio-Stake blanket pins at least 6 inches long;
8. Steel anchoring pins are not allowed without written permission of the Engineer.

D. Hydro-Mulch:
1. Biodegradable, Hydraulic Mulch (HM) composed of 100% recycled cellulose fibers and a tackifier.
2. Terra-Mulch Cellulose with Tacking Agent 3.

E. Tacking Agents:
   1. Materials: Polyacrylamide, acrylamide copolymer, hydro-colloid polymers, marker dye.
   2. pH Range: 7.0 ±0.2.
   3. Surface Tension: 73.9 dynes/cm, based on simulated field application after 5 minutes of mechanical agitation.
   4. Viscosity: 102 CPS ±2, Saybolt value, based on 30 pounds per 1,000 gallons of water and 197 CPS ±2, Saybolt value, based on 60 pounds per 1,000 gallons of water, based on simulated field application after 5 minutes of mechanical agitation.
   5. University tested to reduce erosion 68.6% and reduce water runoff 21.7% on a 45% slope without having to cure (dry out), effective immediately after hydro-seeding application.
   6. Terra-Mulch Tacking Agent 3 by Profile Products LLC.

F. Riprap:
   1. Stone for riprap shall consist of field stone or crushed quarry stone of approximately rectangular shape. The stone shall be hard and angular and of such quality that it will not disintegrate on exposure to water or weathering. The specific gravity of the individual stones shall be at least 2.5.
   2. Recycled rubble concrete may not be used, unless noted otherwise on the Drawings.
   3. The riprap shall be composed of a well-graded mixture such that 50% of the mixture by weight shall be larger than the d50 size as determined from the design procedure. A well-graded mixture as used herein is defined as a mixture composed primarily of the larger stone sizes, but with a sufficient mixture of other sizes to fill the progressively-smaller voids between the stones. The diameter of the largest stone size in such a mixture shall be 1.5 times the d50 size. The d75 should be 1.25 times the d50 and the d15 should be 0.5 times the d50 size.

G. Geotextile Fabric for Riprap:
   1. Synthetic Industries, Terra Tex HD, or equal.
   2. Woven, high strength polypropylene.
   3. Grab Tensile Strength: 315 pounds (min) in accordance with ASTM D4632 (min).
   4. Apparent Opening Size: 40 US sieve (max) in accordance with ASTM D4751 (max).
   5. Water Flow Rate: 4 gpm/sft (min) in accordance with ASTM D4491 (min).

H. Silt Guard:
   1. Above Ground Filters:
      a. Frame and Filter Assembly: Silt Saver, Inc.; or equal.
      b. Nonwoven polypropylene filter with needle punched holes.
      c. High density polyethylene frame.
      d. 60-inch frame, high flow filter.
      e. Filter Material: 120 gpm/sft (min).
      f. Apparent Opening Size (AOS): 40 US Std. Sieve.
      g. Tensile Strength (ASTM D4632): 410/300 (min).
   2. Inlet Protection (Catch Basins):
      a. Siltsak; by ACF Environmental, Inlet Pro Sediment Bag High Flow; by Hanes Geo Components; or equal.
      b. Geotextile fabric silt sump.
      c. Grab tensile strength: 250 to 275 pounds in accordance with ASTM D4632 (min).
      d. Zero gallons per minute per square foot (GPM/SF), water flow rate in accordance with ASTM D4491 (min).

e. Apparent Opening Size (AOS): 40 US Sieve.
f. Manufactured to meet size of inlet.

I. Dewatering Filter Bags:
1. Ultratech International, Inc.: Ultra Dewatering Bag, SedCatch dewatering Bag; or equal.
2. Manufactured with pump pipe connection sized to match pump hose.
3. Nonwoven Geotextile, Needle Punched Polypropylene, 8 oz/syd (min).
4. Grab Tensile: 205 pounds in accordance with ASTM D4632 (min).
5. Flow Rate: 90 gpm/sft in accordance with ASTM D4491 (min).
6. Apparent Opening Size (AOS): 80 US Sieve.

J. Geotextile Silt Fence:
1. Synthetic Industries, Terra TexSF-90.
2. Woven, high strength polypropylene.
3. Grab Tensile Strength: 124/101 lbs (min) in accordance with ASTM D4632 (min).
4. Apparent Opening Size (AOS): 30 US sieve (max) in accordance with ASTM D4751 (max).
5. Water Flow Rate: 10gpm/sft (min) in accordance with ASTM D4491 (min).
6. Wood Stakes, Hardwood: 1.5-inch x 1.5-inch x 48-inch (min), 6 foot spacing (max) with 3/8-inch thick lath fastening bar.

K. Check Dams:
1. Washed Crushed Stone.
2. Size: 2-inch minimum, 4-inch maximum.

PART 3 - EXECUTION

3.1 GENERAL

A. Standards:
1. Achieve Effective Erosion Control to prevent erosion of Site slopes and ditches.
2. Achieve effective control of sedimentation to prevent any offsite discharge or tracking of Site soils.
3. Maintain soil erosion and sedimentation controls until the Site is stable. Definition of stable site is final concrete and/or asphalt paving is complete, and all turf areas have 80% growth.
4. Do not remove temporary soil erosion and sedimentation control measures until Site is determined to be stable by the Engineer.
5. Sweep streets weekly, or more frequently if required, or directed by Engineer.

3.2 DUST CONTROL

A. Prevent blowing and movement of dust from exposed soil surfaces, prevent on Site and off Site damage and health hazards and improve traffic safety:
1. The following methods should be considered for controlling dust.
a. Apply water to dry soil
b. Temporary Vegetative Cover.
c. Spray-on Adhesives: Keep traffic off these areas.

3.3 CONSTRUCTION ENTRANCE DRIVE

A. Employ water truck and street sweeper as necessary to keep sediment off of on Site and off Site roadways. The entrance must be maintained in a condition which will prevent tracking or flowing of sediment onto roadways. This may require periodic top dressing with additional stone or additional length as conditions demand and repair and/or cleanout of any measures used to trap sediment. All sediment spilled, dropped, washed, or tracked onto roadways (public or private) or other impervious surfaces must be removed immediately.

B. Where accumulation of sediment is inadequately cleaned or removed by conventional methods, a power broom or street sweeper will be required to clean paved or impervious surfaces. All other access points which are not stabilized must be blocked off.

3.4 INLET PROTECTION

A. Install on existing inlets prior to any grading or excavation. Install on new inlets as soon after installation as practical.

B. Inspect frequently, especially after any rain event. Maintain repair, and replace promptly, as needed.

C. Remove barrier only when the area draining toward the inlet has been stabilized.

3.5 SOIL ROUGHENING

A. On all slopes 1:3 or steeper, grade the slope with a dozer taking a vertical path so that the track marks on the slope create a horizontal roughened grooved condition to help prevent erosion of the slope.

3.6 TEMPORARY VEGETATIVE COVER

A. General:
   1. Provide temporary seed if permanent measures will not be placed within 15 days of initial disturbance and area will not undergo further earth change within 15 days of initial disturbance.
   2. Seed: Apply uniformly at a minimum rate of 3 to 5 pounds per 1,000 square feet.
   3. Mulch:
      a. Mulching is required on all seeding. Mulch will protect against erosion before grass is established and will promote faster and earlier establishment. The existence of vegetation sufficient to control soil erosion must be deemed compliance with this mulching requirement.
      b. Straw: Unrotted small grain straw, free of seeds

c. Application: Spread mulch uniformly by hand or mechanically so that at least 85% of the soil surface is covered. For uniform distribution of hand-spread mulch 75 to 100 pounds per 1,000 square feet. Anchoring must be accomplished immediately after placement to minimize loss by wind or water. This may be done by one of the following methods, depending upon the size of the area, steepness of slopes.
   1) Peg and Twine. Drive 8 to 10 inch wooden pegs to within 2 to 3 inches of the soil surface every 4 feet in all directions. Stakes may be driven before or after applying mulch. Secure mulch to soil surface by stretching twine between pegs in a crisscross and a square pattern. Secure twine around each peg with two or more round turns.
   2) Mulch Nettings: Staple paper, jute, cotton, or plastic nettings to the soil surface. Use a degradable netting in areas to be mowed.
   3) Crimper (mulch anchoring coulter tool): A tractor-drawn implement, somewhat like a disc harrow, especially designed to push or cut some of the broadcast long fiber mulch 3 to 4 inches into the soil so as to anchor it and leave part standing upright. Straw mulch rate must be 3 tons per acre. No tackifying or adhesive agent is required.
   4) Liquid Mulch-Binders (May be used to anchor straw mulch):
      a) Applications should be heavier at edges where wind may catch the mulch, in valleys, and at crests of banks. The remainder of the area should be uniform in appearance.
      b) Organic and Vegetable Based Binders: Naturally occurring, powder-based, hydrophilic materials when mixed with water formulates a gel and when applied to mulch under satisfactory curing conditions will form membraned networks of insoluble polymers. The vegetable gel must be physiologically harmless and not result in a phytotoxic effect or impede growth of turf grass. Use at rates and weather conditions as recommended by the manufacturer to anchor mulch materials.
      c) Synthetic Binders: High polymer synthetic emulsion, miscible with water when diluted and, following application of mulch, drying and curing, shall no longer be soluble or dispersible in water. Binder must be applied at rates recommended by the manufacturer and remain tacky until germination of grass.
      d) Wood-fiber or paper-fiber mulch: must be made from wood, plant fibers or paper containing no growth or germination inhibiting materials, used at the rate of 1,500 pounds per acre (or as recommended by the product manufacturer) and may be applied by a hydroseeder. Mulch must not be mixed in the tank with seed. Use on flatter slopes and during optimum seeding periods in spring and fall.

3.7 PERMANENT VEGETATIVE COVER

A. General:
   1. Seed all disturbed areas within 5 days of final grading.
   2. Apply uniformly at a minimum rate of 3 to 5 pounds per 1,000 square feet.
   3. Mulch as indicated on the Drawings or as needed to effectively control soil erosion.

3.8 MULCH BLANKET

A. Direction of installation, staple patterns and other requirements in accordance with Manufacturer's directions, and Project Drawing detail sheets.

B. Location: Where indicated on the Drawings or as specified.

3.9 HYDRO MULCH

A. Apply in accordance with manufacturer, Application Rate: 2,000 pounds per acre.

3.10 TACKING AGENTS

A. Fiber Mulch Binding:
   1. Flat to 5:1 Slope: 20 pounds per acre.
      a. 4:1 to 3:1 Slope: 30 pounds per acre.
      b. 3:1 to 2:1 Slope: 40 pounds per acre.
      c. Greater than 2:1 Slope: 60 pounds per acre.
   2. Straw Mulch Binding: 30 pounds Tacking Agent III and 150 pounds cellulose fiber per 1,000 gallons of water per acre, or 50 pounds Tacking Agent III per 1,000 gallons of water per acre.

3.11 GEOTEXTILE SILT FENCE

A. Space posts 6 feet center-to-center or closer. Extend at least -12 inches into the ground. Posts shall be constructed of hardwood with a minimum diameter thickness of 1-1/2 inches.

B. Wire Backed silt fence: A metal fence with 6 inch or smaller wire mesh openings and at least 2 feet high may be utilized, fastened to the fence posts, to provide reinforcement and support to the geotextile fabric. Place posts 6 feet on center.

C. Bury geotextile fabric at least 6 inches deep in the ground. Extend The fabric at least 2 feet above the ground, unless noted otherwise. The fabric must be securely fastened to the posts using a system consisting of metal fasteners (nails or staples) and a high strength reinforcement material (nylon webbing, grommets, washers, etc.) placed between the fastener and the geotextile fabric. The fastening system must resist tearing away from the post. Install silt fence in accordance with manufacturer's instructions, and Project Drawing detail sheets.

D. Location: Where indicated on the Drawings or as needed to prevent offsite movement of soil.

3.12 FIBER ROLLS

A. Vertical spacing on slopes:
   1. As indicated on the Drawings, or
   2. 1:1 slopes: 10 feet apart.
   3. 2:1 slopes: 20 feet apart.
   4. 3:1 slopes: 30 feet apart.

3.13 RIPRAP

A. Place no bends or curves at the intersection of the conduit and apron or scour hole will be permitted.

B. There must be no over fall from the end of the apron to the receiving channel.

3.14 DEWATERING

A. If during construction excavated facilities need to be dewatered to facilitate or complete the construction process and the water pumped out of the excavated areas contain sediments, these sediments must be removed prior to discharging to receiving bodies of water. This standard does not address the removal of ground water through well points etc.

B. Pumping system must include adequate sized perforated riser pipes, stone filters and sediment pumping bags to achieve desired results. Place the suction hose from the pump inside the inner pipe to begin dewatering. Place the discharge hose in a stabilized area downslope of unstabilized areas to prevent erosion.

C. Sediment Tank / Silt Control Bags may be used when sediment laden water is pumped to trap and retain the sediment. A sediment tank or a silt control bag is to be used when excavations are deep, and space is limited and where direct discharge of sediment laden water to stream and storm drainage systems is to be avoided.
   1. Locate containers (tanks or bags) for ease of clean-out and disposal of the trapped sediment and to minimize interference with construction activities and pedestrian traffic. Do not place bags directly into receiving waters.
   2. Tank size: The following formula should be used in determining the storage volume of the tank: 1 cubic foot of storage for each gallon per minute of pump discharge capacity. Typical tank configuration is indicated on Standard Detail. Tanks may be connected in series to increase effectiveness.

3.15 SEDIMENT BASIN

A. Size and location as indicated on the Drawings. Sediment basins, not indicated on the Drawings but required due to Contractor's means, methods or convenience, will be considered incidental work.

B. Maintenance:
   1. Remove sediment when sediment from runoff gets to be an average of 10” deep.
   2. Remove all sediment prior to final completion.
   3. Remove outlet barrier stone filter when stone becomes clogged or ineffective.

3.16 BUILDING PROJECT CONSTRUCTION

A. During construction conform to the following general rules:
   1. Minimize the amount of earth disturbed at any one time.
   2. Establish a construction sequence which includes adequate erosion control.
   3. As much as practical, direct stormwater away from the construction area. Direct diverted stormwater to a stable on-Site area.

4. Collect runoff from the Site in sediment basins, traps or through filters.
5. Establish an inspection and maintenance schedule, paying special attention to the beginning of the various stages of construction.

3.17 AIRBORNE SEDIMENT

A. Dust Control:
   1. Use legal means necessary to control dust on and near the Work and on and near off Site borrow areas if such dust is caused by Contractor's operations during performance of the Work or if resulting from the condition of the Site when earthwork operations are suspended.
   2. Treat haul roads, delivery roads, temporary Site access roads and other surfaces as required to prevent dust from being a nuisance to the public, neighbors, and concurrent performance of other work on the Site, and as directed by Engineer.
   3. Periodically scrape and broom adjacent streets and paved areas to remove tracked dirt.

B. Wind Erosion:
   1. Erect and maintain barriers to prevent migration of windblown sediment offsite.
   2. Conduct operations in such a manner as to minimize the amount of Site area exposed to wind erosion.
   3. Be responsible for removal of windblown sediments deposited off Site, including costs for cleaning or repairs required due to sediment deposition and removal.

END OF SECTION 312500

SECTION 320514 – TOPSOIL

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 RELATED DOCUMENTS

A. Provide all labor, materials and equipment as necessary to complete all work as indicated on the Drawings and specified herein.

B. This section includes topsoil work for disturbed areas, as indicated on the Drawings, and by provisions in:

1. Division 01 Section “General Requirements - Temporary Facilities and Controls.”
2. Division 31 Section “Earthwork.”

C. Related section includes Division 31 Section “Earthwork.”

1.3 SUBMITTALS

A. Test Reports: Provide reports as described in this section.

1.4 QUALITY ASSURANCE

A. Provide and pay for testing and inspection before and during topsoil operations. Testing laboratory shall be acceptable to the Project Representative.

1. Approved Testing Laboratory:

Soil and Plant Nutrient Laboratory
A81 Plant and Soil Sciences
Department of Crop and Soil Sciences
Michigan State University
East Lansing, MI 48824-1325
(517) 355-0218
(Schedule a minimum of 14 days to complete the required tests.)

B. Test representative material samples as follows:

1. Test each topsoil stockpile by using 3 samples, sufficiently in advance of commencement of topsoil operations (to allow for testing additional stockpiles should the first stockpile test fail). 1 sample shall be taken from the surface, 1 sample half way into the stockpile and 1 sample in the center of the stockpile.

2. During topsoil operations, test approximately every 200 CY of topsoil being placed from samples taken during topsoil placement. Owner may require that samples be taken from on site at a frequency that is determined by the Project Representative. The Owner reserves the right to witness the sample selections.

C. Test Requirements:

1. Routine Soil Fertility Test.
2. Mechanical Analysis
3. Percentage of organic content and loss by ignition.

D. Submit test reports for approval prior to beginning topsoil placement.

E. Submit a sample of screened and unscreened topsoil to the Landscape Services Department at Michigan State University at least three weeks prior to placing the soil on the Project. Sample size shall be a 5 gallon bucket.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Topsoil shall be provided by Contractor from off-site sources with the specified minimum quality specified herein.

B. Topsoil proposed for use shall meet testing criteria results specified and conform to adjustments as recommended by the soil testing laboratory and the Project Representative.

C. Provide sufficient quantity of topsoil as required to complete the Project.

D. Testing, processing, cleaning and preparation of topsoil to render it acceptable for use is the responsibility of the Contractor.

E. Topsoil shall meet the following requirements:

1. Topsoil shall be fertile, friable and representative of local productive soil, capable of sustaining vigorous plant growth and screened free of clay lumps, subsoil, noxious weeds and other foreign matter such as stones greater than 1-inch in diameter in dimension, roots, sticks, and other extraneous materials and not frozen or muddy.

2. Topsoil shall have a pH range between 5.0 and 7.5, adjusted to not more than 7.0 by additives as required by soil test.

3. Topsoil shall be not less than 2% and not greater than 5% native organic matter, not compost material, as determined by a loss by ignition test at 360 degrees C.

4. Topsoil shall have a soil textural classification of SANDY LOAM.

5. Topsoil clay content as determined by Bouyoucous Hydrometer Test shall range between 5% and 20%.

6. Topsoil sand content shall be not less than 40% and not greater than 80%, as determined by a mechanical analysis as follows:

   a. Screened Topsoil

Passing	Retained On	Percentage
1-Inch Screen		100%
1-Inch Screen	3/4-Inch Screen (Gravel)	Not More Than 3% and Not Greater Than 5%

   b. Unscreened Topsoil

Passing	Retained On	Percentage
1-Inch Unscreened	3/4-Inch Screen (Gravel)	Not More than 10%

7. Phosphorus: Adjust as required by soil test and recommendations.

8. Potassium: Adjust as required by soil test and recommendations.

9. Magnesium: Adjust as required by soil test and recommendations.

10. Calcium: Adjust as required by soil test and recommendations.

PART 3 - EXECUTION

3.1 GENERAL

A. Refer to Division 31 Section “Earthwork.”

END OF SECTION 320514

SECTION 321216 – BITUMINOUS PAVEMENT

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. Provide all labor, materials, and equipment as necessary to complete all work as indicated on the Drawings and specified herein.

B. This section includes bituminous pavement.

C. Work Excluded: This section does not apply to bituminous pavement patching.

D. Related sections include the following:

1. Division 02 Section 024113-SITE DEMOLITION
2. Division 31 Section 312300-EARTHWORK
3. Division 32 Section 321218-BITUMINOUS PAVEMENT PATCHES
4. Division 32 Section 321723-PAVEMENT MARKING

E. Quality assurance

1. Removal:

a. If the pavement density for a sublot (average of sublot cores) is less than 92.0 percent, the Contractor shall remove and replace the sublot.

b. The Engineer reserves the right to evaluate a sublot whose test results for asphalt binder content, Gmm, VMA, or air voids, exceed the single test tolerances indicated in Table 1 – Bituminous Quality Assurance Testing Tolerances (+ or -) from JMF, included at the end of this section. If the Engineer determines that the in-place mixture will not perform in accordance with normal standards, the Contractor shall remove and replace the sublot.

c. General: The cost of the mixture removed and the removal cost shall be borne by the Contractor. Removal decisions will be applied to individual sublots.

1.3 REFERENCES

A. Except as herein specified or as indicated on the Drawings, the Work of this section shall comply with the following:

1. ASTM:

a. C 117 – Test Method for Materials Finer Than 75µ-m (no. 200) Sieve in Mineral Aggregates by Washing.

b. C 136 – Test Method for Sieve Analysis of Fine and Coarse Aggregates.

c. D 1559-89 – Test Method for Resistance to Plastic Flow of Bituminous Mixtures using Marshall Apparatus (section 4.5).

d. D 2041 – Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures.

e. D 2172 – Test Methods for Quantitative Extraction of Bitumen from Bituminous Paving Mixtures.

f. D 2726 – Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Saturated Surface-Dry Specimens.

g. E 29 – Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications. All equipment requirements to perform these sampling and testing procedures shall apply.

2. MTM (Michigan Test Method):

a. 110 – Determining Deleterious and Objectionable Particles in Aggregates.

b. 117 – Determining Percentage of Crushed Particles in Aggregates.

c. 118 – Measuring Fine Aggregate Angularity.

d. 311 – Determining Aggregate Gradation for Bituminous Mixture.

e. 313 – Sampling Bituminous Mixtures.

f. 319 – Determination of Asphalt Content from Asphalt Paving Mixtures by the Ignition Method.

1.4 DEFINITIONS

A. Quality Control (QC): Activities that have to do with the Contractor producing a quality product as specified; including training, materials sampling and testing, project oversight and documentation.

B. Quality Assurance (QA): Activities that have to do with the Owner ensuring a quality product, as specified; including materials sampling and testing, construction inspection, and review of Contractor quality control documentation. To perform this service, the Contractor shall notify the Engineer 2 days (see definition below) in advance so that QA activities can be properly performed.

C. Bituminous Mix Design: The selection and proportioning of aggregate(s), mineral filler (if required), reclaimed asphalt pavement (RAP) and asphalt binder such that the specified mixture design criteria are met. Laboratory evaluation is required to determine if the stated mix design complies with specifications.

D. Job Mix Formula (JMF): A bituminous mixture for a specific project. This may include adjustments to the mix design to optimize the field application.

E. Target Value: A JMF parameter value that may be adjusted, if approved by the Engineer, to account for changes in the physical properties of the mixture.

F. JMF Adjustment: The Contractor may propose an adjustment to the JMF based upon QC or QA test results; or both. The proposed JMF shall meet the requirements of MDOT 2012 Standard Specifications for Construction. When approved by the Engineer, a JMF adjustment may be applied retroactively to 1 lot, for parameters with target values. The Engineer may also require the Contractor to make adjustments to the mixture to assure that the parameters of the mix design are being met.

G. Voids in Mineral Aggregate (VMA): The volume of void space between the aggregate particles of a compacted paving mixture that includes the air voids and the asphalt binder, including the absorbed asphalt binder, expressed as a percent of the total volume of mixture.

H. Effective Specific Gravity (Gse): The ratio of the oven dry weight in air of a unit volume of an aggregate (excluding voids permeable to asphalt) at a stated temperature to the weight of an equal volume of water at a stated temperature.

I. Bulk Specific Gravity of Aggregate (Gsb): The ratio of the oven dry weight in air of a unit volume of an aggregate at a stated temperature to the weight of an equal volume of water at a stated temperature.

J. Maximum Specific Gravity of Mixture (Gmm): The ratio of the weight in air of a unit volume of an uncompacted bituminous paving mixture at a stated temperature to the weight of an equal volume of water at the same temperature.

K. Lot: Bituminous mixtures produced and placed under this specification will be evaluated on a lot-by-lot basis. A lot is made up of a discrete tonnage of 1 mixture. Each lot consists of up to 3 sublots. These sublots shall be of approximately equal size up to a maximum of 2,000 tons. The sublot size shall be approved by the Engineer prior to the start of production. The Contractor may request a change in the sublot size during production based upon the Contractor's ability to produce a mixture that meets the specification contained within the Contract Documents, and upon approval of the Engineer. If only 1 or 2 sublots are included in a lot at the end of production, they shall be combined with the previous lot using the same mix, and this combined lot shall be evaluated based upon all sublot samples.

L. Lot Average Test Result: The average of all sublot QA test results, for a specific parameter, for the lot. Test results for a sublot removed from the project shall not be used in calculating a lot average. However, the replacement material shall be tested and the results included in the lot average.

M. Process Quality Control Targets: Targets established by the Contractor based upon initial production lot test results (and from an approved trial run) for air voids, VMA, asphalt binder content and Gmm. QC tolerances shall be applied to these established targets to determine the need for production changes, including stopping production, to control the quality of the product. Process quality control targets shall be reported to the Engineer prior to the end of placement of the second lot.

N. Rounding of Numbers: Rounding of numerical data shall follow ASTM E 29-93a, as described in MDOT Bituminous QC/QA Procedures Manual of Field Testing.

O. Random Sampling: Selection of QA samples (bituminous mixture and density) and verification samples may be by a random process managed by the Engineer. The Engineer may use a random number generating calculator to determine the locations of each density core and mixture sample. The Contractor will be given the opportunity to observe the sampling process. However, the random numbers selected and the sampling locations will not be revealed to the Contractor until the time of sampling in order to avoid bias in the random sampling process.

P. Project Representative: An individual appointed by the Owner, Board of Trustees, Michigan State University.

Q. Engineer: Third party testing and inspection agency. The Contractor will contract directly with the Engineer for the QA services under the allowance indicated the bid form.

R. MDOT Specification: Michigan Department of Transportation 2012 Standard Specifications for Construction.

S. RAP: Recycled Asphalt Pavement.

1.5 SUBMITTALS

A. Submit a 4-point mix design, including regression chart, to the Owner for review and approval. Mix design shall follow the format as indicated in the Asphalt Institute Manual MS-2 Marshall Stability Method. It is the intent of this specification for the Contractor to produce mixtures at the parameters indicated in Table 3 – Mixture Type and Table 4 – Gradations (Percent Passing), both included at the end of this section.

B. If the Engineer believes the Contractor is producing mixture at the high or low end of any of these specification limits, the Engineer shall have the authority to make changes necessary to bring the mixture back to the specified parameters.

C. Quality Control Test: Provide test reports as described in this section.

D. Project Documentation: Provide documentation as described in this section.

E. Warranties: Submit written special warranty as specified in this Section. Include contact information, description of coverage, and start date for each special warranty.

1.6 QUALITY CONTROL

A. Sampling and Testing:

1. Follow the sampling and testing procedures listed in Article 1.2 - References in completing this work.

B. The Contractor shall take random samples of loose mixture at a sampling frequency agreed upon with the Engineer. The Contractor shall provide the Engineer a split Sample of QC Samples. This Sample may be taken anywhere in the production process, except behind the paver. The Contractor shall be responsible for establishing process quality control targets for air voids, asphalt binder content, aggregate gradation, Gmm, obtaining QC Samples, and conducting QC testing in accordance with the Contractor's quality control plan (QCP).

C. Each QC Sample shall be identified to allow test reports to be linked to a specific lot or sublot within the Project.

D. The Contractor shall maintain daily control charts and have them available for review at Infrastructure Planning and Facilities at all times. Copies of these control charts shall be provided to the Engineer, if requested. Test results shall be plotted and used in quality control decisions. When corrective action is necessary, the Contractor shall notify the Engineer in writing of the specific action taken, if it required a JMF adjustment.

E. The Contractor shall have available a density gauge for quality control testing during the compaction process and an apparatus for determining the temperature of the hot mix asphalt. The Contractor shall also have the capability to take 6-inch cores from random locations throughout the paved area for acceptance testing. The Contractor may take up to 3 informational cores from each mixture type, to help correlate the density gauge. The average in-place density shall be not less than 95 percent of the theoretical maximum density.

1.7 QUALITY ASSURANCE

A. The Engineer may collect bituminous mixture quality assurance Samples and provide the Contractor with splits of these Samples. If the criteria for the verification procedure are satisfied, the Contractor's test results may be incorporated into the acceptance and payment decisions for the mixture. During the course of production, the Engineer may acquire random Samples at any point in the production process. These Samples may be tested to determine if the mixture, the aggregate and the binder meet the specification requirements contained in the Contract Documents. As the Samples are collected, the Engineer will assign an alphanumeric identifier to the sample and split, which can be used to trace the test results to the lot and sublot. This alphanumeric identifier must be included on Engineer test reports associated with that Sample. An example is 4-2-A, which would designate the Engineer's split (A) of the Sample from sublot 2 of lot 4 on a Project.

B. A minimum 16,000 gram Sample may be taken. The Sample will be divided equally for Contractor and Engineer testing. The following tests may be conducted by the Engineer on the QA Sample splits.

1. Maximum Specific Gravity, Gmm (ASTM D 2041).

2. Bulk Compacted Density (ASTM D 1559, paragraph 4.5).

3. Air Voids (calculated).

4. Voids in Mineral Aggregate, VMA (calculated).

5. Composition of the Mixture: Asphalt binder content based on calculated value using sublot maximum specific gravity (Gmm) and current JMF effective specific gravity (Gse). The retained Gmm sample may be used for gradation (ASTM C 117 and C 136) and crushed particle content (MTM 117) from extracted (ASTM D 2172) or incinerated (MTM 319) aggregate, or from MTM 311.

C. In-Place Density: The Engineer may identify random core sample locations for each sublot based on longitudinal and transverse measurements. The Engineer will mark each core location with a paint dot, which represents the center of the core. The Contractor shall drill a 6-inch core sample at each core location. The Contractor shall notify the Engineer sufficiently in advance of coring to ensure that a representative can be present to witness the coring. The core Samples shall be taken after final rolling.

1. As an option, when mutually agreed to by the Engineer and Contractor, the core Samples may be waived and the density gauge will be used for acceptance testing.

2. Core Samples shall not be damaged during removal from the roadway. If, for any reason, a core is damaged or determined not to be representative at the time of coring, the Engineer will evaluate and document the problem and determine whether re-coring is necessary.

3. All previous pavement, base aggregate or bond coat material shall be sawed off the bottom of the core Samples before the core density is calculated.

4. The core holes shall be filled with hot mixture and thoroughly compacted as part of the coring operation. The method of filling holes and obtaining compaction shall be agreed upon prior to production. Pavement density acceptance testing will be completed within 1 work day after the cores were taken. Testing will be in accordance with ASTM D 2726. The test results on the compacted bituminous mixture may be used as a basis of acceptance and payment.

D. Verification of Quality Control Test:

1. The Engineer will review the Contractor’s sampling and testing procedures, test results and Engineer QA test results. If, in the opinion of the Engineer, sampling and testing procedures are proper, the Contractor’s quality control test data may be used for acceptance decisions.

2. The Contractor's QC test results may be considered verified if the following criteria are satisfied:

   a. The difference between the Contractor's QC test results and the JMF fall within the single test tolerance indicated in Table 1 – Bituminous Quality Assurance Testing Tolerances (+ or -) from JMF, included at the end of this section, **or**

   b. The difference between the Engineer's test results and the Contractor's test results fall within the single test tolerance indicated in Table 1 – Bituminous Quality Assurance Testing Tolerances (+ or -) from JMF, included at the end of this section.

3. If the difference between the Contractor's QC test results, compared to the JMF, exceed the single test tolerances indicated in Table 1 – Bituminous Quality Assurance Testing Tolerances (+ or -) from JMF, included at the end of this section, the Engineer's test results will be used as the acceptance test. If the sublot is not verified, the Contractor shall be notified and given a copy of the test results. Both the Contractor and the Engineer will verify that testing equipment is calibrated and operating properly, and correct testing procedures have been followed. Unless it is documented that the difference resulted from equipment or procedural problems, the Engineer's test results will remain as the acceptance test of record.

E. Project Documentation:

1. The format of test reports and QC charts to be submitted by the Contractor shall be approved by the Engineer before mixture production is allowed to commence. Suggested formats of reports and charts are available from the Engineer. Project documentation to be provided by the Contractor shall include, but may not be limited to, the following:

   a. Lot Basis:

      1) A complete report of QA tests shall be submitted to the Engineer within 24 hours of the time the last tests were completed.

      2) Control charts of test data must be current (data should be plotted as soon as the test is complete) and available for review by the Engineer.

   b. Project Summation:

      1) Control charts for test data indicating individual test values, lot averages and the running average of 5.

      2) A tabulation of test data including sublot data, lot averages, Project average, Project standard deviation and a projection of which lots are subject to a price adjustment.

2. Provide documentation to confirm that the material used on the Project meets or exceeds minimum specified requirements in accordance with MDOT 2012 specifications.

3. The Contractor shall provide a letter to the Owner certifying that materials approved in the mix design were, in fact, used in the production of the mixture installed on this Project.

1.8 DELIVERY, STORAGE AND HANDLING

A. Provide to the Engineer the asphalt delivery tickets showing asphalt cement grade, date of delivery, and quantity delivered.

1.9 PROJECT CONDITIONS

A. Weather and seasonal limitations shall not exceed those specified in MDOT 2012
B. MSU will reject loads with a temperature either below 250 deg F or greater than +/- 20 deg F from the recommended maximum mixing temperature selected by the binder producer at the time of discharge from behind the screed.

1.10 WARRANTY

A. Furnish and sign 5 year written warranty (last page of this section) which shall cover the following conditions:

1. Cracking: A crack caused by improper joints in the pavement, either a construction joint, a butt joint, or cracking caused by expansion or contraction of the pavement, or by any settlement of the pavement.

2. Delamination: An instance where the surface course de-bonds from the underlying layer of asphalt pavement, causing slippage or complete separation.

3. Raveling: An area where the aggregate or matrix becomes loose, or separates from the asphalt pavement. This condition will generally be caused by poor density or segregation.

B. Remedies for the conditions described above shall be as follows:

1. Cracking: Cracks over 3-inch length or wider than 1/8-inch, or both, shall be corrected by routing/sawing and sealing or overband sealing, as directed by the Engineer, with a sealer approved by the Engineer.

2. Delamination: Areas that exhibit delamination shall be repaired by removing the surface course and cleaning the leveling course, installing a bond coat, and furnishing and installing a new surface course of a like hot mix asphalt.

3. Raveling: Areas that exhibit raveling, or a loss of aggregate or matrix, shall be repaired by removing the distressed area, cleaning the leveling course, applying a bond coat, and furnishing and installing a new surface course of a like hot mix asphalt.

C. At least once a year, for the duration of the warranty period, Project Representative will inspect the pavement to determine if warranty work is necessary. If deficiencies are found, the Project Representative shall notify the Contractor in writing as to the extent of the repairs needed. The Contractor shall perform the repairs within 30 calendar days or other period as approved by the Project Representative. Should the Contractor not perform the required repairs, the Owner may make the repairs at the Contractor's expense. The Contractor may also inspect the lot from time to time to determine if warranty work is necessary. The Contractor will be allowed, with approval of the Project Representative, to perform warranty work that will retard any further deterioration of the warranted conditions. Any and all costs to repair deficiencies in the asphalt shall be paid for by the Contractor.

PART 2 - PRODUCTS

2.1 SUBBASE COURSE

A. See Division 31 Section 312300-EARTHWORK.

2.2 BASE COURSE

A. Not used.

2.3 BITUMINOUS MIXTURES

A. See Table 3 – Mixture Type and Table 4 – Gradations, both included at the end of this section.

2.4 ASPHALT EMULSION

A. The bond/tack coat shall conform to MDOT 2012 Specification for Asphalt Emulsion SS-1h.

2.5 ASPHALT CEMENT

A. Final binder properties shall meet asphalt PG 58-28. The asphalt cement shall conform to MDOT 2012 Specification for Asphalt Cement and conform to the Project Specifications. If the binder obtained from the recycled asphalt pavement exceeds 17 percent of the total binder in the mixture, the Contractor shall furnish documentation (i.e., blending chart) in order to determine the proper grade of virgin binder required to achieve the desired final binder properties.

2.6 TRAFFIC PAINT

A. See Division 32 Section 321723-PAVEMENT MARKING.

PART 3 - EXECUTION

3.1 PREPARATION

A. Prepare subbase according to MDOT 2012 Specifications and Project requirements.

B. Where entire pavement thickness is to be completely removed, cut existing pavement neatly with a saw. Otherwise, edges shall be cut straight and smooth allowing for a full depth pavement throughout.

C. Proof roll subgrade and subbase to check for unstable areas and areas requiring additional compaction. Perform proof rolling as directed by the Engineer.

D. Notify Project Representative of unsatisfactory conditions. Do not begin paving work until deficient subgrade areas have been corrected, tested, and approved by the Project Representative.

E. Required Grades for Barrier Free Parking Areas:

1. In areas designated on the Drawings as a barrier free parking space, either so noted or with a uniform barrier free graphic symbol, the slope of the parking space and adjacent access aisle shall not exceed 2 percent (1/4-inch per foot) in any direction.

2. Should this provision conflict with the Drawings, inform the Project Representative so that the necessary revision(s) can be made.

3.2 INSTALLATION OF PAVEMENT

A. General: Place bituminous pavement and bond coats over approved subbase or existing pavement according to MDOT 2012 Specifications, Division 5.

B. Pavement Thickness and Type: Over the subbase, place bituminous pavement as indicated on the Drawings. For courses exceeding 3-inch, place bituminous pavement in 2 lifts with a bond coat between each layer. For patching, provide 4-inch leveling course and 2-inch surface course over compacted subbase.

1. Mix Type:

a. Surface Course – Roadway and Dock Areas:

1) Thickness: 1.5-inch.
2) Yield: 165 lbs/syd.

b. Surface Course – Parking:

1) Thickness: 1.5-inch.
2) Yield: 165 lbs/syd.

c. Leveling Course – Roadway and Dock Areas:

1) Thickness: 3.5-inch.
2) Yield: 385 lbs/syd.

d. Leveling Course – Parking:

1) Thickness: 2.5-inch.
2) Yield: 275 lbs/syd.

C. Bond Coat: Uniformly apply a coat of SS-1h at a rate of 0.10 to 0.15 gallon per square yard over the entire surface of each bituminous course, except the last.

D. Protection: After final rolling, protect pavement from vehicular traffic until the surface has cooled sufficiently to eliminate surface abrasion.

3.3 TABLES

TABLE 1 – BITUMINOUS QUALITY ASSURANCE TESTING TOLERANCES (+ OR -) FROM JMF

Parameter	Single Test	Lot Average
Air Voids	1.00%	0.60%
Voids in Mineral Aggregate (VMA)*	1.20%	0.75%**
Maximum Specific Gravity (Gmm)*	0.019	0.012
Asphalt Binder Content*	0.50%	0.35%

* Parameters with Target Values
** Or less, determined by VMA Value from MDOT 2012 Standard Specifications for Construction.

TABLE 2 – BITUMINOUS MIXTURE PAY ADJUSTMENTS

Parameter (Lot Average)	Deviation (d)	Negative Unit Price Adjustment (%)
Asphalt Binder Content (deviation from JMF)	$0.35 < d \leq 0.55$	10
	$d > 0.55$	25
Air Voids (deviation from JMF)	$0.6 < d \leq 0.7$	2
	$0.7 < d \leq 0.8$	4
	$0.8 < d \leq 1.0$	6
	$1.0 < d \leq 1.1$	8
	$1.1 < d \leq 1.2$	10
	$d > 1.2$	25
Maximum Specific Gravity (Gmm) (deviation from JMF)	$0.012 < d \leq 0.014$	2
	$0.014 < d \leq 0.015$	4
	$0.015 < d \leq 0.017$	6
	$0.017 < d \leq 0.019$	8
	$0.019 < d \leq 0.021$	10
	$d > 0.021$	25
Voids in Mineral Aggregate (VMA) (deviation below minimum value in the MDOT 2012 Standard Specifications for Construction)	$0.0 < d \leq 0.1$	2
	$0.1 < d \leq 0.3$	4
	$0.3 < d \leq 0.4$	6
	$0.4 < d \leq 0.5$	8
	$0.5 < d \leq 0.6$	10
	$d > 0.6$	25

TABLE 3 – MIXTURE TYPE

	Surface Course		Leveling Course	
	Roadway & Dock Area	**Parking Only**	**Roadway & Dock Area**	**Parking Only**
Mixture Number	5C Modified	36A Modified	3C Modified	13A Modified
VMA % (Eff. Spec. Gravity)	16.0	16.5	15.0	15.5
Air Voids % *	3.0	2.5	3.0	2.5
Fines to Binder Ratio (Max.)	1.2	1.2	1.2	1.2
Fine Angularity (Min.) MTM 118	4.0	3.0	4.0	2.5

* Modified from MDOT specifications.
No more than 50% of the material passing the #4 sieve shall pass the #30 sieve for Parking mixtures.

TABLE 4 – GRADATIONS (PERCENT PASSING)

	Surface Course		Leveling Course	
	Roadway & Dock Area	**Parking Only**	**Roadway & Dock Area**	**Parking Only**
Mixture Number	5C Modified	36A Modified	3C Modified	13A Modified
1-inch	100	100	100	100
3/4-inch	100	100	99-100	100
1/2-inch	100	100	90 Max.	75-95
3/8-inch	99-100	92-100	77 Max.	60-90
#4	90 Max.	65-90	57 Max.	45-80
#8	55-70	55-75	15-45	30-65
#16	30-55		33 Max.	20-50
#30	20-30	25-45	25 Max.	15-40
#50	15-25		19 Max.	10-25
#100	15 Max.		15 Max.	5-15
#200	3-6	3-7	3-6	3-6
Crush (Min.) MTM 117*	90	60	90	50

* Modified from MDOT specifications.
No more than 50% of the material passing the #4 sieve shall pass the #30 sieve for Parking mixtures.

(BITUMINOUS PAVEMENT WARRANTY ON THE FOLLOWING PAGE.)

BITUMINOUS PAVEMENT WARRANTY

PROJECT:

CONTRACTOR:

OWNER: **BOARD OF TRUSTEES**
MICHIGAN STATE UNIVERSITY

We, the undersigned, hereby provides a five (5) year warranty to Owner against defects caused by deficiencies in the materials and/or workmanship of the bituminous pavement in accordance with the requirements set forth in the Drawings and Specifications for the above named project.

The warranty covers the following conditions:

1. Cracking as defined shall be any cracked caused by improper joints in the pavement, either a construction joint, a butt joint, or any cracking caused by expansion or contraction of the pavement, or by any settlement of the pavement, i.e., thermal cracking. Cracks caused by fatigue or settlement will not be covered by this Warranty.
2. Delamination as defined shall be any instance where the surface course de-bonds from the underlying layer of bituminous pavement, causing slippage or complete separation.
3. Raveling, as defined shall be any area where the aggregate or matrix becomes loose, or separates from the asphalt pavement. This condition is generally caused by poor density or segregation.

Remedies for the conditions described above will be as follows:

1. Cracking. Any cracks over 3” in length and/or wider than 1/8” shall be corrected by routing/sawing and sealing or band sealing, as directed by the Owner’s Representative, with a sealer approved by the Owner’s Representative.
2. Delamination. Any area that exhibits delamination will be repaired by removing the surface course and cleaning the leveling course, installing a bond coat and furnishing/installing a new surface course of a like hot mix asphalt.
3. Raveling. Any area that exhibits raveling, or a loss of aggregate or matrix, will be repaired by removing the distressed are, cleaning and leveling course, applying a bond coat and furnishing and installing a new surface course of a like hot mix asphalt.

At least once a year, for the duration of the Warranty period, Owner’s Representative will inspect the pavement to determine if any warranty work is necessary. If deficiencies are found, the Owner’s Representative will notify the Contractor, in writing, as the extent of the repairs needed. The Contractor will perform the repairs within 30 calendar days, or within period as approved by the Owner’s Representative. Should the Contractor not perform the required repairs, the Owner may make the repairs at the Contractor’s expense. The Contractor may also inspect the lot from time to time to determine if any warranty work is necessary. The Contractor will be allowed, with approval of the Owner’s Representative, to perform any warranty work that it appears will retard any further deterioration of any of the warranted conditions. Any and all costs to repair any deficiencies in the pavement shall be paid by this Contractor.

CONTRACTOR: _____DATE _____

ADDRESS:_____

AUTHORIZED REPRESENTATIVE: _____ _____
(Print) (Signature)

SUBSCRIBED AND SWORN TO BEFORE ME,
THIS____DAY OF_____
A.D._____
NAME
MY COMMISSION EXPIRES

END OF SECTION 321216

SECTION 321313 – CONCRETE PAVEMENT

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. Provide all labor, materials and equipment as necessary to complete all work as indicated on the Drawings and specified herein.

B. This section includes concrete pavement.

C. Related sections include:

1. Division 01 Section 014000-QUALITY REQUIREMENTS
2. Division 31 Section 312300-EARTHWORK
3. Division 33 Section 334000-STORM DRAINAGE

1.3 SUBMITTALS

A. Shop Drawings: For heated walks, paving areas showing the layout of expansion joints, tubing and manifold areas.

1. Submit to Project Representative for approval.

2. Design tubing system to minimize the crossing of expansion joints. Adjustments can be made to correspond to design requirements of the tubing system, with approval from Project Representative.

B. Warranties: Submit written special warranty as specified in this Section. Include contact information, description of coverage, and start date for each special warranty.

1.4 QUALITY ASSURANCE

A. Provide required testing and inspection as indicated in Division 01 Section “General Requirements - Quality Requirements.”

B. Concrete sampling, testing, and inspection shall conform to the following requirements:

1. Sampling Fresh Concrete: ASTM C172, except initial Samples shall be taken immediately after first 1/4 cubic yard (CY) has been discharged and subsequent Samples shall be taken as specified herein. If found to be in non-conformance, the concrete shall be removed from the forms.

2. Slump: ASTM C143, except initial Sample shall be taken in accordance with paragraph above. Additional tests shall be made for each set of compressive strength test specimens, and as required by the Project Representative.

3. Air Content: ASTM C231, except as previously specified herein and additional tests at the end of the load, if possible.

4. Concrete Temperature: Taken each time compression test specimens are made and hourly when temperature is 40 degrees F and below and over 80 degrees F.

5. Unit Weight: ASTM C138, except the Sample volume shall be equal to air content specimen.

6. Compressive Strength: ASTM C31 and C39, except one set of 3 cylinders for every 40 cy or fraction thereof. One specimen shall be tested at 7 days and the remaining 2 specimens shall be tested at 28 days. Strength level of the concrete will be considered unsatisfactory if the 7 day compressive strength does not equal or exceed 60% of the 28 day design strength. Strength level of concrete will be considered satisfactory if the average compressive strength of two consecutive 28 day tests equals or exceeds the 28 day design strength, and neither individual strength test results falls below the specified compressive strength requirement by more than 100 psi.

7. Inspection: Monitored by the Project Representative.

8. Frequency: In accordance with Division 01 Section “General Requirements - Quality Requirements.”

9. Concrete Replacement: Failure of a test or to follow proper installation procedures will require that the concrete be removed and properly replaced at Contractor’s expense.

10. Additional Tests: Contractor may have the testing agency make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained. Testing agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42. Contractor shall pay for all such tests conducted. Holes shall be patched at the Contractor’s expense.

1.5 SEQUENCING AND SCHEDULING

A. Concrete shall not be placed after October 15 without written permission from the Project Representative.

1.6 WARRANTY

A. Furnish and sign 2 year written warranty (last page of this section) which shall cover cracking, spalling, settling, finishing and forming.

PART 2 - PRODUCTS

2.1 CEMENT

A. Portland cement conforming to the requirements of the current specifications for Portland Cement ASTM C150 Type 1.

2.2 AIR-ENTRAINING ADMIXTURE

A. Conform to ASTM C260 for concrete.

2.3 FINE AGGREGATE

A. Limestone or other fine aggregate that is free of soft particles or other material that could cause staining or pitting of the pavement surface. For gradation purposes only, the material shall conform to MDOT Specification 2NS.

2.4 COARSE AGGREGATE

A. Well-graded limestone. Gradation and physical requirements to conform to MDOT Specification 6AA.

2.5 WATER

A. Potable.

2.6 REINFORCEMENT

A. Welded Wire Reinforcement:
   1. Standard; Welded wire fabric (6 x 6 - W4.0 / W4.0) in flat sheets only, conforming to ASTM A1064.
   2. Heavy duty and heated pavement; Welded wire fabric (4 x 4 - W4.0 / W4.0) in flat sheets only, conforming to ASTM A1064.

B. Bar Reinforcement: No. 3, No. 4 and No. 5 bar reinforcement as specified on the Drawings. It shall be new billet stock of intermediate grade in accordance with ASTM A615.

2.7 DOWELS

A. Construction Expansion Joints:

   1. No. 5 speed dowel 9 inches long, as manufactured by Greenstreak, Inc., 3400 Tree Court Industrial Blvd., St Louis, MO; 800-325-9504; or approved equal.

   2. Dowel: 18 inches long, No. 5 smooth epoxy-coated rebar (coated all surfaces); or approved equal.

3. 1/4" x 4-1/2" x 4-1/2" electroplated zinc steel, ASTM A36, ASTM B633 with pocket formers

   a. Diamond Dowel System as manufactured by PNA Construction Technologies www.PNA-INC.com ; 800-542-0214 ; or approved equal.

B. Construction Joints:

1. As specified above.

2.8 FORMED KEYWAY

A. Standard keyway, 1-5/8-inch x 1-3/4-inch x 2-3/4-inch, as manufactured by Dee Concrete Accessories Company, P.O. Box 11119, Chicago, IL 60611; or approved equal.

2.9 ASPHALT EXPANSION JOINTS

A. Conform with ASTM Specification D994-53. Fiber joint material is not acceptable.

2.10 JOINT SEALER

A. Tremco Spectrem 800. Primer: Tremco Silicone Primer No. 23. Tremco-Sealant/Weatherproofing Division, 3735 Green Road, Beachwood, OH 44122; 800 321 7906.

2.11 CURING AND ANTI-SPALLING COMPOUNDS

A. Curing and Anti-Spalling Compound:

1. For use when the concrete is placed at 40 degrees F and above.

2. Sealtight brand Lin-Seal Emulsion curing and sealing compound; Clear emulsion product (not to be confused with Lin-Seal or Lin-Seal white).

3. Manufactured by M.G. by W.R. Meadows, Inc, PO Box 338, Hampshire, IL 60140 0338; 847-683-4500, 800-342-5976.

B. Waterproofing Compound:

1. For use when the concrete is placed below 40 degrees F or when the concrete pavement is within 50 feet of building entrances; or both. Either of the following will be accepted.

2. Products:

   a. Lifetime™ Water Sealant by Coatings International, Inc., 112 North Monroe, N.E. Rockford, MI 49341; 616-863-6529; Fax: 616-863-1076; www.coatingsinternational.com

   b. Consolideck Saltguard WB by PROSOCO, Inc., 3741 Greenway Circle, Lawrence, KS 66046; 785-865-4200; Fax: 785-830-9016; www.prosoco.com.

C. Evaporation Retardant:

1. Conspec Aquafilm by Conspec Marketing & Manufacturing, 636 S. 66th Terrace, Kansas City, Kansas 66111; 800-348-7351

2. Confilm Evaporation Reducer by BASF Construction Chemicals, LLC, 23700 Chagrin Boulevard, Cleveland, Ohio 44122-5544, 800-628-9990; Fax 216-839-8821

3. Approved equal

2.12 ADMIXTURES

A. As approved by Project Representative.

2.13 FORMWORK

A. Steel or wood forms of an approved section shall be used throughout the construction. On radii 3 feet or less, 1/4-inch plywood or masonite shall be used. All forms shall have a height equal to concrete thickness. Built-up, battered, bent, twisted, or broken forms shall be removed from the Work. Expansion joint materials shall not be used.

2.14 CONCRETE QUALITY

A. The mixture shall contain 6 sack Portland cement concrete, coarse aggregate, fine aggregate admixtures and water. The concrete mix design shall have a minimum 4000 psi compressive strength at 28 days. The maximum allowable slump shall be 4.5 inches. Aggregates shall be batched by weight. Air content shall be 5% to 8%. Maintain a maximum water/cement ratio of 0.46 pounds of water per pound of cement.

B. Contractor shall provide the Project Representative with delivery tickets which shall list slump, sack mix, percent of air entraining agent, time the truck left the plant, arrived on the site and departed the site, and water added at the site.

C. When requested, Contractor shall provide documentation from the concrete supplier certifying that the concrete meets the specifications of this section.

D. Color shall be limestone. Consistency of the color shall be uniform throughout the Project.

2.15 DETECTABLE WARNING PLATES

A. 24” x 24” Duralast Detectable Warnings, Product number 00700571, Natural Finish by East Jordan Iron Works, Inc.; 800-626-4653

PART 3 - EXECUTION

3.1 PLACING FORMS

A. Forms shall be so constructed and set as to resist, without springing or settlement, the pressure of the concrete. Forms shall not deviate more than 1/8-inch in 10 feet from the true horizontal alignment and no more than 1/8-inch in vertical alignment.

B. Where forms are set above general surrounding area, earth shall be placed along outside edges of forms to ensure stability.

C. Forms shall be cleaned and oiled each time they are used.

D. Forms shall be reviewed by the Project Representative prior to pouring.

3.2 PLACING REINFORCEMENT

A. Place reinforcement mesh as indicated on the Drawings and in the following areas:

1. Where the pavement crosses a recently filled trench and extending a minimum of 5 feet beyond the trench wall.

2. Where fill soil of 18 inches or more occurs.

3. As directed by the Project Representative.

B. Concrete shall be placed in 2 layers when mesh reinforcing is used. Use of brick, stones, etc., or unusual raising with bars or tools is prohibited. Proper positioning of the mesh can be achieved by either; (1) the use of metal or plastic chairs specifically intended for holding mesh reinforcement in the soil conditions present at the required depth, or (2) placing and consolidating a layer of concrete at the specified elevation of the reinforcement prior to placing reinforcement and a top layer of concrete

3.3 PLACING CONCRETE

A. Placing 6-inch (or greater, if specified) concrete shall not commence until the subbase and forms have been approved. Subbase shall be moistened in advance of concreting, but shall not be muddy or excessively wet. A sufficient quantity of forms shall be placed to accommodate the concrete that is scheduled to be poured at any one time. Concrete shall be deposited with a minimum of re-handling and shall be spaded adjacent to forms and joints. In the case of isolation joints, concrete shall be placed simultaneously against both sides of the joint.

B. Concreting shall not be continued when the air temperature is below 45 degrees F, unless the aggregates or water, or both, are heated to produce a placing temperature of the concrete between 60 degrees F and 90 degrees F., and unless adequate provisions are made for maintaining protection against freezing of the concrete for at least 7 days after placing. No concrete shall be placed on frozen subbase.

C. Should placement of concrete be necessary over or near tree roots, a thin layer of sulfur shall be placed on the area of the subbase which may be affected by the roots. Owner shall place sulfur. Provide 2 day notice to coordinate work with Owner's crews.

3.4 JOINTING

A. As indicated on the Drawings, as directed in the field by the Project Representative and in the following situations, unless otherwise specified:

1. Control (contraction) joints shall ordinarily be placed at intervals equal to the width of the slab or 8 feet, whichever is less. They shall be 1/8-inch to 3/16-inch wide and 1-1/4 inch deep, or 1/4 the thickness of the slab, whichever is greater. Where slabs exceed 8 feet in width, a straight longitudinal control joint shall be placed along the centerline of the slab. This joint shall begin and end only at isolation or construction joints.

2. Expansion joints shall be placed as indicated on the Drawings and if not conflicting with Drawings at intervals of at least every 40 lineal feet (LF), adjacent to footings and foundations, adjacent to curbs when required, adjacent to existing concrete where new concrete is to abut or at next available joint that is parallel to the edge of the existing concrete. Continue joints in adjoining concrete, in the same location as existed in the concrete that was removed, and where 2 or more walks intersect. Joints shall be placed in a vertical position through the entire slab thickness.

3. Construction joints (with dowels) shall be installed when placing operations are delayed more than a 1/2-hour at locations where normal control joints would occur, as indicated on the Drawings and as directed by the Project Representative.

B. Joints shall be tooled to the specified depth. If the pavement thickness is greater than 6 inches, sawing will be permitted after the joints have first been tooled. The only exception to this requirement is for basketball courts, where only saw cutting is permitted.

C. Joints shall be perpendicular to the edge and tangents and normal to curves. The joints shall not vary from the true line more than 1/4-inch.

D. When new walkways are adjacent to new curb and gutter or when required by the Project Representative, the Contractor shall install a Diamond Dowel System.

E. Place sealant in non-heated pavement joints when specified, according to manufacturer's recommendations, using primer as specified.

3.5 FINISHING

A. Concrete shall be placed and struck off with a straight board until voids are removed in the surface at the required grade and cross section.

B. Adding water to the surface of the concrete to assist in finishing operations is not permitted. If a finishing aid is permitted by the Project Representative, it shall only be an approved product for that intended purpose and then applied according to the product recommendations.

C. Immediately after the concrete has been struck off, the surface shall be floated with a magnesium bull float, just enough to produce a smooth surface free from irregularities. Edges shall be rounded to a radius of 1/4-inch with an approved edging tool. Jointing shall then commence immediately after edging and before the large aggregate in the concrete has started to settle.

D. The entire surface shall then be steel-troweled so that the large aggregate is set and the surface is free of edging joints and trowel marks.

E. The surface shall be heavy-broomed, keeping mortar out of joints. Brooming direction shall generally be perpendicular to the normal path of travel, unless otherwise directed by the Project Representative. Provide 2-inch retool at joints, if detailed on the Drawings.

F. Surface variations greater than 1/8-inch in 10 feet are unacceptable.

G. Walks shall be protected from pedestrian traffic for 2 days and vehicles for 7 days.

H. Concrete shall be stamped at each end of the work with the Contractor's name and the current year.

3.6 CURING AND ANTI-SPALLING COMPOUND APPLICATION

A. For temperatures above 40 degrees F, concrete shall be cured utilizing the specified curing/anti-spalling compound in accordance with product specifications using only a motorized sprayer. This application includes the sides of the concrete, once the forms have been removed.

B. For temperatures between 32 degrees F and 40 degrees F and on concrete within 50 feet of building entrances, cure pavement using an approved wet cure method for a period of not less than 7 full days while maintaining a concrete temperature above 34 degrees F for 14 days. After 30 days, the specified water proofing compound shall be applied according to product specifications.

3.7 DETECTABLE WARNING PLATES

A. Follow manufacturer’s installation specifications to properly install detectable warning plates per site plan layout. Pay special attention to be sure the plastic concrete comes through all the holes in the plate to eliminate all cavities below the plate that could trap water.

3.8 HEATED PAVEMENT AREAS

A. Layout:

1. Each zone shall have its manifold area within the area heated and each zone shall be independent from other zones and separated with sealed expansion joints.

2. All main line piping shall be bedded under the concrete slab. If this is not possible, then the main line piping shall be installed in appropriate sleeving to protect it from damage by gardening equipment.

B. Coordinate height of sand chair to correspond to the depth of tubing from the concrete paving surface to top of tubing.

C. Reinforcing shall be held at the correct elevation with sand chairs. No other materials shall be permitted.

D. Drainage from a heated pavement area shall flow to a catch basin within the heated pavement area or directly adjacent to the heated paving. No drainage shall flow onto a cold pavement surface.

E. In areas designated on the Drawings as a barrier free parking space, either so noted or with a uniform barrier free graphic symbol, the slope of the parking space and adjacent access aisle shall not exceed 2 percent (1/4-inch per foot) in any direction.

F. Installation of concrete shall be as specified in this section.

G. For heated pavement systems, the heated portion of the concrete shall be stamped with the words "Heated Pavement Limit." Stamp locations shall be approved by the Project Representative.

1. Text shall be placed along the entire edge of the heated concrete at uniform increments of approximately 10 feet to 15 feet and shall be readable when standing on the heated pavement. This includes along buildings and structures.

2. If the edge of the heated surface is curb/gutter, then the stamp shall be placed on the gutter pan rather than on the adjacent pavement.

3. The cast aluminum stamp may be available for use from Engineering and Architectural Services, Physical Plant Division if arrangements are made in advance and the stamp is available. Otherwise, Contractor is responsible to secure a stamp that is approved by the Project Representative and identical to the EAS heated pavement stamps reading "Heated Pavement Limit."

(CONCRETE PAVEMENT WARRANTY ON THE FOLLOWING PAGE.)

CONCRETE PAVEMENT WARRANTY

PROJECT:
CONTRACTOR:
OWNER: **BOARD OF TRUSTEES**
MICHIGAN STATE UNIVERSITY

We, the undersigned, herewith warranty all the work to be free from defective workmanship and/or materials for **two (2) years** from November 1st of the calendar year of the date written below, in accordance with the requirements set forth in the Drawings and Specifications for the above-named Project.

The Contractor agrees that by acceptance of this Work and in consideration thereof, for them and for each of their Subcontractors, binds themselves to all warranties called for. The Contractor shall warranty all work, except as noted elsewhere in these Contract Documents in which a longer warranty is specified. This shall include, but not be limited to, the following defects:

1. Cracking
2. Spalling
3. Settling
4. Finishing
5. Forming

If during the warranty period, it is found by the Owner's Representative, that the warranty Work needs to be repaired or replaced because of the use of materials, equipment, or workmanship which is inferior, defective, or not in accordance with the terms of Agreement, the Contractor, upon notification, shall promptly and without additional expense to the Owner:

a. Place in satisfactory condition all of such warranted Work,
b. Make good all damage to the project, or contents thereof, which is a result of such unsatisfactory warranted Work, and
c. Make good any Work, materials and equipment that are disturbed in fulfilling the Warranty, including any disturbed work, materials and equipment that may have been warranted under another contract.

Should the Contractor fail to proceed promptly in accordance with the Warranty, the Owner's Representative may have such work performed at the expense of the Contractor and their surety.

CONTRACTOR: _____ DATE:_____

ADDRESS: _____

AUTHORIZED REPRESENTATIVE: _____ _____
(Print) (Signature)

SUBSCRIBED AND SWORN TO BEFORE ME,

THIS_____DAY OF_____

A.D._____

NAME

MY COMMISSION EXPIRES

END OF SECTION 321313

SECTION 321613 – CONCRETE CURBS AND GUTTERS

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. Provide all labor, materials and equipment as necessary to complete all work as indicated on the Drawings and specified herein.

B. This section includes:

1. Curb and gutters.

C. Related sections include the following:

1. Division 01 Section 015000-TEMPORARTY FACILITIES AND CONTROLS
2. Division 31 Section 312300-EARTHWORK
3. Division 32 Section 321218-BITUMINOUS PAVEMENT
4. Division 32 Section 321313-CONCRETE PAVEMENT

1.3 SUBMITTALS

A. Testing and Inspection: Provide reports as described in this section.

B. Warranties: Submit written special warranty as specified in this Section. Include contact information, description of coverage, and start date for each special warranty.

1.4 QUALITY ASSURANCE

A. Provide the required testing and inspection as indicated in Division 01 Section “General Requirements - Temporary Facilities and Controls.” Concrete sampling, testing, and inspection shall conform to the requirements found in Division 32 Section “Concrete Pavement.”

1.5 SCHEDULE

A. Concrete shall not be placed after October 15 without written permission from the Project Representative.

1.6 WARRANTY

A. Furnish and sign 2 year written warranty (last page of this section) which shall cover cracking, spalling, settling, finishing and forming.

PART 2 - PRODUCTS

2.1 Refer to Division 32 Section “Concrete Pavement” for all products, except for the following:

A. Reinforcement: Shall be No. 4 bar reinforcement of new billet stock of intermediate grade in accordance with ASTM A615.

PART 3 - EXECUTION

3.1 PLACING FORMS

A. Steel or wood forms of an approved section shall be used throughout the construction. On radii 3 feet or less, 1/4-inch plywood or masonite shall be used. All forms shall have a height equal to concrete thickness. Built-up, battered, bent, twisted, or broken forms shall be removed from the work. Expansion joint materials shall not be used.

B. Forms shall be so constructed and set as to resist, without springing or settlement, the pressure of the concrete. On curbs of sharp radius, plywood or other approved flexible material shall be used in sections short enough to form a smooth, uninterrupted curb which shall not vary form the true radius by more than 1/4-inch. Forms shall not deviate more than 1/8-inch in 10 feet from the true horizontal alignment and no more than 1/8-inch in vertical alignment.

C. Where forms are set above general surrounding area, earth shall be placed along outside edges of forms to ensure stability.

D. Forms shall be cleaned and oiled each time they are used.

E. Forms must be approved by the Project Representative prior to placing concrete.

3.2 PLACING REINFORCEMENT

A. Place 2 bars in gutter pan as specified in Drawings and in the following areas:

1. Where curb crosses a recently filled trench and extending a minimum of 5 feet beyond trench wall.

2. Where fill soil of 18 inches or more occurs.

3. In all valley gutter pans. (exception – 3 bars as shown on the detail drawing)

4. In all path ramps and extending a minimum of eighteen inches beyond the bottom of the curb taper or curb transition.

5. As directed by the Project Representative.

3.3 PLACING CONCRETE

A. Refer to Division 32 Section “Concrete Pavement.” However, the time restriction may be extended with the approval of the Project Representative.

3.4 JOINTING

A. Control (contraction) joints shall be perpendicular to the curb edge, 1-1/2-inch deep, open and free of all excess concrete. Control joints shall be placed at intervals of not more than 10 feet as indicated on the Drawings.

B. Expansion joints shall be placed at all points of curvature, tangency, and at intervals of not more than 100 lineal feet.

3.5 FINISHING

A. Concrete shall be struck off true to cross section, after which it shall be finished smooth and even. Face forms, if used, shall be left in place until the concrete has set sufficiently so that they can be removed without injury to the curb. The remaining forms shall be rounded with an edging tool. No tool marks are to be left on exposed edges.

B. A straight edge check is to be made while concrete is still plastic. Irregularities exceeding 1/8-inch shall be corrected. Finish surfaces shall not vary form the required cross section as indicated on Drawings by more than 1/8-inch. They shall not vary from the true horizontal alignment by more than 1/4-inch in 10 lineal feet. Sections exceeding those limitations are subject to rejection and replacing at Contractor's expense.

C. Adding water to the surface of the concrete to assist in finishing operations is not permitted. If a finishing aid is permitted by the Project Representative, it shall only be an approved product for that intended purpose and then applied according to the product recommendations.

D. For heated pavement (or snow melt) systems, the heated portion of the concrete shall be stamped with the words "Heated Walk Limit" at the edge of the heated pavement. If part of the system includes the curb or gutter, then the stamp shall be placed on the gutter pan. Stamp spacing shall be at approximately 20-foot increments and positioned exactly between each control joint. Stamp locations shall be approved by the Project Representative in advance. A stamp may be available for use from the Project Representative if arrangements are made in advance. Otherwise, the Contractor is responsible to secure a stamp that is approved by the Project Representative.

3.6 CURING AND ANTI-SPALLING COMPOUND APPLICATION

A. Refer to Division 32 Section "Concrete Pavement."

(CONCRETE CURB AND GUTTER WARRANTY ON FOLLOWING PAGE.)

CONCRETE CURB & GUTTER WARRANTY

PROJECT:
CONTRACTOR:
OWNER: BOARD OF TRUSTEES
MICHIGAN STATE UNIVERSITY

We, the undersigned, herewith warranty all the work to be free from defective workmanship and/or materials for **two (2) years** from November 1st of the calendar year of the date written below, in accordance with the requirements set forth in the Drawings and Specifications for the above-named Project.

The Contractor agrees that by acceptance of this Work and in consideration thereof, for them and for each of their Subcontractors, binds themselves to all warranties called for. The Contractor shall warranty all work, except as noted elsewhere in these Contract Documents in which a longer warranty is specified. This shall include, but not be limited to, the following defects:

1. Cracking
2. Spalling
3. Settling
4. Finishing
5. Forming

If during the warranty period, it is found by the Owner's Representative, that the warranty Work needs to be repaired or replaced because of the use of materials, equipment, or workmanship which is inferior, defective, or not in accordance with the terms of Agreement, the Contractor, upon notification, shall promptly and without additional expense to the Owner:

a. Place in satisfactory condition all of such warranted Work,
b. Make good all damage to the project, or contents thereof, which is a result of such unsatisfactory warranted Work, and
c. Make good any Work, materials and equipment that are disturbed in fulfilling the Warranty, including any disturbed work, materials and equipment that may have been warranted under another contract.

Should the Contractor fail to proceed promptly in accordance with the Warranty, the Owner's Representative may have such work performed at the expense of the Contractor and their surety.

CONTRACTOR: _____ DATE:_____

ADDRESS: _____

AUTHORIZED REPRESENTATIVE: _____ _____
(Print) (Signature)

SUBSCRIBED AND SWORN TO BEFORE ME,

THIS_____DAY OF_____

A.D._____

NAME

MY COMMISSION EXPIRES

END OF SECTION 321613

SECTION 323113 – CHAIN LINK FENCES AND GATES

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. Provide all labor, materials and equipment as necessary to complete all work as indicated on the Drawings and specified herein.

B. This section includes chain link fences and gates.

C. Related section includes Section 312300 Earthwork for filling and for grading work.

1.3 REFERENCES

A. Referance to “PVC/vinyl coated fence” or “galvanized fence” referes only to the final appearance. Both shall be constructed of galvanized steel. However, the cantilever gates may be constructed of aluminum as specified in this document.

B. Product Standard: Chain Link Fence Manufacturers Institute (CLFMI) Product Manual, dated 1992 or later.

C. Installation Standard: ASTM F567, unless specified otherwise.

D. ASTM Chain Link Fence Standards is required and when no reference is given.

E. Should specifications provide insufficient detail, the Owner shall be consulted.

1.4 SYSTEM DESCRIPTION

A. Approximately (contractor to field measure prior to bidding) lineal feet of including posts, rails(if specified), tension wire and required hardware.

B. Three wide swing gate opening consisting of one gate leafs and cantilever sliding gate

1.5 SUBMITTALS

A. Shop Drawings:

1. Locations of fence, each gate, posts, rails, and tension wires and details of extended posts, extension arms, gate swing, cantilever gate or other operation, hardware and accessories.

2. Indicate materials, dimensions, sizes, weights and finishes of components.

3. Include plans, elevations, sections, gate swing and other required installation and operational clearances, and details of post anchorage and attachments and bracing.

B. Product Data:

1. Fence and gate posts, rails and fittings.

2. Chain-link fabric, reinforcements and attachments.

3. Gates and hardware.

4. Material certification and test documentation as specified in Part 3, prior to final payment request.

C. Samples: For the following products, showing the full range of color, texture and pattern variations expected. Prepare Samples from the same material to be used for the Work.

1. Provide a 1SF piece of steel wire (for fabric)
2. Provide a 1LF piece of.
3. One sample each: latches and locking assemblies.
4. One sample each: stops, drop rod assemblies and keepers.

D. Waiver of Lien/Wage Statement, as specified in the General Conditions, prior to final payment request.

E. Warranties: Submit written special warranty as specified in this Section. Include contact information, description of coverage, and start date for each special warranty.

1.6 QUALITY ASSURANCE

A. Provide dated written certification and test documentation from each manufacturer that the material they provided for this Project meets or exceeds the Specifications of this Contract. The documentation shall provide product requirements; the name, address and phone number of the manufacturer(s); and the name of a contact person.

1.7 WARRANTY

A. Contractor agrees that by acceptance of this work and in consideration thereof, binds self and Subcontractors the guarantees and warranties herein. Contractor guarantees materials to be free from defects in materials and installation for 5 years after the date of final acceptance.

B. If within warranty period, it is found that the warranted materials need to be replaced because of the use of materials which are inferior, defective, not properly installed or not in accordance with the terms of the Contract Documents, Contractor, upon notification, shall promptly and without additional expense to MSU replace such materials immediately.

C. Should Contractor fail to proceed promptly in accordance with the warranty, the Owner may have such replacements made at the expense of the Contractor and sureties.

D. Contractor shall execute and deliver to the Owner, before final settlement, a written warranty and submittals subject to and stipulating the provisions above.

PART 2 - PRODUCTS

2.1 FABRIC

A. 2" mesh, 9gauge steel core wire, before PVC coating (if PVC fence is specified). (9 gauge core shall have an 8 gauge final size with PVC coating or 6 gauge shall have a 5 guage final size with the PVC coating

B. PVC- coated, ASTM F 668, Class 2b (fused and adhered) over zinc-coated steel wire.

C. If fence shall be zinc coated, coating shall be hot dipped after fabrication with a **minimum** of 1.2 oz of zinc per square foot of fabric.

D. Selvage shall be twisted top and bottom, for fences 6 feet and taller. Fences 4 feet and under twisted bottom and knuckled top. Coat selvage ends of fabric in the same manner and color as the fabric.

2.2 LINE POSTS

A. SS40 Pipe:

1. Standard Duty is 2 1/2" dia.

B. Line post length shall be in accordance with that which is required under Section 2.4.

2.3 TERMINAL, CORNER AND PULL POSTS

A. Type 1 Round Pipe, Schedule 40, Nominal Size:

1. 6 ft. or shorter: 3 " dia. O.D.
2. Over 6 ft: 3" dia. O.D.;

2.4 LINE POST FOOTINGS

A. Shall be driven posts with a total length below grade according to the following:
1. 4' fence height - 4' below grade
2. 6' fence height - 4.5' below grade
3. 8' fence height - 6' below grade
4. 10' fence height – 6' below grade

2.5 CORNER, GATE AND TERMINAL POST FOOTINGS

A. In accordance with ASTM F567 except:

1. Concrete footings shall be 12-inch diameter x a minimum of 42-inch deep.
2. Concrete shall be 3,500 psi.
3. Footing hole shall have a uniform vertical surface to the bottom of the footing.

2.6 PULL POST FOOTINGS

A. In accordance with ASTM F567, except concrete shall be 10-inch diameter x a minimum of 42-inch deep with a uniform and plumb vertical surface. Footings shall be approved by the Project Representative prior to post installation.

2.7 SWING GATES

A. Include the entire assembly to make an [Specify foot height] high gate system to match fence height and either galvanized or PVC coating. Unless otherwise specified, PVC and galvanized coatings shall be identical to fabric. Refer to Article 2.1.

1. Frames:

a. Conform to ASTM F 900 Type 2, Class 2.

b. 2”dia. SS20 steel pipe

c. [REVISE THE FOLLOWING TO MEET PROJECT REQUIREMENTS] PVC coated galvanized steel gates shall have separate steel gate corner sections mechanically (multiple screws) secured to the frame pipe. Galvanized steel gates shall have welded corners. After fabrication the welded areas will be brush coated with ZRC Cold Galvanizing Compound (no exceptions or subsistutes permited) according to the manufactures specifications. Contractor will provide purchase receipts for ZRC and notify the Project Representative to inspect the fabrication and application fo the ZRC Cold Galvanizing Compound.

2. Hinges, Stops, Center Drop Rod and Keepers: Items shall be of structural steel and shall be of appropriate size and quality to accomplish hinges from not twisting and turning, plus holding the gate even with the rest of the fence. Latches shall keep the gates even with each other and/or the rest of the fence. Stops, center drop rod and keepers shall prevent the fence from going in undesired areas and/or directions for the purpose intended. All appurtenances shall match color of fence fabric..

3. Latches:

a. Double Gate Latch: Commercial galvanized steel as manufactured by DAC Industries, Inc., 615 Eleventh Street, NW, Grand Rapids, MI 49504; 800-888-9768.

b. Walk Gate Latch: Heavy duty galvanized as manufactured by DAC Industries, Inc., 615 Eleventh Street, NW, Grand Rapids, MI 49504; 800-888-9768.

4. Single Swing Gate Posts: Shall meet the following minimum size.

a. For less than 13ft. opening shall be 4” O.D. (at 9.11 lb/lf

5. Double Swing Gate Posts: Shall meet the following minimum size.
   a. 3ft. to 13ft. gate leaf shall be 4”O.D.(minimum) at 9.11 lb/ft

2.8 CANTILEVER SLIDE GATE

A. Frame Assembly

1. Gate Manufacturer - Furnish Fortress Heavy Duty Cantilever Slide Gate by Tymental Corporation, Greenwich, NY 800-328-4283. If an alternate is to be submitted, approval, prior to bidding will be required.

2. Gate Size – Furnish gate to accommodate width of clear opening as shown on drawings and desired height. [SELECT APPROPRIATE GATE(S) THAT FOLLOW] 1) Fortress Heavy Duty Gate opening to 30’ opening, 2) Fortress Structural Gate opening to 40’ opening, and 3) Fortress Box Frame to 60’ opening. Wider openings for unique situations will require two gates.

B. Power Opener System

1. For all Tymetal gates that require a power opener system, use [Select appropriate item for gate size)

   a. Tymetal TYM -2000 Chain Driver Operator for gates to 45’

   b. Tymetal TYM-VS2 Chain Drive Operator for larger gates./

2. For gate operator, [Select one or more of the following for each gate depending on the situation] 1. Key pad, 2) Card reader or 3) Remote 3 button operator.

C. Chain link fence fabric in gate shall match fence.

2.9 POST CAPS AND BRACE ENDS

A. Formed steel, cast malleable iron, or aluminum alloy, weather tight closure, cap for tubular posts, connection of braces to terminal posts [DELETE FOLLOWING IF NO TOP RAIL] and top rail. “C” shape posts shall not have cap. PVC coated to match fabric.

2.10 HOT DIP GALVANIZED ZINC COATING

A. Coat steel with a galvanized coating 0.30 oz/sf, in accordance with ASTM.

2.11 PVC COATING

A. Black (color to be approved); ASTM F668, Class 2b fused and adhered coating for specified parts. Unit ends shall be coated.

2.12 TENSION WIRE

A. 6 gauge core spring coil wire with 1) Class 2b PVC coating or 2) specified zinc coating, to match fabric

2.13 POST BRACE ASSEMBLY

A. 1-5/8" O.D. galvanized steel tubing at 1.35 lbs/lf and a 5/16-inch diameter truss rod and turnbuckle to be attached between end, pull or gate post and adjacent line post. [EDIT] Parts shall be PVC coated or zinc coating, to match fabric

2.14 TENSION (STRETCHER) BARS

A. One piece lengths equal to 2-inches less than full length of fabric with a minimum cross section of 3/16-inch x 3/4-inch or equivalent fiberglass rod. Provide tension (stretcher) bars where chain fabric meets terminal posts. Coating (if steel) to match fabric.

2.15 TENSION AND BRACE BANDS

A. Galvanized steel 12 gauge, 3/4-inch for 4-inch O.D. or less posts and 7/8-inch for larger posts. Parts shall be PVC coated.

2.16 TIE WIRES AND HOG RINGS FOR FABRIC ATTACHMENT

A. Rings shall be 6 gauge galvanized steel. Tie wires shall be 6 gauge galvanized steel. Parts shall be PVC coated.

2.17 TRUSS RODS AND TURN BUCKLE

A. PVC coated galvanized or galvanized coated steel rods with a minimum diameter of 5/16" to match fence fabric

2.18 TOP and or Bottom RAIL ASSEMBLY

A. [EDIT LINE] PVC coated galvanized or galvanized coated pipe to match fabic. Delete or edit if top and/or bottom rail assembly is not used.

PART 3 - EXECUTION

3.1 GENERAL

A. Conform to ASTM 567 with the exceptions noted herein.

3.2 FENCE INSTALLATION

A. Line Post Spacing: Set first corner, gate and pull posts first. Space line fence posts equally not exceeding 10-foot on center.

B. Corner, Gate, Terminal and Pull Post Footing: Only concrete footings shall be used and shall be 12-inch diameter x a minimum of 42-inch deep, shall be flush with the grade sloped to drain moisture away from the post. 2 inches of concrete shall be placed below the bottom of the post. Check each post for vertical and top alignment, and maintain in position during placement and finishing operations. Pull post footings shall be 10-inch diameter x a minimum 42-inch deep. Owners Representative will be notified sufficiently in advance so that an inspection of the concrete footing holes can be inspected

C. Line Post Footings: Shall be driven to the proper depth depending on the height of the fence in accordance with these specifications.

D. Fabric: Install fabric on security side and attach so that fabric remains in tension after pulling force is released. Leave approximately 4 inches between finish grade and bottom selvage. Fasten fabric to line post at 6 equally-spaced intervals. Fasten fabric to each tension wire at intervals not exceeding 18 inches. If new fabric abuts existing fabric, the new fabric shall be woven in the existing fabric at both ends of the 2 sections.

E. Tension (Stretcher) Bars: Pull fabric taut, thread tension bar through fabric and attach to terminal post with bands. One tension bar for each terminal and 2 for each corner or pull post.

F. Tension Wire: Attach directly to the fabric not less than 3 inches or more than 6 inches from the top of the fabric and 6 inches from the bottom of the fabric with appropriate steel clips to match the fabric.

G. Tension Bands: Six per terminal and pull post and 12 per corner post.

H. Top Rail: Shall be attached to the line, corner and pull posts by means of appropriate post caps securely fastened to the posts and fitted to the top rail. Fabric shall be attached to the top rail with tie wires at equal spacing not to exceed 1 ft.

3.3 SWING AND CANTILEVER SLIDE GATE

A. Install gate posts in accordance with manufacturer's instructions as well as specified in Article 3.2 B. Set keepers, stops, sleeves and other accessories into concrete and position out of the way of normal traffic but located to provide reliable performance.

B. Install gate plumb, level and secure for full operation without interference.

C. Attach hardware by means which will prevent unauthorized removal.

D. Adjust hardware for smooth operation and lubricate where necessary. Confirm that latches and locks engage accurately and securely without forcing or binding.

3.4 ADJUSTING

A. Fence and accessories shall be installed in strict accordance with the Drawings and Specifications in a workmanlike manner. Finished fence shall be in proper alignment with posts plumb, and fabric, tension and barb wires taut.

3.5 CLEANING

A. Fence installation will not be considered complete until excess excavated materials, cut wires, spilled concrete, and other debris, including the existing fence to be removed, resulting from the fence construction, is removed and legally disposed of off the Owner's property.

END OF SECTION 323113

SECTION 329200 - TURF AND GRASSES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Turf Seeding
   2. Slope Stabilization native forbs and grasses seeding.
   3. Low Profile Prairie native forbs and grasses seeding.
   4. Storm water Basin native forbs and grasses seeding.
   5. Fertilizer and mulch.
   6. Topsoil.

1.2 DEFINITIONS

A. Finish Grade: Elevation of finished surface of planting soil.

B. Manufactured Soil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

C. Planting Soil: Native or imported topsoil, manufactured topsoil, or surface soil modified to become topsoil; mixed with soil amendments.

D. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill immediately beneath planting soil.

E. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.
   1. Pesticides and Herbicides: Include product label and manufacturer’s application instructions specific to this Project.

B. All submittals must be received 30 days prior to installation.

C. Soil test including physical properties.

D. Chemicals and fertilizers to be used (including MSDS)

E. Top soil analysis

F. Certification of Seed: From seed vendor for each seed monostand or mixture stating the botanical and common name and 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.
   1. Mix labels: For certified seed mixes.

G. Material Test Reports: For existing surface soil and imported topsoil.

H. Qualification Data: For qualified landscape Installer.

I. Qualification Data: For qualified seed vendor.

1.4 QUALITY ASSURANCE

A. Native forbs and grasses Installer Qualifications: A qualified landscape Installer whose work has resulted in a minimum of ten (10) years successful native turf and stormwater basin establishment, ecological restoration, and projects of this scale.
   1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
   2. Installer must provide a list of recent native seeding project references with bid.
   3. Installer must be knowledgeable in plant identification both of seeded native species as well as weed species.
   4. Installer must provide list of plant and seed sources within ten (10) days of award.
   5. Installer must possess license for pesticide/herbicide application with public right-of-ways, aquatic applications and restoration.
   6. Acceptable Installers:
      a. Wildtype Native Plant Nursery, Inc., 900 N Every Rd, Mason, MI 48854, (517) 244-1140.
      b. Native Connections, Inc., 17080 Hoshel Rd, Three Rivers, MI 49093, (269) 273-1367.
      c. Michigan Wildflower Farm, 11770 Cutler Rd, Portland, MI 48875, (517) 647-6010.
      d. Cardno, Inc., 11181 Marwill Avenue, West Olive, MI 49460, (616) 847-1680

B. Soil-Testing Laboratory Qualifications: An independent laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

C. Topsoil Analysis: Furnish soil analysis by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; sodium absorption ratio; deleterious material; pH; and mineral and plant-nutrient content of topsoil.
   1. Report suitability of topsoil for lawn growth. State-recommended quantities of nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory topsoil.

D. Preinstallation Conference: Conduct conference at Project site.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Seed: Deliver seed in original sealed, labeled, and undamaged containers.

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 run-off, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.

C. Ensure that the cell packs and plugs of native plant cover are delivered moist and in good condition for planting. Review plants after delivery with the Landscape Architect and Owner.

1.6 PROJECT CONDITIONS

A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of Substantial Completion.
1. Spring Planting: May 15th to June 30th.
2. Fall Planting: September 1st to October 31st.
3. Native Seed Frost Planting: November 1st to December 31st.

B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit.

1.7 MAINTENANCE SERVICE

A. Initial Seeded Area Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until acceptable coverage is established, but for not less than the following periods:
1. Seeded Lawns: 90 days from date of Substantial Completion.
a. When initial maintenance period has not elapsed before end of planting season, or if lawn is not fully established, continue maintenance during next planting season.

B. Maintain and establish lawn by watering, fertilizing, weeding, mowing, trimming, replanting, and other operations. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth lawn.
1. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch. Anchor as required to prevent displacement.

C. Watering: Provide and maintain temporary piping, hoses, and lawn-watering equipment as required to convey water from sources and to keep lawn 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 lawn at a minimum rate of 1 inch per week.

D. Mow lawn as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 40 percent of grass height. Remove no more than 40 percent 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.

E. Schedule initial and subsequent mowings to maintain the following grass height:
   1. Mow Stormwater and Swale Seed Mix:
      a. First Year: Mow to 6-inch height when it has grown to a 12-inch height.
      b. Second Year: Mow to 8-inch height when it has grown to a 12-inch to 18-inch height.
   2. Mow Low Profile Prairie and Slope Stabilization Seed Mix:
      a. First Year: Mow to 4-inch to 6-inch height when it has grown to a 10-inch to 12-inch height.
      b. Second Year: Mow to 8-inch height when it has grown to a 12-inch to 18-inch height.
   3. Mow turf grass to a 2.5-inch to 3-inch height when it has grown to a 4-inch height.

F. Lawn Post fertilization: Apply fertilizer after initial mowing and when grass is dry.
   1. A phosphorous free fertilizer that will provide actual nitrogen of at least 1 lb/1000 sq. ft. to lawn area.

1.8 GUARANTEE FOR NATIVE FORBS AND GRASS SEEDED AREAS

A. A real coverage of the seeded areas will be at least 50% by time of 1 year warranty review after Substantial Completion.

B. No more than 10% (by real cover) of the seeded area will be dominated by perennial weedy species.

C. If these standards are not met, the Contractor will be responsible for supplemental seedings as approved by the Architect.

PART 2 - PRODUCTS

2.1 TURF SEED

A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances.

B. Fresh, clean, and new crop seed mixture. Each seed type certified blue or gold tag.
   1. Mixed by an approved method.
   2. Test for germination made within preceding six months. Not to exceed 0.25% weed seed. Seeding rates shall be determined by the percent pure live seed, where PLS = % pure seed x % germination x 100.
   3. Turfgrasses:
      a. **Standard Turf Seed Mix:**
         1) Earth Carpet “Survivor Lawn Mixture” as provided by Michigan State Seed Solutions, www.seedsolution.com, or approved substitute.
            a) 15% Kentucky Bluegrass.
            b) 30% Creeping Red Fescues.
            c) 40% Tall Fescue
            d) 15% Perennial Ryegrass.
            e) Perennial Ryegrass and Tall Fescues varieties must meet the minimum rating of 6.0 or higher for a seed tested at a Michigan location on the National Turfgrass Evaluation Program (NTEP) National Test.

4. Obtain the Owner's specific written acceptance for substitution of seed other than those named above. Proposed substitutes shall have essentially the same characteristics as seed specified in appearance, ultimate height, shape, habit of growth, general soil, and other requirements. Average cost and value of seed specified. Seed of greater value may be accepted without additional cost to the Owner.

2.2 ACCEPTABLE SEED SPECIES

A. The seed species that shall be used shall be obtained from one of the licensed nursery or seed companies listed below that normally handles or has experience handling native seeds, or approved substitute:
   1. Native Connections, 17080 Hoshel Road, Three Rivers, MI 49093, (269) 580-4765. http://www.nativeconnections.net
   2. Michigan Wildflower Farms, 11770 Cutler Road, Portland, MI 48875, (517) 647-6010. http://www.michiganwildflowerfarm.com/
   3. Wildtype Native Plant Nursery, Ltd., 900 North Every Road, Mason, MI 48854, (517) 244-1140. http://www.wildtypeplants.com/
   4. Cardno, Inc., 11181 Marwill Avenue, West Olive, MI 49460, (616) 847-1680 https://www.cardnonativeplantnursery.com

B. All seed shall be from Michigan seed stock, preferably obtained from local sources within 100 miles of the project site if possible. All species shall be true to species.

C. Substitutions: Submit list of growers for each plant species to be installed within 15 days following award of contract. Include substitution requests based on plant non-availability.
   1. Substitution requests after this period will not be accepted.

2.3 HYDROMULCH

A. Hydromulch slurry mixture is to be composed of a suitable rate of mulch and water to allow for even coverage of seed that will protect plant growth while allowing necessary light and water to penetrate.

2.4 MULCHES

A. Straw Mulch: Provide air-dry, clean, mildew- and seed free, salt hay or threshed straw of wheat, rye, oats, or barley.

B. Fiber Mulch: Biodegradeable, dyed wood, cellulose-fiber mulch; non-toxic and free of plant growth or germination inhibitors; with a maximum moisture content of 15% and a Ph range of 4.5 to 6.5.

C. Nonasphaltic Tackifier: Colloidal tackifer recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant growth or germination inhibitors.

2.5 WATER

A. Free of substance harmful to plant growth.

2.6 TOPSOIL, SOIL MIXES, SOIL AMENITIES

A. Topsoil: ASTM D 5268, pH range of 5.5 to 7, 4 percent organic material minimum, free of stones 3/8 inch or larger in any dimension, and other extraneous materials harmful to plant growth. Soil shall be a loam or sandy loam texture and free of debris.
   1. Topsoil Source: Import topsoil from offsite sources as necessary. Obtain topsoil from naturally well-drained sites naturally well-drained construction or mining sites where topsoil occurs at least 4 inches deep; do not obtain from agricultural land, bogs or marshes.

B. Lime: ASTM C 602, Class T, agricultural limestone.

2.7 PLANTING SOIL MIX

A. Planting Soil Mix: Mix topsoil with the following soil amendments in the following quantities:
   1. Ratio of Loose Compost to Topsoil by Volume: 1:3.

2.8 PLANTING ACCESSORIES

A. Selective Herbicides: EPA registered and approved, of type recommended by manufacturer for application.
   1. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
   2. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.
      a. Surfactant-loaded liquid formulation for post-emergent weed control; active ingredient: Glyphosate Isopropylamine Salt.

2.9 FERTILIZER

A. Commercial Fertilizer: Commercial-grade complete fertilizer for turf seed establishment shall be a starter fertilizer with a ratio of 1:2:1 for NPK.

2.10 MULCHES

A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

B. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic; free of plant-growth or germination inhibitors; with a maximum moisture content of 15% and a pH range of 4.5 to 6.5.

C. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

2.11 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.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive lawns and grass for compliance with requirements and other conditions affecting performance.
   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. Do not mix or place soils and soil amendments in frozen, wet or muddy conditions.
   3. Suspend soil spreading, grading and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
   4. Uniformly moisten excessively dry soil that is not workable and which is too 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 overspray.
   2. Protect grade stakes set by others until directed to remove them.

B. Provide 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.

C. Verify limits of seeding material with the Owner’s Representative in the field before starting seeding and sodding work.

D. Limit preparation to areas which will be immediately seeded.

E. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 4 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

F. Spread topsoil to a depth of 4 inches minimum - except to a depth of 6 inches on berms of contaminated soil - to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.

G. Fine grade to a smooth even surface with no 'bird baths', having loose, uniformly fine texture. Remove trash, debris, stones larger than 1-inches in any dimension, and other objects that may interfere with planting or maintenance operations.

H. Fine grade to within plus or minus 1/2 inch of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit fine grading to areas that can be planted in the immediate future.

I. Apply herbicides per manufacturer's written instructions. Delay seeding per manufacturer's written instructions.

J. Apply fertilizers by mechanical rotary or drop type distributor thoroughly and evenly incorporated with soil. Fertilize areas inaccessible to power equipment with hand tools and incorporate into soil.

K. Restore prepared areas to specified condition of eroded, settled, or otherwise disturbed after fine grading and prior to seeding and sodding.

L. Moisten prepared lawn areas before planting when soil is dry and allow surface to dry before planting.

3.3 HERBICIDES ON SEEDED AREAS

A. Apply 2 applications of herbicide to all soils to receive new perennial plants at least 1 month prior to plant installation. Applications to be applied at least 2 weeks apart with at least 2 weeks between last application and plant installation.
   1. Herbicide: Round-up® or approved substitute.
   2. Application rate and quantity: Per manufacturer's written instructions for complete weed kill-off.

B. Once both herbicide applications have occurred, do not turn up any more new soil, as this brings new weed seeds to the surface. Roll prior to seeding to firm the seedbed. Do not work soil further, but seed directly.

3.4 DRILL SEEDING/HYDROMULCHING TURF SEED

A. Turf seed mix shall be mechanically seeded with a "Brillion" or equivalent seeding machine. Do not broadcast or drop seed. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
   1. Do not use wet seed or seed that is moldy or otherwise damaged.
   2. Seed at the following minimum rates: Apply at 8 lbs per 1,000 square feet of pure live seed.
   3. Apply Commercial Fertilizer 1/2/1 at 200 lbs./acre.

3.5 SEEDING PRAIRIE, SLOPES, AND STORMWATER BASIN

A. Prairie and stormwater seed mixes shall be seeded with a native no-till seed drill or a culti-packer native seeder. Evenly distribute seed by seeding in multiple directions at right angles to each other.
   1. Sow seed at the rates as recommended by the manufacturer.
   2. Do not use wet seed or seed that is moldy or otherwise damaged.
   3. Mix clean, dry sand (or other inert filler) as a carrier for seed at a ratio of 1 part sand and 1 part seed.
   4. Criss-cross the seedbed several times to spread the seeds evenly.
   5. Bare, erosive soil should be lightly mulched with oat straw so that 50% of the soil still shows. Roll with lawn roller or tamp small area with rake or foot so seed will make good contact with the soil.

3.6 SEEDING PRAIRIE, SLOPE, AND STORMWATER BASIN MIXES

A. Seed application shall be as installed as stated in above paragraphs.

B. Seed shall not be covered with more than 1/4 inch of soil.

C. In places inaccessible to mechanical equipment, or where the area to be seeded is small, a hand operated cyclone seeder or other approved equipment may be used.

D. The seeding equipment shall be calibrated to sow the seeds at the rates and proportions as specified in the plans.

E. No fertilizers or soil conditioners will be required or allowed.

3.7 MULCHING

A. Hydromulch seeded areas within 24 hours after seeding.

B. Replace mulch displaced before grass has made a growth of 1-inch to 1-1/2-inch.

C. Provide straw bale checking in ditches or problem swales at intervals required to adequately slow water velocity and impede soil loss or other methods as required by governmental agencies.

D. During germination period, the Contractor shall protect and water seeded areas, maintain top 1/2-inch to 1-inch soil in a moist condition. Continue watering until turfgrass is established.

3.8 PREPARATION FOR EROSION-CONTROL MATERIALS

A. Prepare area as specified in "Lawn Preparation" Article.

B. For erosion-control blanket, install from top of slope, working downward, and as recommended by material manufacturer for site conditions. Fasten as recommended by material manufacturer.

C. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

3.9 SATISFACTORY TURF

A. Lawn 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% over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.

B. Use specified materials to reestablish lawns that do not comply with requirements and continue maintenance until lawns are satisfactory.

3.10 SATISFACTORY PRAIRIE, SLOPE, AND STORMWATER BASIN SEEDING

A. Real coverage of the seeded areas will be at least 50% by time of 1 year warranty review after Substantial Completion.

B. No more than 10% (by real cover) of the seeded area will be dominated by perennial weedy species.

C. If these standards are not met, the Contractor will be responsible for supplemental seedings as approved by the Architect.

D. Inspection and Acceptance of native areas.
   1. Reseeding: Parts of the seeded area that fail to show uniform development as determined by the Architect shall be reseeded and such reseeding shall continue until the Contractor produces a uniform stand of permanent native plants.
   2. Damage to seeded areas resulting from erosion or the Contractor’s operations shall be repaired by the Contractor until the native area is accepted.
   3. Final inspection of native area will be made at the conclusion of the maintenance period. Written notice requesting inspection shall be submitted to the Architect at least 10 days prior to the anticipated inspection date.

3.11 CLEANUP AND PROTECTION

A. Any soil, peat or similar material which has been brought onto paved areas by hauling operations or otherwise shall be removed promptly. Upon completion of planting, all excess soil, stones, and debris shall be removed from the site or disposed of as directed by the Owner. All planting areas shall be prepared for final inspection.

B. Promptly remove soil and debris, created by lawn work, from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

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 lawn is established.

D. Remove nondegradable erosion-control measures after grass establishment period.

3.12 ACCEPTANCE

A. Inspection to determine acceptance of installed turfgrass will be made by Landscape Architect.
   1. New turfgrass areas will be acceptable provided all requirements, excluding maintenance, have been compiled with.
   2. No individual turfgrass area shall have bare spots or unacceptable cover totaling more than 2% of the individual areas requested to be inspected.

B. Planted areas will be inspected at completion of installation and accepted subject to compliance with specified materials and installation requirements.

3.13 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by lawn work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Erect barricades and warning signs as required to protect newly planted areas from traffic. Maintain barricades throughout maintenance period and remove after lawn is established.

END OF SECTION 329200

SECTION 330524 – DIRECTIONAL DRILLING

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 design, furnishing and installation of a pipe crossing under a driveway, without disturbing the surface.

B. Related sections include the following:

1. Division 31 Section “Earthwork.”

1.3 REFERENCES

A. Except as herein specified or as indicated on the Drawings, the work of this section shall comply with the following:

1. ASTM Standard Specifications:

a. D2774 - Underground Installation of Thermoplastic Pressure Pipe.

b. F1962 - Guide for Use of Maxi-Horizontal Directional Drilling for Placement of Polyethylene Pipe or Conduit Under Obstacles, Including River Crossings.

2. MDOT:

a. Standard Specifications for Construction.
b. Standard Plans.

1.4 DESIGN AND PERFORMANCE REQUIREMENTS

A. Minimum Requirements:

1. The requirements herein and indicated on the Drawings are minimum requirements.

2. Select equipment necessary to provide the indicated finished product in the conditions present at the Project site.

3. Conform to more stringent requirements if necessary to produce the finished product.

4. Review of submittals by Engineer does not relieve Contractor from responsibilities under this Specification.

1.5 SUBMITTALS

A. Design Data to Include:

1. Method for directional drill.

2. Equipment and method for monitoring the location of the drill head.

3. Information on slurry mixture to be used.

4. Calculations and drawings to support and identify the pipe class, installation, thrust and tensile forces, and proposed pipe profile to be used.

5. Calculations and methods for buoyancy modifications during pull back.

B. Close-Out Submittals:

1. After completion of the directional drilling operation, provide an as-built drawing.
2. Drawing to Include:

a. Scale: Same as Project Drawings.

b. Tabulation of pipeline depth at 25-foot intervals referenced to a stationed alignment located above the pipe.

c. Each horizontal alignment point witnessed to two permanent landmarks.

1.6 QUALITY ASSURANCE

A. Installation Personnel Qualifications:

1. Trained and experienced in the use of directional drilling equipment and installation of the materials, for the specific application of this Project.

2. Knowledgeable of the design and in down hole drilling, impact of drilling in various geological formations, sensing and recording instrumentation and interpreting computer printout data.

3. Experienced in a minimum of 3 installations of similar or greater complexity and under similar conditions in the last 3 years.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Product Pipe:

1. High density polyethylene pipe.

2. Minimum SDR 9. Determine if thicker walled pipe is necessary based on the proposed drilling depth, Site conditions, and a reference internal design working pressure of pounds per square inch at elevation.

B. Drilling Fluids:

1. Organically inert.
2. Fluid composition must comply with applicable environmental regulations.
3. Select drilling fluid appropriate for conditions encountered at the site.

C. Detection Wire:

1. Copper wire, solid or braided, with coating to prevent oxidation and deterioration.
2. Minimum Gage: 12 AWG.

D. Staging Area Fencing:

1. Orange, plastic safety fence supported by steel fence posts.
2. Minimum Height: 4 feet.
3. Maximum Fence Post Spacing: 8 feet.
4. No vertical sags greater than 6 inches between posts.

E. Water: Contractor shall be responsible for supplying water required for the Work.

1. Water required for the performance of the Work may be obtained through the municipal water supply system. Contractor shall coordinate and pay for temporary connections and usage fees.

PART 3 - EXECUTION:

3.1 LINE AND GRADE

A. Pilot Hole Alignment:

1. [Follow the grade as submitted by Contractor and reviewed by Engineer:

a. Minimum Cover: 4 feet at ends and 4 feet elsewhere along pipeline unless otherwise indicated on the Drawings.

b. Alignment shall be uniform and not include high points greater than 25% of the pipe's inside diameter.]

1. Follow the grade of the ground surface:

a. Minimum Cover: 4 feet.
b. Do not create high points in the pipe.

2. Provide Engineer with a tabulation and plot of the pilot hole coordinate data at 25-foot intervals referenced to a datum line located above the entrance and exit elevations of the drill.
3. Obtain written acceptance of pilot hole alignment data from Engineer prior to reaming and pipe installation.

B. Final Product Pipeline: Allowable alignment deflection:

1. Horizontal: 5 feet.
2. Vertical: 2 feet.

3.2 STAGING AREAS

A. Drill Staging Area:

1. Disturb as little area as possible while providing adequate area for workers and equipment.

2. Keep area neat and orderly.

3. Install and maintain staging area fencing around perimeter.

B. Pipe Staging Area:

1. Disturb as little area as possible while providing adequate area for workers and equipment and to string, fuse and inspect pipe.

2. Keep area neat and orderly.

3. Install and maintain staging area fencing around perimeter.

4. Provide protection of exposed ends of pipe to prevent entry by children and animals.

C. Establish and maintain within right-of-way and easement boundaries identified by Owner.

D. Restore to original grade and condition after completion of work.

3.3 INSTALLATION

A. General:

1. Install pilot hole and pipe in conformance with the reviewed submittals.

2. Minimize subsurface disruption during pilot hole installation.

3. During pilot hole installation, notify Engineer immediately if partial or full blockage is encountered.

4. Complete operation as expeditiously as possible.

5. Disposal:

    a. Locate an acceptable site for disposal of drilling fluids and excess soils resulting from drilling operation.

    b. Be responsible for transport of materials to and from the drilling site to the disposal area as well as disposal costs.

    c. Disposal shall be in compliance with applicable environmental and right-of-way regulations.

B. Drilling Fluids:

1. Source:

    a. Supply materials required for drilling fluids including but not limited to water.

2. Inadvertent Returns:

    a. Minimize drilling fluid returns at locations other than drilling entry and exit points.

    b. Immediately clean up inadvertent returns.

    c. Be responsible for paying for costs and obtaining permits required for cleanup efforts.

    d. Be responsible to repair damage caused by inadvertent returns.

    e. Be responsible to repair, clean up, or replace, including temporary water supply required water supply wells affected by inadvertent returns.

C. Drill Head Locating:

1. Establish method for determining the location of the advancing drill head.
2. Calculate and plot true vertical depth, horizontal distance and right and left bearing drift.
3. Verify drill head location at least every 25 feet.

D. Prereaming:

1. Determine if prereaming is required.
2. If Prereaming is Performed:

    a. Determine required diameter to minimize subsurface disruption and allow unhindered pullback of the product pipeline.

    b. Ensure that annular space around product pipeline is stabilized to prevent settlement.

3. During the operation, monitor the movement of the reaming head to ensure the hole is free of obstructions along the walls which could reduce the cross section of the installed pipe or which may hinder the pullback of the product pipeline.

E. Placement of Pipe:

1. Pull Back:

a. Use appropriate connection equipment between product pipeline and pullback pipe to eliminate transfer of rotational forces to product pipeline.

b. Support pipe as required to ensure a smooth, freely moving pull back.

c. Control and limit tensile load on the pipe by devices such as hydraulic pressure regulators or load sensors.

d. The maximum tensile load on the pipe shall not exceed the maximum allowable recommended by the pipe manufacturer.

2. Detection Wire:

a. Tape the detection wire to the outside top of the pipe at 25-foot intervals.
b. Pull detection wire along with the pipe.

END OF SECTION 330524

SECTION 334000 – STORM DRAINAGE

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. Provide all labor, materials and equipment as necessary to complete all work as indicated on the Drawings and specified herein.

B. This section includes storm drainage systems.

C. Related sections include the following:

1. Division 01 Section “General Requirements - Temporary Facilities and Controls.”
2. Division 31 Section “Earthwork.”

1.3 DESCRIPTION

A. Storm and sanitary sewers shall be 2 separate systems.

B. New manholes and catch basins shall be precast construction except for bases.

C. Surface drainage shall be to catch basins; no storm water shall pass into a storm sewer without first passing through a catch basin.

D. Concrete storm sewer pipe shall use a rubber "O" ring joint.

E. Manholes and catch basins shall be constructed as specified herein and indicated on Drawings.

1.4 REFERENCES

A. Except as herein specified or as indicated on the Drawings the work of this section shall comply with the following:

1. AASHTO Standards M36 – Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains

2. M218 – Sheet Steel, Zinc-Coated (Galvanized) for Corrugated Steel Pipe.

3. MDOT:

a. 2012 MDOT Standard Specifications for Construction.
b. MDOT Standard Plans.

1.5 SUBMITTALS

A. Before commencing work, the Contractor shall provide an affidavit from the material manufacturers, that their materials meet the Specifications.

PART 2 - PRODUCTS

2.1 PRECAST CONCRETE SECTIONS

A. ASTM C-478: Cone section shall be eccentric to allow for a straight vertical ladder.

2.2 STRUCTURE BLOCK AND BRICK

A. Block: ASTM C-139.

B. Brick: ASTM C-139.

2.3 COVERS AND GRATES:

A. As specified on Drawings, or as indicated below:

1. Curb Inlet: EJIW 7045, M1 grate.

2. Square Inlet: EJIW 5105, M1 grate (for valley gutter pans).

3. Round Inlet – Light Duty: EJIW 1130, M3 grate.

4. Round Inlet – Heavy Duty: EJIW 1040, M1 grate for parking lots, M3 grate for walks – ADA compliant.

5. Manhole Structure: EJIW 1040, Type B – Vented cover.

6. Rolled Curb: EJIW 7065, M1 grate.

2.4 TRENCH DRAIN

A. Klassik Drain by Acodrain KS1005; or approved equal.

1. Drains: Part Number K1 through K3 sloped channels.
2. Universal Plastic Coatings: Part Number 96825.
3. Grates: ADA stainless grate DIN 19580 Class A.

B. Square Inlet: EJIW 5105, M1 grate (for valley gutter pans).

2.5 ADJUSTING RINGS

A. The inside diameter shall not be less than the diameter of the casting for which it is used.

B. Allowable types include:

1. Precast Reinforced Concrete: Without cracks. 2-inch to 6-inch thick, minimum 3000 psi. Reinforcement rod shall not be visible on the surface.

2.6 MANHOLE STEPS

A. EJIW 8500.

2.7 PORTLAND CEMENT

A. ASTM C150 Type 1.

2.8 HYDRATED LIME

A. ASTM C207.

2.9 SAND AND GRAVEL AGGREGATE

A. ASTM C33.

2.10 CONCRETE

A. Refer to Division 32 Section “Concrete Pavement.”

2.11 MASONRY CEMENT

A. ASTM C91.

2.12 CORRUGATED PERFORATED POLYETHYLENE DRAIN TILE

A. ASTM F405 with heavy sock.

2.13 PVC GASKETED DRAIN PIPE

A. Storm sewer up to and including 12-inch diameter and for pipe leading from catch basins.

1. SDR 35, ASTM D2729.
2. Other products as specified.
3. Rubber boot to connect pipe to structure.

2.14 REINFORCED CONCRETE PIPE

A. Storm Sewer 12-inch Diameter and Larger: ASTM C76.

2.15 CORRUGATED METAL PIPE

A. Manufacturers: Contec, Republic; or approved equal.

B. Pipe Material:

1. Galvanized (AASHTO M36) Zinc Coated Sheets (AASHTO M218).

2. Corrugations: Helical corrugations for shall form a minimum 45 degree angle with the longitudinal axis.

3. Pitch and Depth: 2-2/3-inch x 1/2-inch.

4. Wall Thickness: MDOT Class B.

5. Coupling Bands: Coating and wall thickness shall match pipes being connected. Type options:

a. Corrugated band with sleeve gasket.
b. Semi-corrugated band with O-ring.
c. Flat band with O-ring.

6. End Section: Flared end section.

2.16 INLET STRUCTURE SILT SCREEN

A. Silt-Saver sold by Price and Company, Inc. 425 36th St., SW, Wyoming, MI 49548; 800-248-8230, 616-530-8230; or approved equal.

1. SS-100A: Fits round structures to 48-inch ID.
2. SS-200A: Fits square structures to 60-inch OD.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Connections and changes in direction or grade shall be made in manholes.

B. Structure bases shall be cast-in-place concrete, transit mixed with minimum compressive strength of 3000 psi at 28 days, formed and finished level. Precast bases may be used with written approval of the Project Representative and where required by extremely difficult site conditions. Base slab shall be fully cured before precast portions are set.

C. Precast concrete shall be used to construct structures. Only when precast sections are not manufactured in the size and shape required will block constructed structures be permitted. The Project Representative shall be notified prior to construction of block structures. Set precast sections in full mortar bed.

D. Trench drains shall be constructed so that they sit on a foundation of a minimum depth of 42 inches, measured from finish grade to bottom of structure.

E. Adjustment to Casting Elevations:

1. Concrete rings shall be used wherever possible to adjust casting elevations. Rings shall be set in full mortar bed. Use a maximum of 3 rings.

F. Tile shall be laid through the manhole and 3000 psi concrete shall be placed around the tile up to half of the diameter. The concrete shall slope from the walls of the manhole to the sewer. When there is a change in grade, direction, or pipe size, the flow channel shall be built from bricks and 3000 psi concrete to make a uniform, smooth change in grade, direction or pipe size.

G. Vertical elevation of the invert shall be within plus or minus 0.04 foot (1/2-inch) of required elevation. Horizontal alignment must meet the same tolerance.

H. Pipe Connections to Structures:

1. Connections with existing sewers shall be made at points and in a manner indicated on the Drawings and approved by the Project Representative.

2. Sewers being disconnected shall be sealed off with concrete.

3. If PVC pipe connects to an existing or new structure, the pipe shall connect with an appropriately sized rubber boot.

I. Catch basin sump shall extend 2 feet below the pipe outlet invert.

J. Construct a peripheral sub-drainage system for catch basins.

1. Install 4-inch diameter perforated polyethylene corrugated drain pipe with a heavy duty sock covering around each new structure and existing structure, if at least 4 vertical feet is exposed or the outlet pipe is exposed.

2. Pipe shall enter catch basin with a tee connector, 2 inches above and directly opposite the outlet invert.

3. The peripheral drain pipe shall be positioned at 1/4-inch to provide positive drainage to the catch basin. The peripheral drain pipe shall be placed over the outlet pipe. Do not cut and cap the drain pipe at the outlet pipe.

4. Backfill the drain pipe with properly compacted Class II sand to the finish subgrade.

K. Treatment of field welds and damaged galvanized steel surfaces of culvert pipe:

1. Clean with wire brush.
2. Two coats of zinc-rich paint, conforming to Federal Specifications ML-P-21035.

3.2 TESTING AND INSPECTION

A. Internal Television Inspection of Storm Sewers:

1. General:

a. Inspect sanitary sewers using a closed-circuit color television camera.

b. Provide Engineer with videos DVD format and written logs to document the internal television inspection:

1) Written logs shall note the location of sewer laterals and pipe deficiencies by distance from the upstream manhole.

2) The video tape shall include audio commentary regarding the sewer condition.

c. Engineer will review the videos and written logs to verify that the storm sewers were constructed in accordance with the Contract Documents.

d. The videos shall verify that the storm sewers are clean and free of sediment and debris to the satisfaction of Engineer. Storm sewers not satisfactorily cleaned shall be promptly cleaned and reinspected by closed-circuit color television camera.

e. Television inspection shall be completed, documentation of television inspection shall be provided and Engineer shall determine that the sewers were constructed in accordance with the Contract Documents before payment for completed sections of sanitary sewer will be recommended to Owner.

2. Performance Requirements:

a. Inspection procedures and equipment shall meet the applicable standards as presented in the National Association of Sewer Service Companies (NASSCO) Recommended Specifications for Sewer Collection System Rehabilitation.

b. Each section of sanitary sewer between manholes shall be television inspected separately utilizing a video camera and related equipment specifically designed for the purpose of internal sewer inspection.

c. The camera speed shall not exceed 30 feet per minute.

d. The camera shall be stopped for no less than 10 seconds at the entrance manhole, each service lateral, exit manhole, and at points where the sewer is damaged or deficient.

e. Lighting for the camera shall be adequate to allow a clear picture of the entire periphery of the sewer and shall be varied as required to be effective for all pipe diameters inspected.

f. Cables and equipment used to propel the camera shall not obstruct the camera view or interfere with the documentation of the sewer conditions.

g. The video recording shall be continuous video file.

h. The mobile recording studio shall have adequate space to accommodate up to 3 persons for the purpose of viewing the video monitor while the inspection is in progress.

i. Whenever possible, the camera shall move in a downstream direction.

j. The location of the camera in the sewer shall be monitored by an accurate measuring system which records the distance traveled from the upstream manhole on the video.

k. Video DVDs and written logs shall be clearly labeled with the Project name and location identification.

l. If sewer has dirt and debris which prohibits video inspection, the sewer shall be cleaned and re-televised at no expense to Owner.

END OF SECTION 334000